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ABSTRACT

This document summarizes an empirical evaluation of the attributes of two alternative approaches to expanding public higher education in Texas: (1) expansion of existing senior institutions to meet projected enrollment for 1980, and (2) construction of new 4-year public institutions. The costs and benefits of higher education were estimated on a per student or per graduate basis, and were analyzed relative to both the individual and the State. Results indicate that the first alternative is cheaper but fails to encourage low income individuals to enroll in the system. A comparison of the effects of the alternatives on the State economy seems to indicate that (1) expected costs would be greater than the benefits, and (2) State tax revenues would not be significantly affected. (Author)

THE EVALUATION OF DECISION-RELEVANT ATTRIBUTES OF A PUBLIC SYSTEM OF HIGHER EDUCATION

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July 1970

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THE EVALUATION OF DECISION-RELEVANT ATTRIBUTES OF A PUBLIC SYSTEM OF HIGHER EDUCATION*

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This paper will summarize the empirical results of an evaluation of decision-relevant attributes of alternatives for the expansion of the public system of higher education in Texas. The actual numerical results will be presented as an example of the nature of the information which may be obtained from a similar analysis. However, the emphasis of this paper will be placed on the methodology involved in deriving the results and their implications for decisionmaking.

The analysis of an operating system requires that the broad objectives of the system be decomposed into implied sub-objectives, goals, or attributes. This process of sub-division should continue until a level is reached which may be associated with reasonable, preferably quantifiable measures of performance or "effectiveness." Alternative system modifications may be compared by computing their expected impact on these attributes. The resulting information may be synthesized in order to reduce the amount of information presented to the decisionmaker.

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The problem of identifying the objectives of education has been dealt with conceptually by several authors from several different viewpoints.(1) However, the actual results of attempts at estimating the implied performance measures or attributes are seldom presented. While estimates have been made of individual attributes, such as economic returns to the individual or the impact of education on a nation's GNP, these results are generally provided on the basis of their merit as individual items of interest.(2) In this paper, similar results will be derived in relation to their potential impact on the evaluation of alternatives.

The first section of this paper will present the general framework for the analysis. The second section will be devoted to the estimation of relevant attribute values associated with the obtainment of a college education by a citizen of a state. This information will be combined with other data in the estimation of the incremental effects associated with two alternative plans for the expansion of the public system of higher education in Texas. The results of the analysis will then be summarized and evaluated.

FRAMEWORK OF THE ANALYSIS

This study represents an attempt to identify and estimate those attributes of a system of public higher education which would be of relevance to decisionmakers representing the interests of a state;

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(1) The results of this paper are based on the discussion of the objectives of higher education presented in James S. Dyer, "Measures of Effectiveness in Higher Education," Working Paper 69-47, Graduate School of Business Administration, the University of Texas at Austin, presented at the TIMS XVI International Meeting, March 26, 1969.

(2) See the excellent bibliography in Klaus Hofner, "Economics of Higher Education and Education Planning--A Bibliography," Socio-Economic Planning Sciences, Vol. 2, No. 1, October 1968, pp. 25-101.

e.g., a state legislature and/or a board of public higher education. The primary factors which are considered relevant in this situation are estimates of the effects of alternative designs on the citizens of the state, direct costs and returns to the state, and indirect effects on the state economy. For convenience, the attributes may be dichotomized into two groups, "costs" and "benefits." "Benefits" will be used in reference to those effects of higher education which are generally conceded to be of positive worth to the state, while attributes of negative worth will be referred to as "costs." The use of this terminology does not imply that an attempt will or should be made to express all of the benefits and costs in terms of dollars.

The first section of the analysis deals with the identification of the costs and benefits associated with the graduation of one student from a public system of higher education. These data will be based on incremental costs, but on average return figures. The implicit assumption is made that the "quality" of the students who graduate from the system would not be affected significantly by the alternatives which are under consideration. Thus, this method would not be applicable to the evaluation of different teaching techniques unless the results in terms of student learning can be assumed constant, and the costs are the only question of relevance. The elimination of this limitation would require the development of test instruments which could differentiate among the results from different forms of education. Evaluation of these differences would provide additional difficulties. The costs and benefits which are discussed will be grouped according to the categories shown in Table 1.

Table 1

TAXONOMY OF BENEFITS AND COSTS

Benefits

- Returns to the Individual
- Returns to the State
  - Returns to the State from Increased Tax Revenue
  - Returns to the State Economy
  - Non-economic Returns

Costs

- Costs to the Individual
  - Direct Costs
  - Opportunity Costs
- Costs to the State
  - Direct Costs
    - Construction Costs
    - Operating Costs
  - Costs to the State from Foregone Taxes
  - Costs to the State Economy

The assumption that the quality of the educational outputs will not be significantly affected by the alternatives under consideration implies that the costs and benefits associated with different alternatives may be estimated indirectly from their anticipated impact on student enrollments. Incremental enrollment estimates may be projected into expected graduates. The costs and benefits associated with a graduate from the public system of higher education may then be multiplied by the incremental graduation figures to obtain estimates of associated costs and benefits for each alternative (see Fig. 1). This process will be illustrated in the following sections.

COSTS AND BENEFITS ASSOCIATED WITH A COLLEGE GRADUATE

This section will analyze the benefits and costs associated with a graduate from a system of higher education. The benefits, or expected returns, will first be considered. This analysis will deal with the estimation of returns to the individuals participating in higher education and the associated, expected returns to the State of Texas from this participation. Similarly, the costs of higher education to the individuals and to the State will be estimated.

Returns to the Individual from Higher Education

A portion of the cost of education can be considered as an investment in the human capital represented by the student. The return to investment can be broken into two components, private and social. The relevant private return consists of the higher present value of the expected income stream received by the student as the result of his education, as well as noneconomic benefits accruing uniquely to

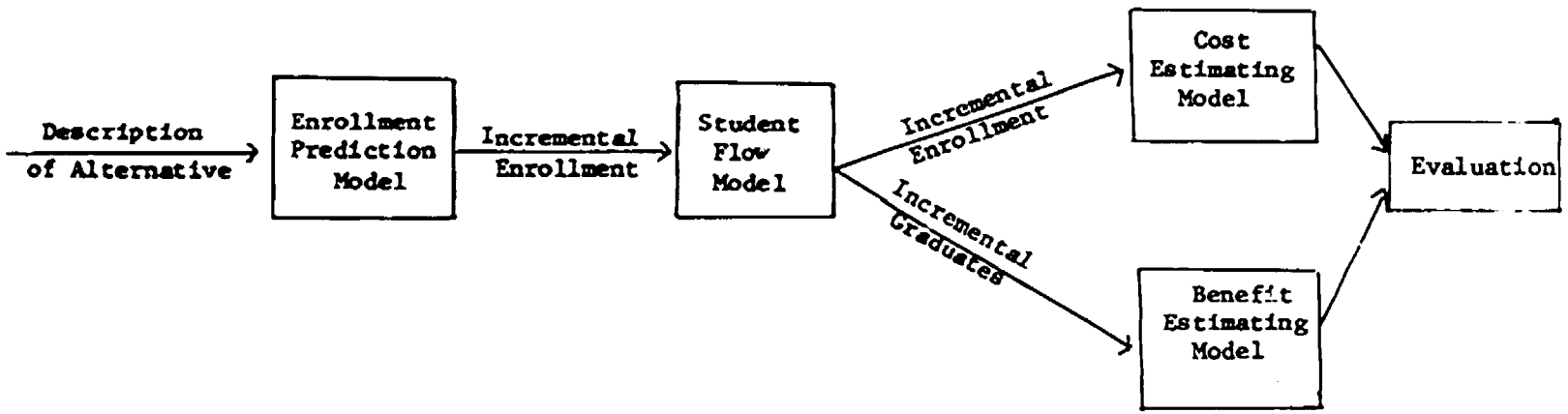
Description
of Alternative
Enrollment
Prediction
Model
Incremental
Enrollment
Student
Flow
Model
Incremental
Enrollment
Incremental
Graduates
Cost
Estimating
Model
Benefit
Estimating
Model
Evaluation

Fig. 1

the individual. The social returns represent benefits to the society as a whole or, relevant to this example, to the State. The economic return to the individual from a four-year institution of higher education will be considered in this section.

Several attemps have been made to estimate the economic benefits of a four-year college education to individuals. These studies are in agreement on the conclusion that persons with a college education have higher expected lifetime earnings than those who do not attend college.[3] However, the proportion to be allocated to education as the "cause" of the difference is not clear. For example, students attending college tend to be those who have displayed more ability in elementary and secondary schools. The greater ability of those attending college may cause a positive bias in the differentials between educational achievement and expected income.

The data which were used in this study were obtained from the U.S. Census and appear in Fig. 2. No attempt was made by the Census to adjust this data for the effects of ability. However, at least two studies have suggested that the adjustment for ability can be approximated by multiplying the expected income differential between groups achieving different educational levels by the constant .6.[4, 5]

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[3] See Hufner, op cit, and Andre Daniere and Jerry Mechling, "Direct Marginal Productivity of College Education in Relation to College Aptitude of Students and Production Costs of Institutions," The Journal of Human Resources, Vol. V, No. 1, Winter 1970, pp. 51-70.

[4] Burton A. Weisbrod, External Benefits of Public Education: An Economic Analysis, Industrial Relations Section, Princeton University, Princeton, New Jersey, 1964.

[5] E. F. Denison, "Measuring the Contribution of Education to Economic Growth," included in E. A. Robinson and J. E. Vaizey, ed., The Economics of Education, St. Martin's Press, New York, 1966.

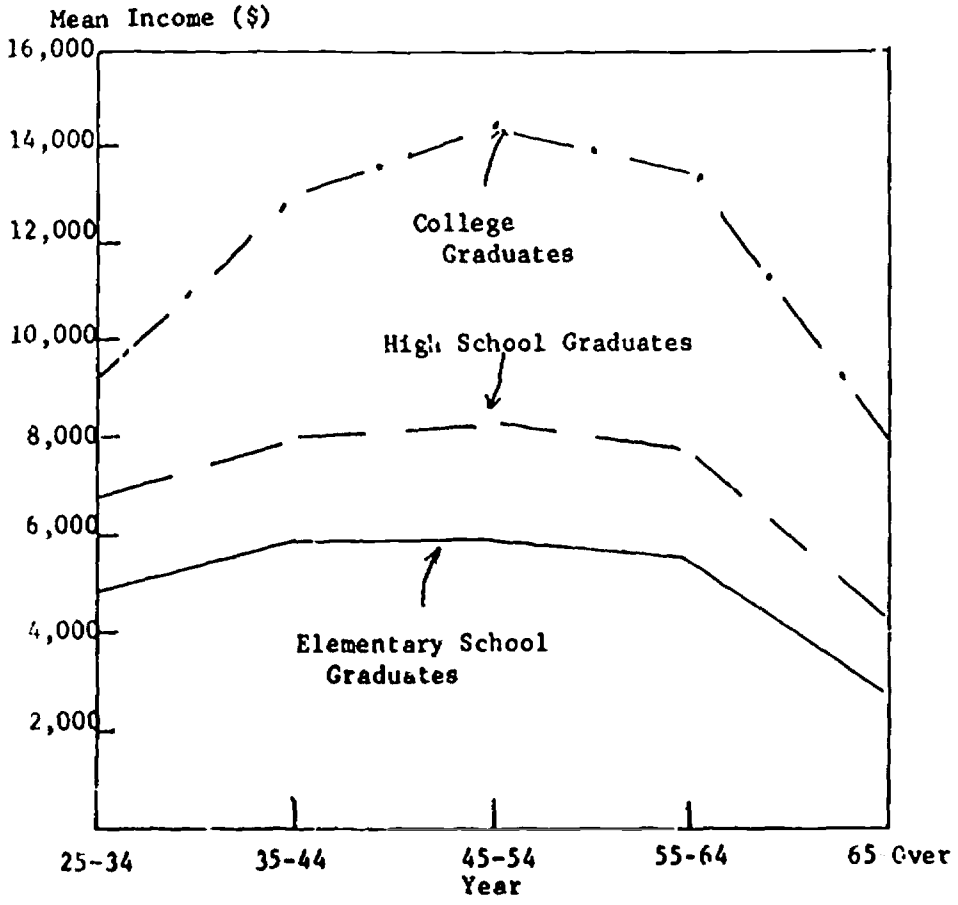

Figure 2

MEAN INCOME IN 1966 OF MALE ELEMENTARY SCHOOL, HIGH SCHOOL, AND COLLEGE GRADUATES, BY AGE, FOR THE UNITED STATES

SOURCE: U.S. Census, Current Population Reports.

Other factors will also serve to reduce the indicated gross effects of education on income. The increased income of the individual will be reduced in part by personal income taxes. The amount of the individual's tax will depend on his total family income and the number of exemptions he claims for his dependents. The approximate tax rate of the individual may be computed from the adjusted income figures. To obtain a rough estimate, the assumption was made of two exemptions until the age of twenty-five, four exemptions from age twenty-five to

age fifty, and two exemptions from age fifty to seventy-five. No income was considered after age seventy-five.

In addition, a 2 percent State sales tax and a 1 percent city sales tax must be paid on expenditures in Texas (in 1969). However, since the returns to education represent incremental income, a proportion would be expected to be saved, not spent. Therefore, the expected State tax rate was estimated from the allowable deductions from income as expressed in the Federal Income Tax Form 1040 instead of by direct application of these percentages. These deductions are a function of income and display the regressive features of a general sales tax.

The expected economic benefits to potential students in higher education will accrue over their lifetimes. Showever, since allocation decisions affecting their probabilities of attending institutions must be made at the present, the present value of these economic benefits should be calculated. Since disagreement exists with regard to the rate to use to discount the future income streams, two rates were used. The first rate was 5 percent, an estimate of the minimum retun that an individual can expect to obtain on savings; the second rate was 15 percent, an estimate of thr rate that an individual would expect to pay if he borrowed the dicounted value of the expected contribution of education. The benefits were discounted over the income producing life span of the individual, which was assumed to range from eighteen years of age to seventy-five.

The present value of the expected economic benefits of higher education to the individual were calculated on the basis of the following model:

$$PVRI = \sum_{t=4}^{58} \frac{(\Delta I_t)\ (.6)\ (1-T_t)\ (1-P_{dt})}{(1+r)^t}$$

where:

- PVRI is the present value of the expected economic benefit of higher education to the individual
- ΔI_t is the difference in average wage income between those with a college education and those with only a high school degree
- t is the time in years since graduation from high school
- .6 is the correction for ability
- T_t is the combined tax rate
- P_{dt} is the probability of death in year t
- r is the individual's rate of time preference.

The expected average income was taken from Fig. 2. Although large errors are invited by the use of cross-sectional data to approximate secular data, the use of a discount rate should reduce the effects of errors at later time periods.(6) The approximate tax rate for the Federal Income Tax deduction was taken from the current rates. Although the tax rate has increased over the past half-century, no adjustment was made in the income figures for inflation or increasing wages; this should compensate for some of the expected increase in Federal taxes. Once again, the discount rate should reduce the effects of errors at

(6) For a further discussion of this problem, see F. S. Pardee, et al, Measurement and Evaluation of Transportation System Effectiveness, RM-5869-DOT, The Rand Corporation, Santa Monica, California, September 1969, pp. 253-257.

later time periods. The probability of death at each age was taken from a mortality table.(7) The results indicate an expected economic return to individuals of $30,839 at a 5 percent discount rate and of $5,572 at 15 percent.

Returns to the State from Higher Education

RETURNS TO THE STATE ECONOMY

The economic benefits of higher education to the individual are computed above. The benefits for the State economy will not be the same. Necessary requirements for equality of the benefits include the following conditions: (a) the college-educated individuals do not replace other individuals in the work force, or alter their income; (b) no other individuals are able and willing to replace the college-educated individuals in the work force; (c) in the absence of higher education, the work force would not adapt to the labor shortages; (d) there are no secondary effects from the increase in income associated with the attainment of higher education; (e) the social rate of time preference is equal to that of the individual; and (f) the individuals receiving higher education remain in the State.(8) These conditions will be considered individually, and the implied modifications will be made on the model for computing individual benefits.

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(7) Samuel M. Selby, ed., Standard Mathematical Tables, 14th edition (Cleveland, Ohio: Chemical Rubber Company, 1964-1965), p. 583.

(8) Similar conditions are suggested by Michael E. Borus, "The Economic Effect of Retraining the Unemployed: A Study of the Benefits and Costs of Retraining the Unemployed Based on the Experience of Workers in Connecticut," Yale Economic Essays, Fall 1964, Vol. 4, p. 396.

With an economy at less than full employment, there is little reason to believe that college-educated individuals are displacing other persons in the labor force. The continuing long-run demand for individuals with a college degree is another indication that existing workers are not being displaced, as they are not being recruited for the available jobs. However, some jobs which could be performed by individuals without a college education may have the policy requirement of a college degree; this would reduce the effect on the economy of the incremental income associated with a higher education. The .6 adjustment factor for ability will be used as a conservative compensation for this effect.

In the absence of higher education, there is no reason to believe that the work force would adapt to labor shortages. However, employers would have the option of reducing the college degree requirements of some existing jobs and of increasing on-the-job training. The first option, if performance and income were not adversely affected, would reduce the economic effects of higher education. The second alternative would shift the responsibility for education from public institutions to private institutions, but the effect of the training on the economy would be virtually the same.

In a less than fully employed economy, such as exists in Texas, the increase in income and presumed increase in production associated with a higher education should have secondary effects which will increase the total benefit to the economy. The Council of Economic Advisors has estimated that the consumption multiplier is approximately two, and that the total transfer multiplier including induced invest-

ment is approximately three.[9] The more conservative estimate of two will be used.

The cost of capital to a state government is lower than to institutions engaged in private enterprise; this argues for the use of a low discount rate in the range of 5 percent in the analysis of governmental investment opportunities. However, the use of a low discount rate would bias the anticipated results of government sponsored projects over those of private industry. Therefore, a compromise rate of 10 percent was adopted.[10] Another factor affecting the relationship between the effects of higher education on the income of the individual and on the State economy is the probability that the individual who receives his education within the State will remain in the State during his income producing lifetime. The figure to be used in the adjustment for migration is .76.[11] No attempt was made to project this probability of migration into the future.

The model used to estimate the present value of expected benefits to the State economy of an individual's higher education is shown below:

$$PVSE = \sum_{t=4}^{58} \frac{(\Delta O_t)\ (M)\ (1-P_{dt})\ (1-P_{mt})\ (.6)\ (1-T_{ft})}{(1-r')^t}$$

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(9) Council of Economic Advisers, Annual Report of the Council of Economic Advisors, transmitted to the Congress, January 1964, Washington, D.C., U.S. Government Printing Office, 1964, pp.171-172.

(10) For a complete discussion of this problem, see U.S. Senate, Committee on Government Operations, Subcommittee on National Security and International Operations, Planning-Programming-Budgeting: Official Documents, 90th Congress, First Session, 1967.

(11) U.S., 1960 Census, Table 39.

where:

PVSE	is the present value of the expected benefits to the State economy of an individual's higher education
ΔO_t	is the expected increment in output attributable to higher education (which will be approximated by ΔI_t)
M	is the multiplier coefficient (2)
P_{dt}	is the probability of death at year t
P_{mt}	is the cumulative probability of migration at year t
.6	is the adjustment for ability
T_{ft}	is the Federal tax rate
r'	is the discount rate for the State (10%),

The results of the calculations from this model showed an expected benefit of $17,867.43 to the economy of the State of Texas from an individual's completion of a program of higher education.

RETURNS TO THE STATE FROM INCREASED TAX REVENUE

The preceding section has discussed the expected returns to the State economy from the benefits of higher education to the individual. The State can also expect an additional tax revenue from these same economic benefits; this revenue will compensate for some of the cost of higher education. The model used to estimate these expected benefits to the State government is shown below:

$$PVRS = \sum_{t=4}^{58} \frac{(T_t)\ (\Delta O_t)\ (M)\ (1-P_{dt})\ (1-P_{mt})\ (.6)\ (1-T_{ft})}{(1-r'')}$$

where: PVRS is the present value of the expected revenue returns to the State from an individual's higher education

T_t is the approximate combined tax rate for the State, and

r'' is the appropriate discount rate for the State. The assumption will be made that r'' = r' = 10 percent,

and the other variables are the same as in the previous model, PVSE.

The combined tax rate for the State, which should include sales taxes, excise taxes, and property taxes, was approximated from the deductions from income allowed in computing Federal Income Tax. The results of the calculations indicate that the State can expect an additional discounted return of $217.16 in taxes from an individual who has completed his higher education. This figure should be significantly higher in states which have income taxes in addition to a general sales tax.

The direct economic gains to the individual and the State from higher education are, on the average, sizable. However, a word of caution is necessary. The above discussion does not imply that if every high school graduate were to attend institutions of higher education, he would receive similar benefits. These income figures are heavily weighted with persons of high ability at the higher levels of educational achievement. Thus, these figures should be applied only to individuals with the necessary motivation and ability required for higher education.

NONECONOMIC RETURNS OF HIGHER EDUCATION TO THE STATE

Obviously, there are numerous noneconomic returns associated with higher education. Such factors as self-esteem and psychic benefits are difficult to quantify. In addition, the continuation of the social values and norms of a society, especially as they are manifested in the informal education of a child of college-educated parents, represents a benefit to both the individuals and society as a whole.

Another effect of higher education on both the individual and society is the reduction of unemployment. Education does not create employment (except for those working directly for the institutions) but makes the individual much more flexible in his ability to perform job tasks. Data from the U.S. Census and the U.S. Department of Labor indicate that the probability of an individual's being unemployed is reduced by 70.6 percent by a college degree with respect to his changes with a high school degree.(12) However, the words of caution with respect to the effects of higher education on expected income also apply in this case. Nevertheless, education should reduce a person's chances of being unemployed by increasing his flexibility; multiplying the 70.6 percent by the .6 adjustment factor for ability that was used for income would indicate approximately a 40 percent reduction in an individual's probability of unemployment attributable to higher education.

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(12) U.S. Census, 1960; and U.S. Department of Labor.

This conservative estimate will be used in subsequent calculations.

The increased participation of persons in the democratic processes is another effect of education of benefit to the individuals and to the society. For example, the voting rate of persons seems to be related to educational achievement.(13)

Certainly this brief discussion of the noneconomic effects of higher education is greatly over-simplified. No attempt has been made to exhaustively consider each possible effect of education. Instead, the objective has been to emphasize that some--and perhaps the most important--benefits of higher education are not measurable economically, and only crudely measurable, if at all.

Analysis of Cost Data

This section will consider the cost of the expansion of a system of higher education. The costs of such an expansion include operating costs, costs to potential students, and costs to the economy of the State, as well as the expected costs of the physical facilities.

Any estimates of the costs of a function of a State government are obviously dependent on many exogenous factors, including a State's population growth, trends of migration, and general economic and political conditions. In addition, other variables more directly related to higher education will have definite effects on its cost. One of these variables is the nature and change of college enrollments in Texas. The enrollment projections which were used in this study were

(13) A. Campbell, W. Miller, P. Converse, and D. Stokes, The American Voter (New York: John Wiley, 1960).

based on current trends, whose change could drastically alter the results. In addition, policy changes with respect to the level of admission requirements and tuition charges could affect the actual college enrollments. Finally, the number and distribution of new State colleges could alter the expected enrollment and associated cost of the higher education system.

COST OF HIGHER EDUCATION TO THE INDIVIDUAL

Direct Costs to Students

There are two significant costs to the individual involved in higher education, the direct cost of higher education in the form of tuition, fees, books, etc., and the cost of income lost during the educational period. The direct costs of higher education will differ from a list of expected out-of-pocket expenses, since the costs not directly associated with higher education are not included. Estimates of the direct costs of higher education to the individual are shown in Table 2.

Cost of Foregone Earnings

The estimate of the cost of foregone income is more difficult to obtain. A study by Theodore W. Schultz in 1960 estimated the annual income foregone by students attending a college or a university at $1,943 in 1956.[14] A conservative adjustment of this figure for 1969 would be $2,250.

[14] Theodore W. Schultz, "Capital Formation by Education," Journal of Political Economy, 68, December 1960, p. 575.

COSTS TO THE STATE OF HIGHER EDUCATION

Direct Costs to State

Physical Facilities. The enrollment projections for the State of Texas show that 345,000 are expected to seek enrollment in the public four-year college and university system by 1980.(15) The estimated enrollment in this system in 1968 was 211,797, indicating a need for expansion of capacity by approximately 133,203, or 63. percent.

Table 2

DIRECT COST OF HIGHER EDUCATION TO THE INDIVIDUAL SINGLE STUDENT

Budget Items	2-Year Public	2-Year Non-Public	4-Year Public	4-Year Non-Public
Tuition	$135	$509	$100	$834
Fees	$51	$33	$72	$73
Room	$279(0)[1]	$232(0)	$388(0)	$302(0)
Books	$150	$150	$150	$150
Travel	$180(300)	$180(300)	$180(300)	$180(300)
Total	$795(636)	$1,124(1,012)	$890(622)	$1,539(1,357)

[1] Amounts in parentheses are those allowed for commuting students when allowable amounts are different from those for resident students.

SOURCE: John J. O'Hearne and H. Paul Kelly, A Survey of College Student Financial Aid in Texas, with Projected Needs Through 1980, A report to the Coordinating Board, Texas College and University System, April 30, 1968.

(15) Coordinating Board, Texas College and University System, Enrollment Projections for Texas College and Universities, 1968-1980--and Tentative Proposals for Establishing New Public Senior Colleges, May 29, 1968.

The cost of constructing facilities for a new four-year public college has been estimated by the Coordinating Board, Texas College and University System, for capacities of 2,000, 4,000, and 6,000 students.(16) These costs are approximately linear, especially for the incremental increases of students from 2,000 to 4,000 and from 4,000 to 6,000, which average $5674/student and $5646/student respectively. The costs for the initial 2000 students average $5922/student.These results seem to imply that while some "fixed costs" are associated with an institution of higher education, the majority of costs vary linearly without displaying significant associated "economies of scale." These figures were used for estimations in this study, and a cost of $5,625/student was used for estimations of incremental expansion costs above 6,000 student capacity.

The Coordinating Board has suggested that the cost of expanding the existing institutions would not differ significantly from the cost of establishing new institutions. This observation is due in part to the linearity in costs noted above. Therefore, the amount of $5,625/student was used as an estimate of the costs of expansion in existing institutions. An increase of 4.5 percent per year was used as an adjustment for rising inflation costs.

Since the costs of constructing new facilities are approximately equal to the costs of expanding existing facilities on a per student basis, the cost of facilities would seem to be a factor that should be ignored in the consideration of alternative designs for a higher

(16) Coordinating Board, Enrollment Projections ..., op. cit.

education system. However, if the expected enrollments under the alternative designs differ, the cost of the additional facilities needed to meet the incremental enrollments must be considered.

Operating Costs. The operating costs of the higher education system of Texas are similar to the expected construction costs in that, assuming equal enrollments, the costs would be approximately the same at a new institution as those incurred in the expanded portion of an existing institution. As a general rule, the amount allocated per student or per semester credit hour is increased by 5 percent a year to cover inflation and the rising costs of higher education. The cost per student during the 1965-67 biennium was approximately $340.00 per year.(17)

Cost to the State from Foregone Taxes

The lost tax revenue to the State is a function of the foregone income of students. This foregone income was estimated above to be approximately $2,250. The resulting lost tax revenue may be estimated from the 1040 Federal Income Tax allowments. This form indicates that approximately $50 from a personal income of $2,250 would be expected to be paid in State taxes in Texas per year. Therefore, an amount of $50 per student per year was used as an estimate of foregone tax revenues due to the existence of higher education in Texas.

(17) Coordinating Board, Texas College and University System, Statistical Supplement to the Annual Report of the Coordinating Board, Texas College and University System for Fiscal Year 1966 and Fall Semester 1966, Austin, Texas, February 15, 1967, p. 90.

Cost to the State Economy

The cost of higher education to the State economy will consist of the total resources devoted to the process, including the opportunity costs of individuals participating in higher education. These costs were estimated to be $2,250 per year for each full-time student.

The other costs of higher education to the economy of the State result from the resources devoted to the educational process. These costs include general administration, instruction, library, organized research, physical plant operation and maintenance, and special items. An estimate of the total cost of higher education to the State economy could be developed from the sum of the direct and foregone costs.

AN ILLUSTRATIVE EXAMPLE OF AN ANALYSIS OF ALTERNATIVES

This section will use the data developed in the preceding sections in an analysis of two alternative plans for the expansion of the public higher education system in Texas. The basis for the selection of the two alternatives which were considered will first be explained. The relevant costs and benefits attributable to the first alternative will be computed. After a consideration of the effects that the second alternative would produce in the system, corresponding costs and benefits will be calculated.

Determination of Alternatives

The alternatives affecting the higher education system of Texas could result from two endogenous sources: (a) changes in policies, or (b) changes in physical facilities, especially with regard to the location and number of institutions. Although both classes of alternatives may be amenable to empirical analysis, proposed changes in physical facilities will be considered in this study.

The anticipated increase in enrollment in the public higher education system of Texas could be met through the expansion of the existing institutions. However, the location of institutions of higher education within densely populated areas in order to provide low-cost education via the opportunity for commuting would appear to be desirable. Thus, the alternatives to be considered are described below:

1. The currently existing senior institutions will be allowed to expand their capacity without limit to meet the projected enrollment for 1980. The junior college system will also be expanded to meet the projected enrollment demands. No new senior institutions will be constructed. Current admission requirements and other policies will be continued.

2. New four-year public institutions will be built in Fort Worth, Dallas, Corpus Christi, and San Antonio. The enrollment limitations suggested by the Coordinating Board, Texas College and University System, will be instituted where necessary.[18] The assumption will be made that the junior college system will be expanded to meet the projected enrollment demands, which will not be significantly affected by the establishment of of the new senior institutions or the enrollment limitations.

The following sections will use the previously developed data to evaluate these alternatives. Because of the massive amount of data, a summary and analysis will be presented in a separate section.

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[18] Coordinating Board, Enrollment Projections, op. cit.

Expansion of Existing Facilities

The analysis of the costs and benefits of alternative number one, the expansion of the existing facilities of higher education, will be organized according to the outline shown in Table 1.

Before evaluating the first item on the outline, returns to the individual, expected enrollments associated with the first alternative must be estimated. The calculations of the direct incremental costs and benefits of the expansion and operation of the existing institutions will be made relative to the projected incremental enrollments shown in Table 3. The assumption will be made that the additional facilities will have a useful life of 40 years. It will also be assumed that new facilities will be used for this incremental enrollment over the entire period. This assumption would be in order if enrollments continue to grow or level off at a figure above the projections of Table 3. The increasing societal emphasis on education would seem to justify this expectations.

Incremental enrollments will be the most important figures in the analysis. Given these estimates, both costs and returns may be estimated from expressions of the form

$$Est = \sum_{i=1} \frac{(\Delta S_i)(X_j)}{(1+r_j)^i}$$

where Est = the estimate of the total cost or return in a particular area,

ΔS_i = an estimate of the expected incremental number of college students or graduates in a particular year as a result of the alternative under consideration,

Table 3

EXPECTED ADDITIONAL ENROLLMENTS

Year	Expected enrollment increase
1969	13,600
1970	29,500
1971	48,600
1972	58,700
1973	68,400
1974	78,600
1975	88,300
1976	98,100
1977	108,600
1978	117,800
1979	125,800
1980	133,400

X_j = the estimated incremental cost or benefit per college graduate (or per student) in area j as computed in the previous section,

r_j = the appropriate discount rate, and

I = the set of indices of the years over which the costs or benefits are expected to accrue.

In the average four-year State-supported college or university, approximately 40 percent of the enrollment are freshmen, 22 percent are sophomores, 18.5 percent are juniors, and 18.5 percent are seniors.[19] In other words, 18.5 percent of the expected increase in enrollment each year can be used as an estimate of the expected increase in college graduates resulting from the increased enrollment. These data form the basis for a Markovian matrix of transition probabilities which would also be of use for other purposes requiring predictions of the student flow through institutions.

[19] James S. Dyer, Cost-Effectiveness Analysis for a Public System of Higher Education, unpublished Ph.D. dissertation, Graduate School of Business Administration, The University of Texas at Austin, August 1, 1969.

ANALYSIS OF RETURNS FROM THE EXPANSION OF THE OLD FACILITIES

Returns to the Individual

The expected economic returns from the expansion of the existing facilities of higher education can be estimated from the expected incomes of college graduates as described in the preceding section. The expected economic benefits associated with these graduates were discounted twice with rates of 5 and 15 percent. The assumption was made that the expected benefits will increase at a rate of 2 percent a year. Under the conservative assumption that the economic benefits of higher education accrue only to graduates, the total discounted returns to individuals over the assumed forty-year life of the facilities was estimated to be $14,544,636,373 at 5 percent and $651,542,907 at 15 percent. No attempt was made to objectively measure the noneconomic benefits of higher education to the citizens of Texas.

Unfortunately, the size of these figures makes them difficult to comprehend and limits their value as as aid in decisionmaking. Therefore, the formula

$$A = \frac{PV}{F(i, 40)}$$

was used to convert the total discounted present values into equivalent annual annuity figures. The F(i, 40) represents the appropriate annuity factor associated with an interest rate i and a time span of forty years. The results were equivalent to an expected return to the graduates from the public higher education system of $847,633,100 per year at 5 percent and $98,094,385 per year at 15 percent. These results are presented in Table 4 along with analogous figures for the other benefits associated with the first alternative.

Table 4

EXPECTED BENEFITS FROM THE EXPANSION OF THE EXISTING FACILITIES

	Present value	Annual Annuity
Direct economic benefits to the individuals:		
5 percent	$14,544,536,373	$847,633,100
10 percent	651,542,907	98,094,385
Benefits to the State (at 10 percent)		
Returns to the State from increased tax revenue	53,036,691	5,423,291
Returns to the State economy	3,540,032,747	362,003,553
Noneconomic returns (1980)		
Expected number of additional voters in a Presidential election		30,076
Expected reduction in unemployed		3,853

Returns to the State

These same assumptions were used to estimate the expected benefits to the State from additional tax revenue and to the State economy as a consequence of the incremental increase in the income of individuals. Measures of noneconomic returns from higher education are more difficult to estimate. Two possible indicators of the effectiveness of higher education relating to the objective of "producing citizens responsive to the social, economic, and political needs of their time" are the voting rate and the unemployment rate. The latter consideration could also be related to the objective of "accelerating the economic progress of the citizens."[20]

[20] Dyer, "Measures of Effectiveness in Higher Education," op. cit.

The effects of the expansion of the existing facilities of higher education on the voting rate in Texas can be roughly estimated. Since approximately 66 percent of the enrollment in the public institutions of higher education are males, these results indicate that an "average" group of high school graduates could be expected to have a voting rate of 50 percent, while an "average" group of college graduates would have a rate of 78 percent (using the figures for individuals younger than 34 years of age.)[21] The total incremental expected number of graduates from 1968 to 1980 under the alternative of expanding the existing institutions is 178,368. Multiplying this total by the expected voting rates indicates that 89,000 would be expected to vote in a Presidential election in 1980 if they had only high school degrees, while 139,127 would be expected to vote if the group had a college education, a difference of 50,127. Even if this number were reduced by the .6 correction factor used for incomes, the result would still be an expected increase in voters in the Presidential election of 1980 of 30,076.

A similar analysis can be applied to the effects of the expansion of the higher education system on the unemployment rate of Texas. The unemployment rate for high school graduates is 5.1 percent versus 1.5 percent for college graduates. Using these rates as approximations of the current rates in Texas, a reduction in unemployed individuals by 6,422 could be expected from the increased enrollment in higher education in 1980. Reduction of this figure by the .6 factor would still result in an expected decrease of 3,853 in the unemployed.

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[21] Campbell, et. al., op. cit.

The assignment of any economic value to these effects will not be attempted. These numbers are only meant to serve as "indicators" of the achievement of objectives, and are not to be considered as sub-goals.

ANALYSIS OF THE COSTS OF EXPANDING THE EXISTING FACILITIES OF HIGHER EDUCATION

The costs of the alternative of expanding the existing facilities of the State of Texas to meet the growing demand for higher education will be considered in two distinct parts: (a) the incremental expected costs to the individuals of the State, and (b) the incremental expected costs of this alternative to the State.

Costs to the Individual

The cost of this alternative to the individual students results from two sources: (a) the direct costs of higher education, and (b) the opportunity costs represented by the foregone income that is the result of attending institutions of higher education. Both of these costs were estimated twice, with discount rates of 5 to 15 percent. The assumption was made that both direct costs and opportunity costs increase at the annual rate of 2 percent. In addition, the assumption was made that 50 percent of the students in the public system of higher education commute, so that the weighted average direct cost of higher education per student per year may be estimated to be $756.[22] This figure was multiplied by the anticipated incremental enrollments and discounted. The results of these and other cost estimates are presented in Table 5.

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[22] Dyer, Cost-Effectiveness Analysis..., op. cit., p. 190.

Table 5

EXPECTED COSTS FROM THE EXPANSION
OF THE EXISTING FACILITIES

Costs to the individual	Present value	Annual annuity
Direct costs		
5 percent	$1,928,314,784	$112,379,205
15 percent	478,485,436	72,039,361
Opportunity costs		
5 percent	5,739,061,840	334,463,654
15 percent	1,423,986,080	214,391,159
Costs to the State (10 percent)		
Direct costs		
Construction costs	553,385,121 *	
Operating costs	1,621,440,320	165,808,681
Costs to the State from foregone taxes	53,245,964	5,444,929
Costs to the State economy	6,122,540,134	626,090,616

*This figure is equivalent to the required investment cost and is not presented in the form of an annuity.

Costs to the State

Direct Costs. Calculations of the direct incremental costs of the expansion and operation of the existing institutions were made relative to the assumption that the enrollment figures for the fall of 1968 represent the enrollment capacity of the currently existing institutions. The assumption was also made that construction costs would be appropriated from the Legislature in two-year intervals to meet the expected increases in enrollment shown in Table 6. From these enrollment estimates and the previous estimate of $5,625/student for expanding the capacity of the existing facilities, an estimate

was made of the total discounted cost of constructing the required facilities.

The operating cost incurred under the alternative of expanding the existing institutions of higher education in Texas can be estimated in a similar manner. The estimated expenditures per student from the State's general revenue fund during the 1965-67 biennium was $680. The figures indicate an approximate increase in appropriations of 5 percent a year or 10 percent per biennium.

Costs to the State from Foregone Taxes. Additional costs of this alternative to the State of Texas will now be considered. These costs represent the loss of tax revenues from the student's opportunity costs. The expected lost tax revenues from the foregone incomes of $50 per student per year were multiplied by the expected enrollment increases each year and discounted at 10 percent.

Table 6

EXPECTED INCREMENTAL ENROLLMENT INCREASES OVER EXISTING CAPACITY

Year	Expected enrollment increase
1970	30,644*
1972	28,159
1974	19,900
1976	19,500
1978	19,700
1980	15,600

*Considers current underuse of capacity.

Costs to the State Economy. The cost to the State economy represents the cost of the resources devoted to the process, including the opportunity costs to the participating individuals. Therefore, a rough estimate of this cost may be taken from the sum of the other costs involved.

Addition of New Facilities

The analysis of the costs and benefits of alternative number two, the addition of new facilities of higher education, will now be considered. As the figures in a preceding section have indicated, the costs of building new facilities for higher education do not differ significantly from the costs of expanding the existing facilities. Therefore, if the expected enrollments are not affected by the addition of new facilities of higher education, the expected costs and benefits of the two alternatives will be approximately the same. The question of enrollment will first be considered. The remainder of the analysis will follow the same format as the previous discussion.

The Effect of the Addition of New Facilities of Higher Education on Expected Enrollment

The assumption will be made that all of those individuals who would choose to enter the public higher education system of Texas in the expanded system would also enter the system if additional institutions were built. In other words, the expected enrollment increase shown in Table 3 will occur. However, an additional enrollment increase will also be expected as a result of the new opportunity for residents of Fort Worth, Dallas, Corpus Christi, and San Antonio to commute.

The theoretical basis for this analysis is the assumption that the percent of eligible persons who will enroll in an institution of higher education is a continuous, monotonically decreasing function of the cost (both opportunity and direct). The form of such a function is shown in Fig. 3.

Notice that the point of 100 percent enrollment corresponds to a negative cost which, it is assumed, represents the positive inducement which would be required to reach this state. This function, denoted as F(c), is equivalent to a population distribution function. A reduction of the costs of higher education from c_1 to c_2 would result in an increase in enrollment corresponding the $N(F(c_2) - F(c_1))$, where N is the relevant total population. The empirical results derived from estimating F(c) and incorporating them into the enrollment prediction model of Fig. 1 may now be summarized.[23]

The size of the expected increase in enrollment over that associated with the expansion of the existing facilities can be estimated from the distribution of family incomes in the cities involved. The results of a chi-square goodness-of-fit test indicate that the distributions of incomes in Fort Worth, Dallas, and San Antonio do not differ significantly from the distribution of incomes within the State of Texas.[24] According to prior studies relating to expected parental contributions to the cost of higher education, the college-age population whose families have incomes within the $5,000-6,999 range can

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[23] For a discussion of other implications of this model, see George B. Weathersby, "Student Tuition Models in Private and Public Education," Office of Analytical Studies, University of California, Berkeley, California, December 9, 1969.

[24] Dyer, Cost-Effectiveness Analysis..., op. cit., p. 203.

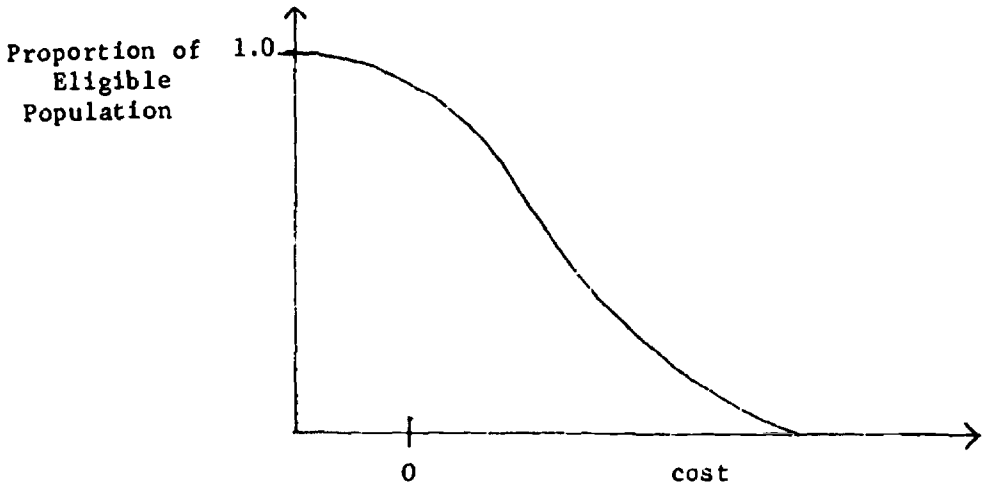

Fig. 3

only be expected to enroll if there exists a State-supported four-year institution within commuting distance.[25] Therefore, the number of families of potential students in these areas within the $5,000-6,999 income range represents the number of persons who would be given the opportunity to attend an institution of higher education by the construction of the new four-year public colleges.

The number of persons in this income bracket who would actually avail themselves of this opportunity for higher education may be estimated from data from The University of Houston, the only existing public four-year institution in a large urban area. In 1966, 13 percent of the students at The University of Houston were from families whose income was in the $5,000-6,999 range.[26] This 13 percent rep-

[25] Dyer, Cost-Effectiveness Analysis..., op. cit., p. 203.

[26] Joseph P. Schnitzen, "The University of Houston Freshman Class of 1967: A Description Summary based on the College Student Questionnaire--Part I," Counseling and Testing Service, The University of Houston, Houston, Texas, May 1968.

resents approximately 2,600 students. Since approximately 90 percent of the students at The University of Houston commute, and an even higher percentage of commuters would be expected from low income brackets, 2,600 was used as a conservative estimate of the number of students attending state institutions of higher education from Harris County whose families have incomes in the $5,000-6,999 range.

According to census data, the college-age population of Harris County in 1966 was 161,100. The number in the $5,000-6,999 income bracket can be estimated to be 33,025.[27] The 2,600 attending The University of Houston represents approximately 7.87 percent of this group, as compared with the college going rate for Harris County of 29.21 percent. This low percentage may be due in part to the attendance of other institutions of higher education by some of the individuals. A more likely explanation is the influence of social pressures within this income bracket, and the fact that the cost of higher education still represents a considerable sum when compared to the expected familial income.

The Coordinating Board, Texas College and University System, has suggested that the college-going rate for college-age individuals will increase over the next twelve years at the average rate of .90 percent per year. Since there is no reason to believe that this rate of increase will not be as fast within the $5,000-6,999 income group, the same figure may be used to forecast enrollments. These figures represent an estimate of the number of individuals who will be attending a four-year institution of higher education who would not have enrolled without the opportunity to commute.

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[27] Dyer, "Cost-Effectiveness...," op. cit., p. 205.

One final adjustment still remains for the projected enrollment. The University of Texas at Arlington lies approximately half way between Forth Worth and Dallas, within commuting distance for some of the students in the area. The results of a California study indicate that the rates of enrollment in four-year institutions decline 60 percent for persons twenty to thirty miles away from the college. Therefore, the assumption will be made that 40 percent of the individuals living in Dallas and Tarrant Counties who can attend institutions of higher education only if they commute, do so at The University of Texas at Arlington. To obtain an estimate of the incremental enrollment to be expected as a result of the construction of the new four-year institutions, the projections of additional enrollments must be reduced accordingly. The final resulting estimates are shown in Table 7.

In addition to the expected incremental enrollment, the expected number of incremental graduates in each year may be estimated from the fact that approximately 18.5 percent of the total enrollment of each year consists of seniors.

ANALYSIS OF RETURNS FROM THE ADDITION OF NEW FACILITIES

The assumption has been made that those individuals who would attend institutions of higher education if the existing institutions are merely expanded as considered in the first alternative would also attend institutions of higher education if new four-year urban colleges are built. Therefore, the returns to be expected from the addition of new facilities of higher education will be exactly the same as before except for the benefits accruing as the result of the expected incremental enrollment and graduates. These incremental expected

Table 7

ESTIMA E OF ENROLLMENT INCREASE AS A RESULT OF THE CONSTRUCTION OF INSTITUTIONS OF HIGHER EDUCATION IN DALLAS, TARRANT, BEXAR, AND NUECES COUNTIES

Year	Estimated incremental enrollment from the construction of new facilities
1969	6,375
1970	7,915
1971	9,118
1972	10,311
1973	11,574
1974	12,905
1975	14,306
1976	15,540
1977	16,816
1978	18,135
1979	19,497
1980	20,902
Total	163,394

benefits may be estimated in exactly the same manner as the benefits resulting from the first alternative. The assumption was made that these new institutions would be ready for classes in 1970. The results appear in Table 8.

Table 8

INCREMENTAL RETURNS FROM THE ESTABLISHMENT OF NEW INSTITUTIONS

	Present value	Annual annuity
Returns to the individual		
5 percent	$2,305,135,240	$134,399,719
15 percent	104,360,048	15,712,142
Returns to the State from taxes	6,885,124	704,072
Returns to the State economy	566,407,158	56,898,165

The noneconomic returns to the State from the addition of new facilities of higher education in Dallas, Tarrant, Bexar, and Nueces Counties can also be estimated using the same techniques as used in estimating the benefits from the expansion of the existing facilities. Using these techniques, and using the .6 correction factor, the addition of four new institutions of higher education could be expected to produce an additional 5,050 voters in a Presidential election by 1980. Also, 649 fewer people would be expected to be unemployed in 1980.

These noneconomic benefits of the addition of new facilities of higher education are incremental in that they are expected in addition to the benefits calculated for the expansion of the existing facilities of higher education.

ANALYSIS OF THE COSTS OF THE ADDITION OF NEW FACILITIES OF HIGHER EDUCATION

The techniques used to estimate the costs associated with the expansion of the existing facilities of higher education were used to estimate the costs from the additional enrollment expected as a result of the addition of new facilities with one exception. The actual cost of constructing new facilities of higher education differs from the cost of expanding old ones, so the costs of construction are computed differently. The costs have been summarized in Table 9.

Several assumptions are necessary for the estimation of the direct costs of constructing the facilities needed under the alternative of adding new facilities. The expected enrollment increases associated with the expansion of the existing facilities of higher education have been estimated in Table 3. The addition of the four new urban insti-

Table 9

INCREMENTAL COSTS FROM THE ESTABLISHMENT OF NEW INSTITUTIONS

	Present value	Annual annuity
Costs to the individuals:		
Direct costs		
5 percent	$ 305,609,865	$ 17,810,470
15 percent	77,517,652	11,670,830
Opportunity costs		
5 percent	909,602,913	53,010,251
15 percent	230,345,218	35,147,874
Costs to the State:		
Cost of facilities	89,138,343 *	
Direct operating costs	456,255,456	46,656,658
Lost tax revenues	6,954,691	711,186
Cost to the economy	$1,190,408,527	$121,731,110

*Investment

tutions will result in the additional expected enrollment shown in Table 10. In addition, Table 10 shows the total expected enrollment under the alternative of adding the four new urban institutions.

Since the costs of building new facilities differs from that of expanding new facilities, the total cost of constructing the new four-year institutions and expanding the existing institutions to meet the expected enrollment increase shown in Table 10 were calculated. The results were subtracted from the cost of expanding the existing institutions to determine the incremental costs. The assumption was made that the four new institutions are each constructed to a capacity of 2,000 students in 1970, expanded to 4,000 in 1972, and to 6,000 in 1974. The remainder of the expected enrollment increase would be met

through the expansion of existing facilities. These incremental costs of the new facilities are presented in Table 11. The incremental operating costs were calculated as before.

Table 10

EXPECTED ENROLLMENT INCREASE CONSIDERING THE ADDITION OF NEW FACILITIES

Year	Expected enrollment increase from the establishment of new facilities	Total expected enrollment increase
1970	7,915	38,559
1972	2,396	30,555
1974	2,594	22,494
1976	2,635	22,135
1978	2,595	22,295
1980	2,767	18,367

Table 11

ESTIMATED INCREMENTAL DISCOUNTED COST OF THE ADDITION OF NEW FACILITIES AND THE EXPANSION OF EXISTING FACILITIES OF HIGHER EDUCATION IN TEXAS

Year	Estimated incremental cost
1970	$42,305,934
1972	11,306,842
1974	10,849,213
1976	7,518,260
1978	8,746,067
1980	8,412,027
Total	$89,138,343

RESULTS OF THE ANALYSIS AND CONCLUSIONS

This section will summarize the comparison of alternatives developed in the previous section. The results indicate that the first alternative, the expansion of the existing facilities, is cheaper, but it does not encourage low-income individuals to enroll in the system.

The following discussion should be interpreted in light of previous caveats with regard to the available data, which in many instances were presented in forms not suitable for the required purpose, were incomplete, or were completely lacking. In these cases, approximations, interpolations, or "educated guesses" were made. In addition, the results are presented in terms of the discounted present value of monetary streams over a period of forty years or in terms of equivalent annuities. Such gross aggregations may obscure many important details.

Costs and Benefits of the Two Alternatives to the State of Texas

A comparison of the computed costs and benefits of the two alternatives under consideration reveals that each category shows an increase of about 16.5 percent associated with the alternative of constructing additional institutions. This result is due to the approximately linear relationship between anticipated increases in enrollment and the resulting costs and benefits.

Obviously, such a situation does not lead to a clear decision with respect to the alternatives. A more desirable situation would have occurred if the costs of the alternatives had been equal, so that the benefits could be compared, or vice-versa. However, this example

may be more common in actual practice in that additional benefits require additional costs. Therefore, an analysis of the impact of these costs and benefits in different sectors may be of interest.

The association of two or more categories of costs and/or benefits for the purpose of comparison and analysis must be considered somewhat arbitrary. However, such a process may be helpful in understanding the implications of the data. In the following tables, the alternative of expanding the existing facilities will be referred to as "expansion," while the alternative of constructing additional facilities of higher education in the urban areas will be referred to as "addition."

A Comparison of the Expected Increase in Enrollment with the Required Direct Costs

In Table 12 the expected increase in enrollment associated with each of the alternatives is compared with the required construction and annual operating costs of providing adequate space and facilities.

An analysis of the direct costs of the alternatives reveal that the State must be prepared to pay $553,385,121 in construction costs over the next twelve years in order to expand the existing facilities of higher education to meet the anticipated increase in enrollment. However, if new four-year public institutions are constructed by 1970 in Fort Worth, Dallas, San Antonio, and Corpus Christi, the total expected construction costs will be $642,523,464, an increase of approximately 16.3 percent.

Table 12

A COMPARISON OF EXPECTED DIRECT COSTS TO THE STATE WITH PROJECTED ENROLLMENTS

Source of costs and benefits	Alternative #1: Expansion	Alternative #2: Addition
Costs:		
Construction	$553,385,121	$642,523,464
Annual operating costs (1980)	45,391,020	52,497,700
Enrollments (1980):		
Incremental annual enrollment	133,400	154,302
Incremental annual number of graduates	24,679	28,546

A Comparison of the Effects of the Alternatives on the State Economy

The costs and benefits expected for the State economy are compared in Table 13. The expected costs to the State economy seem to be greater than the benefits at a ratio of approximately two to one. However, special consideration should be given to the manner in which the "cost" figures were calculated. The "cost to the economy of the State" was determined by summing the other estimated costs of higher education to both the individuals and the State, the assumption being that these "costs" would otherwise be injected into the economy of the State. These costs, being based on historical data, are relatively complete.

The benefits compared against these costs represent only the direct effects of the expected increased income of additional graduates from the public institutions of higher education in Texas. This estimate is conservative by design. For example, the choice of two as

Table 13

A COMPARISON OF THE EXPECTED EFFECTS ON THE STATE ECONOMY

Alternative	Benefits	Costs (10%)
Expansion		
Present value	$3,540,032,747	$6,122,540,134
Equivalent annuity	362,003,553	626,090,616
Addition		
Present value	4,106,439,905	7,312,948,661
Equivalent annuity	419,924,318	747,821,726

the proper economic multiplier was made in the interest of conservatism. The choice of three for the multiplier would increase the estimates of benefits shown above by approximately 50 percent. In addition, benefits were calculated only for college graduates; if the assumption were made that the benefits of a college education accrue linearly throughout the process, the number of dropouts completing one year of college could be weighted by one-fourth, the number completing two years by one-half, and the number completing three years by three-fourths, and added to the number of graduates. Finally, the costs include both the direct and operating expenses of the new facilities, which represent income to workers and investment potential for the owners of the construction firms. These funds will enter the economy of the State and will have the dual effect of increasing the "benefits" and reducing the "costs" reported in Table 13. Thus, this area is in need of additional theoretical study before any conclusions are drawn from the data.

A Comparison of the Effects of the Alternatives on Anticipated Tax Receipts

The expected tax benefits from the expansion of higher educatio are compared with the estimated foregone taxes in Table 14. The for gone taxes from the earnings of the individuals are approximately eq to the benefits which result from the greater expected income of the individuals participating in higher education. The expected tax revenues of the State do not seem to be significantly affected by the expansion of higher education. The point should be made again that Texas receives a relatively small proportion of its tax revenues from individual incomes.

Table 14

A COMPARISON OF THE EXPECTED EFFECT ON THE STATE'S TAX REVENUE

Source of costs and benefits	Benefits (10%)	Costs (10%)
Taxes from earnings:		
Expansion		
Present value	$53,036,691	$53,245,964
Equivalent annuity	5,423,291	5,444,929
Addition		
Present value	59,921,815	60,200,655
Equivalent annuity	6,127,601	6,156,116

Costs and Benefits to the Individuals of Texas

The expected effects of the expansion of higher education in Texas on the citizens of the State are compared in Table 15. Notice that the total economic benefits of higher education to the participating individuals in Texas are expected to exceed the costs by the ratio of approximately two to one at a discount rate of 5 percent. However, with a 15 percent discount rate, the situation is reversed. A rough interpolation would indicate an expected rate of return from higher education of approximately 10 percent for individuals in the State of Texas. This result compares favorably with the conclusions of similar studies.

The noneconomic benefits of higher education are not diectly associated with any of the costs. Table 16 presents a simple comparison of expected results from the two alternatives.

Table 15

A COMPARISON OF THE EXPECTED COSTS AND BENEFITS TO THE INDIVIDUALS OF THE STATE

		Benefits		Costs	
		Present value	Annuity	Present value	Annuity
Total costs and benefits:					
Expansion	(5%)	$14,544,536,373	$ 847,633,100	$7,6[illegible],376,624	$784,065,510
	(15%)	651,542,807	98,094,385	1,902,471,516	194,546,632
Addition	(5%)	16,849,671,613	1,723,046,488	8,882,589,402	908,333,102
	(15%)	755,902,955	77,196,334	2,210,334,386	226.028,672

Table 16

A COMPARISON OF THE EXPECTED NON-ECONOMIC BENEFITS OF HIGHER EDUCATION

Type of benefit	Number of persons affected
Increase in voters in a Presidential election in 1980	
Expansion	30,076
Addition	35,126
Decrease in Unemployment in 1980	
Expansion	3,853
Addition	4,502

Further Synthesis of the Information

Since much of the data presented in the preceding sections were expressed in terms of dollars, a reasonable synthesizing procedure might seem to be the addition of all "cost" and all "benefits" associated with each alternative. The difference, benefits minus costs, or the ratio of total benefits to total costs could then be used to select the "best" alternative. However, even dollars are not always commensurate decision criteria. In this situation, the decisionmaker may be expected to have different measures of "utility" or "worth" associated with an incremental dollar being added to the State economy instead of accruing to an individual from a low socio-economic group. In other words, not only the amount, but also the category into which

these costs and benefits accrue is important.[28]

Information presented in the form of costs and benefits by categories should be valuable in clarifying the expected results of different alternatives. However, unless one alternative is "better" in every category, the decisionmaker(s) is still faced with a problem requiring the subjective trade-off of these results. In some cases this process can be formalized to provide assistance in specifying preference.

After the desired level of detail has been achieved, each alternative a_i (i = 1 or 2 in this case) may be associated with a sequence of numbers $[x_1 (a_i), x_2 (a_i), \ldots, x_n (a_i)]$ which summarize the information relevant to a_i. These x_1 correspond to the incremental enrollments, discounted economic costs or benefits, expected voters, etc., associated with the alternatives. The attributes which were considered in this analysis were a subset of the attributes which could be affiliated with a system of higher education. If the preference of the decisionmaker(s) for the values of the x_i which have been included in this study are independent from values of the omitted considerations, then weak conditional utility holds.[29] In such a case, a ceteris paribus condition with respect to the unspecified attributes, regardless of their value, permits the determination of ordinal preferences for the x_i's. In particular, trade-offs and substitutions among the x_i would be allowed. Therefore, a simplification process

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[28] For a discussion of a possible approach to reconciling these difficulties, see F. S. Pardee, et. al., op. cit., Section IX.

[29] For a discussion of this approach, see Howard Raiffa, "Preferences for Multi-Attributed Alternatives." RM-5868-DOT/RC, The Rand Corporation, Santa Monica, California, April 1969.

could be applied whose eventual result would be the representation of the data in terms of a single numeraire, u_1, for each a_i. Although this procedure has not yet been attempted, the hierarchical structure of these goals lends itself to such an analysis.

The relevant question relating to the use of the technique is this: Are the attributes which have been selected inclusive of the primary considerations relevant to the decisionmaker(s)? If not, other objective statements and associated surrogates may be required. However, the addition of information to the attributes which are provided would only enhance the value of the data.

CONCLUSIONS

This paper has presented a summary of the methodology and results from an empirical evaluation of attributes associated with two alternative approaches to the expansion of the public higher education system of Texas. The numerical results may be of some interest, if only as a catalyst to further discussion and research. However, the emphasis has been on the methodology.

The costs and benefits of higher education were estimated on a per student or per graduate basis. Cost information was developed for the expansion of existing facilities and the construction of new facilities, for individuals, and for the State. The cost information is relatively complete and accurate due to the existence of numerous historical records.

Estimates of benefits were more difficult to obtain. Economic returns to the individual and the State were projected into the future, introducing uncertainty into the results. Therefore, conservative

adjustments were made in the computations. The estimate of economic benefits is also incomplete, for example, the effects of an adequate educational system on the attractiveness of a state to industry were not considered. In addition, no economic values were estimated for the "noneconomic" returns from higher education, as represented by an increased voting rate and reduced unemployment. Therefore, although the results indicated, for example, that the costs of higher education to the economy of Texas were greater than the economic benefits of either of the alternatives considered, the same result would be expected from a similar analysis of the presently existing public system of higher education.

The analysis was performed under the assumption that the outputs of the process were not affected by the alternatives under consideration. At best, such an assumption limits the value of the approach. Unfortunately, such assumptions may not only limit the value of such a study, but may actually have the effect of desensitizing the decisionmaker to "non-quantifiable" criteria. For example, a strong argument could be made for the notion that the education is inferior to that of a student in-residence due to the reduced peer interaction.

Despite these limitations, when performed properly, this type of analysis does force the recognition of the existence of the criteria on which decisions should be based. The method is not biased toward the "maximization" or "minimization" of one of the goals of an organization at the expense of the others as are most existing algorithmic approaches. The methodology's flaws and limitations appear to be the consequence of difficulties in determining objectives, obtaining data,

and predicting the future. These problems are present to a greater or lesser extent no matter what methods are used in designing a higher education system. Future research will be required to determine the practical potentials of the approach.

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