RESOURCE ALLOCATION IN HIGHER EDUCATION: A STUDY OF UNIVERSITY COSTS

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
Philip Edward Austin
1969

This is to certify that the

thesis entitled

RESOURCE ALLOCATION IN HIGHER EDUCATION:
A STUDY OF UNIVERSITY COSTS

presented by

Philip Edward Austin

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Economics

Major professor

Date May 5, 1969

O-169

ABSTRACT

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By

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The demand for educational services on the university level has increased greatly in recent years and every indication is that the trend will continue. It is also likely that the demand for these educational services will increase at a faster rate than the supply, the major limitation on supply being the budget constraint. This situation makes it imperative that decision makers in institutions of higher learning allocate their limited resources in the most efficient manner so as to provide for the attainment of institutional objectives. In order to make intelligent decisions with regard to the allocation of scarce resources, they must know what courses of action will accomplish institutional objectives and the economic costs that will be incurred as a result of the implementation of each course of action. The purpose of this study was to provide a basis for obtaining the cost information needed to make sound decisions in the process of allocating educational resources.

The costs which must be included in an economic analysis were discussed as well as the conceptual framework within which constrained choice problems are solved. Consumer indifference theory was used to demonstrate the method of choosing the point of optimum allocation when resources are limited and wants are insatiable. The isoquant approach to production theory and its application to long-run educational resource allocation problems was reviewed. The opportunity cost principle was outlined and applied to educational costing problems.

Based on these economic principles, a method of determining the costs incurred by the College of Education, Michigan State University, in the production of academic degrees was developed. The total cost of the degree programs of the 180 students in the sample was found by summing five component cost categories: (1) instructional costs, (2) faculty support costs, (3) research costs, (4) space costs, and (5) administrative costs.

The total costs of producing a degree in each of the several degree programs in the sample were presented. On the average, the costs incurred by the College of Education in producing a Ph.D. degree ($1399) were about twice the costs incurred in the production of either a B.A. degree ($653) or M.A. degree ($652). When degree cost variations within each level were considered, these generalizations lost much of their meaning. The cost ranges within each level were as follows: (1) B.A. - $431, (2) M.A. - $278, and (3) Ph.D. - $326.

These total degree costs were used as the dependent variable in the multivariate regression analysis which was the statistical technique used to test the hypothesis. The hypothesis stated that the following factors were statistically significant at the 5 percent level in explaining differences in degree program costs in the College of Education, Michigan State University: (1) class size, (2) level of study, (3) curriculum, (4) number of College of Education student credit hours in the degree program, and (5) ratio of graduate to total student credit hours in the degree program. The null hypothesis was used in the statistical tests and was rejected. That is, the above factors were found to be statistically significant at the 5 percent level.

The regression equation revealed that, in response to an increase in class size of one student, degree costs, on the average, decrease by $3.40. Also, degree costs increase $10, on the average, with each additional College of Education credit hour in the degree program. Policy implications such as the reduction of course duplication were discussed.

Operating under the assumption that no economies of scale were available to the College of Education and that the budget was constant, the degree costs derived in the study were used to show the cost of one degree program in terms of others. For example, on the M.A. level, it was shown that to increase the level of degree production in the area of Student Personnel Work, at the expense of Agricultural Education, requires a reduction of six student positions in the latter area for every increase of four in the former.

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Economics

1969

ACKNOWLEDGEMENTS

Sincere appreciation is extended to Dr. John P. Henderson for his guidance and advice not only during the writing of this dissertation, but throughout the entire period of my graduate study.

Special thanks are also extended to Dr. Lester V. Manderscheid and Dr. James E. Heald for reviewing parts of the manuscript and offering many substantive suggestions.

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CHAPTER I

INTRODUCTION

Educators are becoming increasingly concerned with the rising costs of educational programs on the university level. As the demand for higher education continues to grow, in many cases at a faster rate than resource appropriations, it is evident that given the quality of a program, the costs of providing that program must be minimized if the maximum number of students are to be educated. In order to arrive at reliable cost/benefit decisions, administrators obviously must be aware of the relative costs of the various programs provided by their institutions. Decision makers in higher education, as well as all taxpaying citizens who are interested in attaining the most efficient allocation of educational resources, are looking to economists for alternatives to be used as foundations for educational policy decisions.

The study of educational costs should not be taken as an indication that economic factors alone are the principal

determinants of educational resource allocation. Intelligent educational decisions will always be based on the nature of education and of educational institutions. To achieve efficiency in institutions of higher learning, economy must be consistent with the institutional environment necessary for academic interaction. The primary responsibility of higher education is to increase the store of knowledge, both in terms of quantity and in terms of breadth of distribution. The costs incurred in discharging this responsibility are small relative to the value to society. Obviously, some very high cost programs might be considered of high value and not only continued, but expanded. This does not preclude the necessity on the part of the administrators for being aware of the cost of such programs. There might be instances where a cost analysis would suggest the desirability of the contraction, or the termination, of a particular course of study. For example, a continuum could be constructed arranging all of an institution's programs in decreasing order of educational importance, and a second list could be constructed arranging programs according to a decreasing order of magnitude in terms of cost. If the least important program from an educational standpoint (a value judgment imposed by professional personnel) were the most costly, the continuation of such a program might be called into question.

Previous research in this area has not, in general, been adequately precise to be of great value to university decision makers. Much of the work has taken the form of dividing the total number of student credit hours by the appropriate university or departmental expenditure to arrive at a cost per student credit hour. Comparisons were then made among departments or colleges of one university, or among many universities.[1]

The value of interinstitutional comparisons is quite obviously limited by variations among the several institutions such as the content of course offerings of similar departments, institutional goals and objectives, and accounting procedures. Colleges and universities are diverse operations. The goals and objectives of a small, private liberal arts college, and the functions it performs can be quite different from those of a large state university. Even if they are committed to the same goals, the methods they use to classify financial and academic data

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[1] Three recent studies of this general form are: (1) California and Western Conference Cost and Statistical Study. (New York: Fund for the Advancement of Education, 1960) (2) Ralph Nelson Calkins, The Unit Costs of Programs in Higher Education. (Ann Arbor: University Microfilms, 1963) and (3) Unit Cost Study: Instruction and Departmental Research. (Lansing, Mich.: Michigan Council of State College Presidents, August, 1966).

might vary. Different institutions might also be operating on different cost schedules or at different points on the same schedule. All of these factors limit severely the usefulness and applicability of interinstitutional cost comparisons.

To a lesser extent, objections can be raised about making cost comparisons in a single institution where all accounting and registration procedures are identical. In this case there will still be differences in departmental goals and objectives which will be reflected in the average student credit hour production per faculty member. For example, one department might be largely committed to educating graduate students and conducting research, while the faculty of another might perceive their responsibility to be one of providing educational resources for undergraduates. The student credit hour production per full-time equivalent faculty member in the former would most often be significantly lower than the latter; this difference would have a corresponding effect on the average cost per student credit hour in the departments.

In addition to the problems of data homogeneity, it must be emphasized that unit costs themselves have limitations. They reflect a situation in which a given number of students are consuming a given amount of educational resources, at a given price at a point in time. A change in the educational production function or any of the inputs, regardless of size, might change the relative unit costs entirely. Also, higher costs per unit of educational output can mean greater inefficiency, greater quality, or simply reflect the desire of administrators to allocate more resources to one program than to others.

In spite of their limitations, unit costs can be of great assistance to administrators if they are aware of the assumptions under which the costs are derived and use them accordingly. However, even if the cost information is completely accurate and administrators use the figures only to the extent of their reliability, unit costs alone do not provide enough information to be of assistance in making some types of decisions. For example, assume there are a number of degree programs that will accomplish a particular goal or set of goals in an institution. Additionally, due to a limited resource base, only one program can be offered. If all programs are equally effective in accomplishing institutional goals or objectives, and there are no rigidities such as tenured faculty members in one area, the relative costs would be the major criterion used in deciding upon which will be offered. In this case, the

cost of the entire program of study is the relevant figure for decision making.

General Objective of the Study

This study is undertaken with the general objective of developing a model which will provide administrators of institutions of higher learning with the data needed to make decisions concerning resource allocations. More specifically, it will provide degree program cost figures for the College of Education, Michigan State University, and identify some major factors responsible for cost variations among programs. It is a part of a wider study being conducted by the Planning and Development Office of the College in which all existing programs being offered by departments and institutes will be examined with respect to objectives value and cost. In short, the purpose of the study is to provide a basis for evaluating alternative allocation policies under the assumption that the College of Education has a range of values and changing objectives, but a fixed resource base that provides a very important constraint.

Hypothesis of the Study

The hypothesis of the study is that the following factors are statistically significant at the 5 percent

level in explaining differences in degree program costs in the College of Education, Michigan State University: (1) class size, (2) level of study, (3) curriculum, (4) number of College of Education student credit hours in the degree program, and (5) ratio of graduate to total College of Education student credit hours in the degree program. To conduct the statistical tests, the null hypothesis is constructed. The null hypothesis states that the five factors listed above are not statistically significant at the five percent level in explaining differences in degree program costs. The hypothesis and the appropriate statistical tests are discussed in detail in Chapter V.

Sources of Data

Data were obtained from the College of Education Office of the Dean, the Office of Institutional Research, and the Graduate and Undergraduate Student Affairs Offices of the College of Education, all of Michigan State University. Other data, as necessary, were collected from the several department chairmen and institute directors.

CHAPTER II

REVIEW OF LITERATURE

The economics of education is a relatively wide area of academic inquiry. Such diverse research topics as determining the role of education in economic development, measuring the economic return to education, determining the demand for educational services, and discovering efficient methods of allocating educational resources on the institutional level have all been included in the category of the economics of education. This generic classification can be divided into macro and micro subcategories, with the first three of the above four categories being included in the macro section. It is to this category that economists have directed most of their research efforts in recent years.

The literature on the micro or institutional level (usually concerned with resource allocation problems) has increased in recent years, but many conceptual and methodological questions remain to be solved. The literature which is of particular relevance will be reviewed in this

chapter. The general areas to be considered are as follows: (1) the classification of academic data, (2) methods of educational cost analysis, (3) computer programming and educational costs, and (4) cost-utility analysis in education.

Classification of Academic Data

A cost analysis has many aspects. Subsequent to the statement of the problem, terms must be defined. That is, before engaging in an analysis of resource allocations, the economist must decide in what units the various inputs and outputs of the educational process are to be measured. A recent National Science Foundation study was designed to:

> ...devise and test systems of measuring and reporting activities in colleges and universities so that such institutions would be enabled to maintain records adequate both for their own purposes and for reporting to the various agencies which stand in need of this type of data.[1]

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[1] Systems for Measuring and Reporting the Resources and Activities of Colleges and Universities, National Science Foundation, NSF - 67-15 (Washington, D.C.: U.S. Government Printing Office, July 1967), p. 5. Some other publications in this area that have been widely used by various institutions of higher learning over the past four decades are as follows: (1) Edwin B. Stevens and Edward C. Elliott, Unit Costs of Higher Education (New York: Macmillan and Company, 1925); (2) National Committee on Standard Reports for Institutions of Higher Education, Financial Reports for Colleges and Universities (Chicago: University of Chicago Press, 1935); (3) National Committee on the Preparation of a Manual on College and University Business Administration, College and University Business Administration (Washington, D.C.: Center

The NSF researchers recognized that the activities of academic personnel have traditionally been categorized in terms of teaching, research, and public and professional activities. Additional categories sometimes included are administration and student services. From their study of basic personnel data items, however, several new categories were established.

The new categories were concerned with the overlapping of two traditional categories (teaching and research), and with creative activity in the arts and humanities as opposed to creative activity in scientific research. Many professors suggested a need for a category to cover research activity when the research was part of the educational process. When a professor is conducting a research project with a graduate student he is engaged in both teaching and research. To represent the role of the professor in this type of research and teaching activity, the category of "Teaching-Research" was established.

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for Applied Research in Education, 1952 /Vol. I/ and 1955 /Vol. II/); (4) California and Western Conference Cost and Statistical Study (Berkeley: University of California Printing Department, 1960); and (5) American Association of Collegiate Registrars and Admissions Officers, Handbook of Data and Definitions on Education (Chicago: University of Chicago Press, 1962).

A separate category was also needed to cover "creative activity" in non-scientific disciplines when such activity could not be appropriately designated as research. The production of a play is quite a different activity from the clinical testing of a drug, and the time allocation reports should reflect these differences. To fill this need, the "Creative Activity in Art and Scholarship" category was devised. Once this classification was established, a category parallel to that of teaching-research was established. The new category was labeled "Teaching Through Creative Art and Scholarship" and defined as follows: "That kind of creative activity which is carried on with one or more apprentices for whom this involvement is part of their formal educational program."[2]

The study resulted in a list of ten major categories which, taken collectively, represent the full professional life of the academic-professional person. This list includes: (1) teaching, (2) research, (3) teaching-research, (4) creative activity in art and scholarship, (5) teaching through creative activity in art and scholarship, (6) public service, (7) administration, (8) formal personal education, (9) intra-university activities, and (10) other extra-university activities.

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[2] _Ibid._, pp. 73-74.

While this set of categories is quite complete, an operational problem exists. It would be very difficult to generate enough interest among faculty members to cause them to become acquainted with the categories, or to record the allocation of their time, on a regular basis, among the categories. Also, in general, as a group of data is subdivided to a greater extent, there is a tendency for those using the data to place more reliance in its authenticity. To the extent that the more precise classifications are accurate, they are more helpful to decision makers, but it must be remembered that the chance of classifying the allocation of one's time incorrectly increases as the number of categories increases.

Methods of Cost Analysis

Costs can be expressed in many forms. Some of the common units of presentation are cost per student credit hour, cost per course taught, cost per academic program, cost per full-time equivalent student, and expenditures by department. In a thesis completed at Purdue University,[3] a unique approach to educational costs was taken. The product of higher education was considered to be unquantifiable. Therefore, rather than assigning costs directly to

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[3]Harry Hamel Hirschl, Some Economic Considerations and a Procedure for a University Cost Study, M.S. Thesis (Lafayette: Department of Economics, Purdue University, 1965).

the product, they were assigned to a quantity that represents the product. The quantity used in the study was the class, defined as the meeting of students and teacher. The final figure presented as the unit of comparison was the average expense per student by academic level and field of study. The total cost of offering each course was distributed over the student body on the basis of the composition of the class. For example, the number of sophomore students majoring in electrical engineering would be allocated 20 percent of the total costs of a given class if ten out of the fifty students in the class were in this category. This cost is derived for each category of student for each class. These figures are then summed, and this figure divided by the number of students in the appropriate category. This average expense per student minus the average fees collected per student represent the average net cost per student in each category to the State of Indiana.

One of the fundamental differences between the Indiana study and the present thesis lies in the educational product or service being measured. In the former study, costs per student were calculated by level of study and academic area. In the latter study, the total costs involved in the process of degree production are considered to be the relevant units of measurement. To carry out a cost benefit analysis of several degree programs, the total costs of each must be known. The Indiana study did not provide the information needed for this type of analysis while the present study does.

A recent U. S. Office of Education study[4] considered the costs and returns of only doctoral programs in four academic disciplines. Separate rates of return were calculated for different employment possibilities open to bachelor degree holders in the four areas and, on the assumption that an individual's contribution to output is reflected by these rates of return, they were used as "earnings foregone" estimates, and included as opportunity costs in the total cost of education figures.

The sample from which the cost data were obtained was composed of eleven universities known to have varying qualities of cost data and accounting records. Since inter-institutional data were used and only doctoral programs were considered, the general applicability of the conclusions is limited. Also, even though it is one of the most impressive of the recent studies in the economics of education, the cost analysis section had some limitations. The costing

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[4] Irene Butter, Economics of Graduate Education: An Exploratory Study, U. S. Office of Education Cooperative Research Project No. 2852 (Ann Arbor: Department of Economics: University of Michigan, 1966).

procedure which was used implied that the cost per student credit hour of all courses was equal.

The following costs were considered in the analysis: (1) instructional costs consisting of graduate faculty salaries, staff benefits, departmental supplies, equipment, and clerical costs, (2) research costs, (3) costs of physical facilities, (4) administrative costs, including both general university and departmental administration, (5) library costs, and (6) opportunity costs. The total costs were divided by the number of student credit hours produced by each department to arrive at a cost per student credit hour. The number of student credit hours in the course taking phase of the academic program of each discipline was multiplied by one cost per student credit hour figure for each university and the research credit hours were multiplied by another. This method ignores the fact that a relatively large class taught by a relatively low paid professor will produce lower cost student credit hours than a relatively small class with a relatively high-salaried professor. Since only doctoral programs were considered, the criticism is less valid than if the procedure were used in the present study where degree programs of all levels are analyzed. The deficiency does not exist in the present study because, rather than determining an average cost for course credit hours and another average cost for research credit hours, the cost per credit hour was calculated for each course taught in the College of Education, Michigan State University, during the academic year 1967-68. The total costs for the appropriate courses were then summed to determine the degree cost of each student in the sample. A more detailed account of the procedure will be presented in Chapter IV.

Butter found that the average costs of training Ph.D. students in sociology and English were less than one-half of the average costs of training doctoral students in physics and zoology. The cost levels of physics and zoology were quite close to each other, while English was less than sociology. When the opportunity costs referred to above were added, the relative cost positions changed: the difference between zoology and physics increased, but the difference between the average costs of the natural sciences on the one hand, and of sociology and English on the other, decreased. The changes in the relative cost positions when opportunity costs were included resulted primarily from the differences in the number of years required to complete the doctorate in the four fields.

It was also found that at the 5 percent level no significant differences existed in the total cost of the Ph.D.

between departments of the public and private universities in each discipline. Economies of scale measured by the number of graduate students enrolled in the department appeared to exist in physics and sociology, but not in English. The difference in the economies of scale observed in the sciences and English is probably generated by the larger equipment expenditures of the fixed cost variety required in the sciences. As more students are added to a given plant, capacity utilization increases and the costs per student decrease. The faculty-student ratio was not a statistically significant factor, but average faculty salaries accounted for 70 percent and 91 percent of the variance in average total costs in zoology and sociology, respectively, when all other variables were held constant. Average faculty salary played only a minor role in explaining cost variations in physics. Analyses of variance indicated that at the 5 percent level, the average costs of the research phase in physics and zoology are significantly higher than the corresponding costs in sociology and English. No significant differences were found at the 5 percent level in the cost of the research phase between departments in public universities and the same departments in private universities. The differences in the costs of the research phase of the degree programs are generated primarily by the

varying laboratory and space requirements of the four disciplines.

The _California and Western Conference Cost and Statistical Study_,[5] published in 1960, gave support to many theories of educational costs which had either never been tested or the evidence supporting them was very limited. The data for the study were collected from ten colleges and universities and included all persons who were paid from an instructional budget. Expenditures were allocated to three levels of instruction: (1) lower-division undergraduate, (2) upper-division undergraduate, and (3) graduate. Total instructional costs within each department were divided by the number of student credit hours produced by that department to arrive at costs per student credit hour. Therefore, in the sense that the data were not disaggregated to the individual course level, the results suffer from the same deficiency as those of the Butter study. Additionally, since only instructional costs were considered, the usefulness of the results is restricted. As was indicated above, an attempt has been made to remedy these deficiencies in the present study.

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[5]_California and Western Conference Cost and Statistical Study_, op. cit.

Analysis of the results indicated (1) significant variation in unit costs among institutions within subject fields, (2) the unit costs of graduate instruction were significantly higher than those of upper-level which was higher than the costs of lower-level instruction, and (3) high or low unit costs were not peculiar to specific subject fields, but were the result of a combination of factors which affect the costs of organized classes. The last of the three findings is contrary to Butter's conclusion that curriculum has an influence on the behavior of unit costs. The results of the present study, to be reported in Chapter V, support Butter's conclusion. A possible explanation for the different results reported by the California group is that they considered only instructional costs. In the institutions studied in the California study, the most important factor explaining variations in unit costs is the ratio of students to staff in the particular subject field. The effect of changes in the ratio on educational quality was not considered.

The researchers concluded that no generalized statement could be made with regard to the effect of enrollment changes on unit costs. Also, among the institutions studied, it was found that high faculty salaries are not necessarily associated with high costs per student. Other factors, such

as size of class, faculty assignment, and teaching expenditures other than faculty salaries influenced costs per student more than did the level of academic salaries. A policy conclusion drawn from this finding was that it was quite possible for an institution to raise its faculty compensation without causing an increase in per student costs. It was predicted that the increasing costs of higher education will continue partially in response to the broadening of curricula which is made necessary by scientific and technological progress. Theoretically, unit costs would be minimized if all students followed the same curriculum, since only the minimum number of courses would have to be offered. A policy conclusion to be drawn is that the number of courses offered by any given university subunit should be the minimum level necessary to achieve institutional goals and keep pace with scientific and technological progress.

Computer Programming and Educational Costs

In making administrative decisions, university officials should have at their disposal tools as sophisticated and precise as those used by their counterparts in the business world. One of the most widely used recent developments in this area is the simulation model.

Computers have been used for some time in decision making in the business world, but their use in universities has been largely restricted to payroll, registration, and other simple data reduction activities. Within the last few years several separate research projects have been conducted which have attempted to apply simulation analysis to university operations. Two of the most relevant studies will be reviewed.

Models are simply abstractions from the real world and, to the extent that they reflect reality, they can be used to simulate the behavior of the real world. The model becomes to the administrator what the laboratory is to the engineer; he is able to test alternatives before making a decision and anticipate problems rather than face unexpected crises. The analyst can vary the inputs of a system and note the effects on cost and output prior to deciding which of the systems is the most desirable. Obviously, before these comparisons can be made, all of the costs, alternative processes and output measures have to be worked out. In this sense, the methodologies and conceptual frameworks developed in many of the recent simulation studies are similar to those used in the present study.

One of the most complete studies in this area was sponsored by the National Science Foundation and carried out

by the Division of Engineering Research at Michigan State University.[6] The model developed by the research group was a mathematical description of the way a university utilizes its resources in production. The resources were categorized as personnel, space, and equipment while the products were identified as developed manpower, research, and public or technical services. The purpose was to provide a basis for evaluating alternative allocation policies. No attempt was made to define the goals of higher education or to determine optimum allocation policies.

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[6]Herman Koenig, et. al., "A Systems Approach to Higher Education," Interim Report No. 3, Project C-396, National Science Foundation (East Lansing: Division of Engineering Research, Michigan State University, 1966); Rita Zemach, "A State-Space Model for Resource Allocation in Higher Education," Technical Report (East Lansing: Division of Engineering Research, Michigan State University, 1967); and Herman Koenig and Martin Keeney, "A Prototype Planning and Resource Allocation Program for Higher Education," paper presented at the Symposium on the Operations Analysis of Education, U. S. Office of Education, Washington, D.C., November 19-22, 1967. Some related publications of a more general nature are: J. A. Kershaw and R. N. McKean, Systems Analysis and Education, Memorandum RM-2473-FF (Santa Monica, California: The Rand Corporation, 1959); Richard W. Judy and Jack B. Levine, A New Tool for Educational Administrators, The Commission on the Financing of Higher Education (Toronto: University of Toronto Press, 1965); and Roger L. Sisson, Some Results of a Simulation of an Urban School District (Philadelphia: Management Science Center, University of Pennsylvania Press, 1967).

The model consisted of sets of equations which described the relationship of resources to production and the associated costs of production. The model was composed of several sectors, each of which was related to a specific operation of the university. The characteristics of each sector were modeled independently, then the model of their interrelationship was developed.

The input-output relationships of the model were obtained from actual university data. Since some of the variables, such as the imputed value of manpower output were not directly measureable, the model could not be validated by observation. It was assumed that if those parameters, which depend on human behavior, accurately reflected the collective behavior of students and administrators, the validity of the non-measurable values was implied. Other parameters were based directly on university records, and were valid to the extent the data base was valid.

The data used in the cost analysis are of special concern here. To arrive at the institutional costs for any given quarter, it was necessary to know the total faculty time devoted to each course and the total number of students, as well as the salary of each faculty member. The final

figure presented was the instructional cost (i.e., faculty salaries) per student credit hour by student field and level.

The major problem encountered in the cost analysis portion of the study was in the defining of terms. For example, the faculty time expenditure categories of instruction, research, and administration were not clearly defined, so the data collected from the several departments were not homogeneous. The researchers attempted to remove this deficiency by making a series of recommendations with regard to future data gathering procedures. They outlined a centralized and mechanized record system that would (1) supply day-to-day operational data, (2) provide a data base for model building, and (3) serve as a part of the general university data base. The information would be stored on magnetic tape and would be segmented into four subdivisions, determined on the basis of type of data and frequency of use. A central office would be in charge of all data gathering activities to insure not only efficiency but also homogeneity.

A group of researchers at Tulane University[7] also constructed a simulation model which, in many respects, was similar to the NSF work at Michigan State University.

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[7]Peter A. Fermin, Seymour S. Goodman, Thomas E. Henricks, and James J. Linn, University Cost Structure and Behavior (New Orleans, La: Department of Economics, Tulane University, 1967).

The Tulane study began with a careful examination of the nature of a university, its goals and objectives, and the relationship of these goals and objectives to the behavior of costs. Using data from several unidentified public and private institutions, historical cost behavior was analyzed. Relationships between expense categories and various university functions such as library, food services, housing, student activities, and physical plant were studied.

On the basis of empirical data, a model was constructed to simulate the behavior of university costs. The basic framework of the model was a seven part conception of the following university functions: (1) teaching, (2) administration, (3) research, (4) professional activities, (5) community service, (6) supporting activities, and (7) student activities. The simulation model facilitated comparative analyses of interdepartmental costs and was used to predict future costs. On the basis of five years of historical data, the model would predict cost levels and behavior for the four subsequent years.

Some of the important and obvious conclusions reached by the Tulane researchers were: (1) enrollment is the best available predictor of the aggregate level of university costs, (2) the most important element of university costs

is salaries. Salary payments, however, represent different proportions of total departmental expenditures, and this proportion varies with the discipline which the department represents. In those departments which require few physical facilities or laboratories, salaries are the dominant--almost exclusive--expenditure. Alternatively, in the physical sciences salary payments, obviously, constitute a smaller proportion of total instructional expenses; (3) the assumptions that the unit cost of instruction increases with the level of instruction in the undergraduate program, and that unit costs of instructing graduate students are higher than the units of instructing undergraduates, were confirmed by the study. This simply reflects the patterns of academic effort which typically call for smaller section sizes and higher ranking professors for higher level courses.

Cost Utility Analysis in Education

As was pointed out in the introduction, the results of the present study are to be used as part of the data base for a cost/utility analysis of the College of Education, Michigan State University. Most of the recent work in the cost/utility analysis area has been related to government

activities, particularly the Defense Department.[8] The basic principles, however, apply to analyses of educational institutions as well.

Cost/utility analysis refers to the systematic examination of alternative courses of action which might be taken to achieve specified goals for a given time period. Many factors must be considered in evaluating the alternatives, but two are of special importance: (1) the economic costs incurred in providing each of the alternatives, and (2) the benefits or utility available from each alternative. It is assumed in the present study that the several degree programs offered by the College of Education are alternative methods of achieving stated college objectives. It is the purpose of the study to calculate the amount of economic resources consumed in the process of

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[8]Charles J. Hitch and Roland McKean, The Economics of Defense in the Nuclear Age (Cambridge: Harvard University Press, 1960); Roland McKean, Efficiency in Government Through Systems Analysis (New York: John Wiley and Sons, 1958); David Novick, Program Budgeting in the Department of Defense, RM-4210-RC (Santa Monica, Cal: The Rand Corporation, 1964); Arthur Smithies, A Conceptual Framework for the Program Budget, RM-4271-RC (Santa Monica, Cal: The Rand Corporation, 1964); J. String, A Model for Projecting Costs of Space Exploration, P-3119 (Santa Monica, Cal.: The Rand Corporation, 1965); J.D. McCullough, Cost Analysis for Planning Programming-Budgeting-Cost-Benefit Studies, P-3479 (Santa Monica, Cal.: The Rand Corporation, 1966).

providing each alternative so the administrators and faculty members of the College will be better equipped to make intelligent resource allocation decisions. The primary purpose of cost/utility analysis is not to make the decision, but to improve the judgment and intuition of the decision makers. Most problems involve political, sociological and psychological considerations that cannot be measured and included in the analysis in quantitative form. Therefore, human judgment is still an important aspect of the decision-making process.

Fisher[9] lists a series of important guidelines to be followed when carrying out a cost/utility analysis. The most important is the proper structuring of the problem and design of the analysis. It is in the design stage that most cost/utility studies either become hopeless or cross the most crucial barrier to success. The problem must be structured so the right questions are being asked and only the relevant aspects of the environment are considered in the analysis. One group of costs which have been either omitted entirely or incorrectly measured in most previous educational cost studies is the one pertaining to space and physical

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[9] G. H. Fisher, The Role of Cost/Utility Analysis in Program Budgeting, RM-4279-RC (Santa Monica, Cal.: The Rand Corporation, pp. 8-16, 1964).

facilities. Some researchers, apparently assuming that capital account expenditures are sunk and should not be considered when making allocation decisions, have implicitly assumed the cost of building space to be zero by analyzing only operating costs. Others, realizing that the construction of physical facilities consumes resources, have amortized construction costs over a given number of years. Neither of these methods is acceptable in an economic analysis since opportunity costs are not considered. That is, the relevant costs of a given building are those incurred as a result of not devoting the space to alternative uses. The method used to handle these problems in the present study is discussed in Chapters III and IV.

Building the model is another important step and, again, Fisher emphasizes that only the most relevant data be included. As the amount of data considered increases, the model becomes more unmanageable. The fundamental purposes of the model are: (1) to develop a meaningful set of relations among objectives, (2) to develop alternative methods of arriving at those objectives, (3) to estimate the costs of the alternatives, and (4) to estimate the utility functions of the alternatives. Finally, there is the testing of the validity of the model which is quite

often a difficult task. Fisher suggests[10] the analyst should attempt to answer whether: (1) the model describes the known facts and situations reasonably well, (2) when the principle parameters involved are varied, the results remain consistent and plausible, (3) the model can handle special cases where there is already some indication as to what the outcome should be, and (4) it can assign causes to known effects.

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[10] Ibid., pp. 14-15.

CHAPTER III

ECONOMIC THEORY AND EDUCATIONAL COSTS

Educational Resource Allocation

The efficient allocation of scarce resources is one of the central problems of microeconomics. As Robbins has written, microeconomics "...is concerned with that aspect of behavior which arises from the scarcity of means to achieve given ends."[1] If the attainment of one set of ends involves the sacrifice of others, the problem has an economic aspect, an opportunity cost element. Clearly, then, the allocation of educational resources is a problem which deserves the attention of economists.

Resources allocation within educational institutions is a unique problem because, unlike business firms in the private sector, there are no built in mechanisms which lead to efficiency. In universities, for example, no profit motive exists and promotions, salary increases, desirable

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[1]Lionel Robbins, The Nature and Significance of Economic Science, 2nd Edition (London: Macmillan and Company, 1952).

appointments, and prestige do not depend on the accumulation of profits. In short, the tendency of inefficient firms to be forced out of the market simply is not a characteristic of the state-supported higher education industry in the United States. This characteristic makes the existence of non-market efficiency criteria all the more important.

Efficient Resource Use

The term efficiency as used in this thesis refers to the situation in which the production of one output cannot be increased without decreasing the production of another output, given the size of the budget. In other words, it is impossible to increase one output without either increasing the quantity of inputs or decreasing an alternative output. Maximizing output given the budget constraint is equivalent to minimizing cost given the level of output, if the size of either the gain or the cost is the same in the two methods. The former analysis was chosen for this study because the problem facing the College of Education is to maximize educational services given the constraint of the annual budget. Either the quantity of educational services given quality, or the quality of educational services given quantity, can be maximized in this case, but not in both. Similarly, it is impossible to simultaneously maximize gain and minimize cost. In comparing two

courses of action, X and Y, alternative X might produce a higher output at a lower cost than alternative Y, but this will not hold true when course of action X is compared with all other alternatives. Maximum gain is infinity and minimum cost is zero, a combination that is not attainable. To reach a specified goal, many alternatives may exist, each of them requiring resources. Since the resources are limited and the goals and alternatives are not, a choice must be made.

Budget allocation under constrained choice may be viewed as the process of choosing methods for channeling limited resources into alternative areas of use. In the process of funding programs which will lead to the attainment of long-run institutional objectives, the decision maker is faced with the situation in which there are more competing demands for resources than there are resources available. Classical economic theory provides a framework for making such a choice: under competitive conditions, market processes are adjusted by the constrained choices of consumers.

Figure 1 is a graphical example of the analytical process in which the resources of a university would be distributed under conditions of constrained choice. Each radial line represents a different program area and the

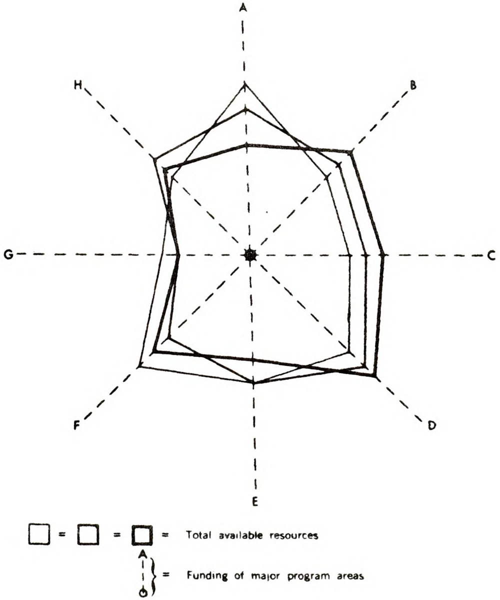

Figure 1. Iterations in the Program Budgeting Process

Source: Harry Williams, Planning for Effective Resource Allocation in Universities (Washington, D.C.: American Council on Education, 1967). p. 5.

length of the line segments within the closed figures represents the level of funding allocated for the particular program. The areas enclosed by the three sets of lines in this example are constant, representing a fixed quantity of resources. Therefore, increasing the resources allocated to one program (moving out along one of the radial lines), decreases the resources available for other program areas. Alternatively, moving toward the center on one of the radial lines releases resources for use in other areas.

To make an intelligent selection, the relative costs of the alternative courses of action must be known. The real cost of any alternative is whatever must be foregone to adopt that alternative. The cost is the sacrificed alternative opportunity; therefore, the sacrificed alternatives may be called the "opportunity costs" of the chosen course of action.

The application of this concept to education can be demonstrated quite clearly by the use of indifference curve analysis. Assume that a certain college goal or objective can be accomplished by training and graduating a specified number of students of a given quality on the B.A. level in two curriculum areas: Area A and Area B. The problem facing the decision makers is to determine how resources should be allocated between these two

programs. A production possibility curve can be constructed representing the maximum number of students who can be trained in Area A and the maximum number that can be trained in Area B, given the budget constraint. The X intercept represents the number of students who could be trained if all resources were devoted to Area A. A corresponding relationship exists for the Y intercept and Area B students. Any point on the curve that connects these two points is efficient in the sense that no increase in the output of students in one area can be realized unless either the output of students in the other area is decreased or the input base is expanded.

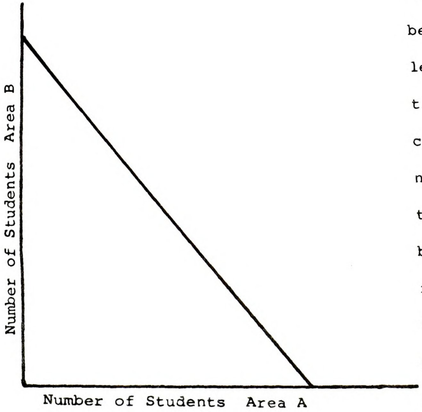

Figure 2. Production Possibility Curve

Any points lying below and to the left of the production possibility curve are obviously not efficient, given the existing budget, but are feasible. That is, they are at attainable. Any point above and to the right of the curve is infeasible or not attainable. The locus of efficient points, therefore, is the boundary between feasible and infeasible points.

The concept of opportunity cost is quite apparent in this example. The real cost of training X number of students in Area A is the sacrifice that must be made in the training of students in Area B. The gains that could have been obtained by using the resources in Area B are what have to be given up or sacrificed when the resources are devoted to Area A.

Any point on the production possibility curve represents technical efficiency. The curve is a locus of efficient alternatives, but technical efficiency is not a sufficient condition for reaching an economic optimum. At the one extreme there will be no students graduated in Area A, while at the other extreme there will be no students graduated in Area B. To determine which of these extremes, or combination of students from the two areas, will be chosen the preferences of the decision makers (or those to whom the decision makers are answerable) must be known.

The course of action which is chosen should maximize "quantities" such as the satisfaction of an individual, the profits of a firm, the well-being of a group, or the

educational services of a school. In education, the goals or objectives are usually defined by answering questions such as what knowledge and skills should be developed, and when, where, how, by whom, and for whom. In other words, in a given period of time, what kind of education should be offered for how many students. In the case of the example cited above, after these questions have been answered, various combinations of students in the two areas that will be equally acceptable to the decision makers are determined and plotted on a graph. This locus of points is an indifference curve.

Any combination of the two outputs on a given curve represents equal utility, so there is indifference as to which point is chosen. The slopes of the indifference curves indicate the rate at which the decision makers are willing to trade one output for another. The more of one output that is given up, the more valuable it becomes, and more of the other good is needed to substitute for one unit of it. Two assumptions underlying indifference theory are (1) the consumer finds both commodities desirable (this ensures a negative slope to the curves and, as between two indifference curves, ensures the higher one is preferred because it contains as much X and more Y, or as much Y and more X), and (2) the commodities are continuously divisible (this assumption ensures that the curves will be continuous and not a series of discrete points).[2]

An infinite number of indifference curves will theoretically exist in any graphical space but only one point of one curve will be tangent to the production possibility curve, assuming convexity to the origin over the relevant ranges of the whole set of indifference curves, and concavity to the origin over the relevant range of the production possibility curve. The point of tangency between the two curves is the optimum point, and is the combination that will be chosen.

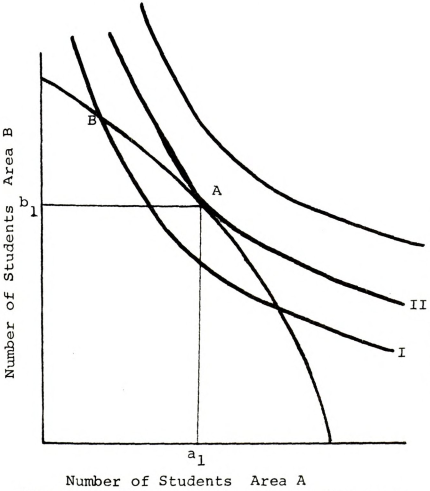

Figure 3. Optimal Allocation of Resources.

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[2] George J. Stigler, *The Theory of Price* (New York: The MacMillan Company, 1966), pp. 50-51.

In the case of Figure 3, the optimum combination is represented by point A (a_1 students in Area A and b_1 students in Area B). As indicated above, the equilibrium point must be in a feasible area so all indifference curves above II are irrelevant given the existing production constraint. No indifference curve below II would be chosen, such as Curve I which crosses the production possibility curve at point B, because by moving toward point A a higher level of utility is achieved. That is, by moving on the production possibility curve toward point A, positions on higher level indifference curves are attained. At the point of tangency, the marginal rate of substitution (the rate at which the decision makers are willing to substitute A for B) is equal to the marginal rate of transformation (the rate at which they can substitute A for B). Unless this point is reached, it is possible to change the allocation of resources so as to achieve a higher level of utility.

Indifference curve analysis is helpful in conceptualizing the process of determining the amounts of each of two products to be produced. The isoquant approach to production theory is helpful in conceptualizing the process of determining what combination of resources will produce a given output in the most efficient manner.

An isoquant is a locus of points representing different combinations of two inputs with which a given amount of product can be produced. At each point on Isoquant I in Figure 4 total product is the same, just as on a given indifference curve total utility is the same. At point X, a_1 units of Resource A and b_1 units of Resource B are required to produce the output. The slope of the isoquant between any two of its points is equal to the ratio of the marginal products of A and B.

Isocost lines (such as CC, DD, and EE in Figure 4) show the various combinations of inputs that can be purchased for a specific outlay, given the prices of the inputs.

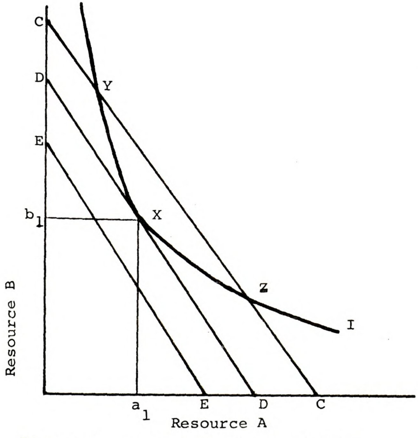

Figure 4. Isoquant and Set of Three Isocost Lines.

If the level of output to be produced has been determined, the problem is to combine resources in the most efficient manner so as to minimize the cost of producing the output. The problem can be solved graphically by the isoquant-isocost approach. The cost level represented by EE in Figure 4 is not feasible because output level I cannot be produced by any combination of inputs available for this outlay. Cost level CC is possible but will not be chosen because by moving from either Point Y or Point Z to Point X, the same level of output can be obtained at a lower cost. The optimum combination of resources is given by the point of tangency between the isocost curve and the isoquant. At this point, the marginal rate of technical substitution of A for B equals the ratio of the price of A to the price of B. That is, the last dollar spent on one input yields the same marginal product as the last dollar spent on the other input.

Since appropriations for productive resources (faculty salaries, supplies and services, and equipment) in institutional subunits of Michigan State University cannot be shifted from one account to another, the applicability of this analysis in the short run is limited. However, to the extent that budget officials allow changes at the beginning of each fiscal year in the proportion of the total budget accounted for by the various accounts, this analysis is valid for long run resource allocation decisions.

Assume a given number of students can be presented a certain amount of academic material by any one of several combinations of faculty members and computers. An isoquant can be constructed reflecting these combinations, and an isocost curve can be drawn indicating the relative costs of these factors of production. The point at which these two curves are tangent represents that combination of faculty members and computers which can present the material to the students in the most efficient or least-cost manner. Similar problems can be handled involving the trade-off values between other sets of factors of production such as faculty members and graduate assistants.

The methods used in Chapter IV to determine the costs of degree programs and the implications drawn in Chapter VI are based on the theoretical concepts outlined in this Chapter.

CHAPTER IV

DERIVATION OF EDUCATIONAL DEGREE COSTS

The justification for an economist devoting his efforts to educational resource allocation problems was established in the last chapter. In order to make this type of analysis, the costs of the various educational programs must be determined. Being a part of the overall economic problem, therefore, the development of a method of costing educational programs is also an area germane to economic research.

The initial problem is to determine what costs are to be included in the analysis, and the units in which the costs are to be presented.

Costs to be Included

All costs - both direct and indirect - that are incurred at any point in time as a result of implementing a given course of action are to be included in the analysis. If a cost will be incurred at some point in the future as

a result of adopting an alternative or course of action, it must be considered.

Some assets, such as a classroom building, are likely to be inherited from the past. These are sunk costs and are not relevant in comparisons of alternative methods, of accomplishing objectives, unless they have value in other present or future uses. That is, the use of these assets might involve opportunity costs, and make it necessary to forego opportunities of using them to reach other objectives. For example, the building space that would be used for classrooms in one plan might be used in another plan as storage space. If this is the case, the net value of the space for storage is an opportunity cost that should be included in the costs of the program requiring the space for classrooms. The essential point is that the value of the space as classrooms is not related to the historical construction cost of the building. The only costs and benefits of interest to the economic analyst in comparing alternatives are future costs and benefits. As was implied above, this assumes that the opportunity costs associated with using inherited assets are included in the "future costs" category.

Measurement of Costs

If the decision makers are to determine policies which achieve a certain objective at minimum cost, they must consider the costs that provide the real constraint. For example, if only one input is the real constraint, the costs of all alternative courses of action should be expressed in terms of that one input. If several individual inputs are limited, costs should be expressed in terms of those inputs. If there is a general monetary constraint with no limits on the various inputs, costs should be expressed in dollars. Dollar costs indicate what must be given up in order to adopt a particular policy. The prices of different items show the rates at which they can be substituted for one another. Admittedly, the dollar costs measure real sacrifices accurately only to the extent that they accurately reflect the relative scarcity of resources. There is, however, no close substitute for the use of dollar costs in this study. Costs in terms of professorial expertise and numbers of secretaries could be very misleading. To say that a BA degree in one area costs so many professors, secretaries, and equipment does not say how these resources can be traded off to produce an MA in the same field. Expressing the relative values in terms of dollars facilitates better comparisons, therefore, aids in planning future trade-offs.

Another reason for using dollars as the basic unit of measurement in this study is that the annual college budget is expressed in dollar terms; also, no significant inelasticities exist in educational resource markets. As was pointed out above, one exception to this might be the existence of tenured faculty members in an academic area or field of study which is to be dropped from the College program.

Determining Educational Costs

The goal of this study is to determine and compare the costs (and the factors that affect them) of programs that are already in operation rather than programs that are in the planning stage of development. This reduces the element of uncertainty in the figures which are derived, since they are based on experience, not judgments of what might happen. The research methods used are the same, however, whether the analysis is of the planning variety or of the re-evaluation variety.

The total costs incurred in the production of a series of degree programs are the ultimate figures to be derived. Since the purpose of the study is to provide a

decision making tool for the administrators of a college with a fixed resource base, only costs internal to the college will be considered. Other costs, such as those incurred by the university administration and foregone student earnings, are parts of the total social cost of educating the students, but should have no direct effect on resource allocation within the college. These costs should enter the analysis at higher decision-making levels such as the Board of Trustees and the State Legislature.

It is assumed throughout this study that no College of Education student credit hours were produced on a contributed basis, that is, taught by a professor who was not paid by the College of Education for his services. An example of this situation is a university administrator teaching a course for the Department of Administration and Higher Education but not receiving a salary for teaching. This also applies to the direction of doctoral dissertation research where the advisor might actually be contributing his time because it is on an overload basis. The results of the study, therefore, will indicate the costs that would be incurred by the College of Education if it had to pay for all courses taught with a College of Education title.

Each of the departments in the College of Education offers a degree program on one or more of four different levels: (1) bachelors, (2) masters, (3) educational specialist, and (4) doctorate. In some departments more than one program of study is offered at each level; the Department of Secondary Education and Curriculum offers programs in both Secondary Education and Curriculum. Eighteen of these programs (three on the bachelors level, ten on the masters level, and five on the doctoral level) were selected for this study on the basis of the availability of transcripts. A sample of ten recent graduates in each area was selected from a stratified population on a systematic basis.

The cost of each individual degree was determined by summing the following component categories: (1) instructional costs, (2) faculty support costs, (3) research costs, (4) space costs and (5) administrative costs. The derivation of the costs in each of these categories is discussed below.

Instructional Costs

The instructional costs of each course offered by the College of Education during the academic year 1967-68 were determined by dividing the appropriate faculty

salaries by twelve under the assumption that each faculty member receives four (4) assignments per academic quarter, and teaching one course is equivalent to one assignment.[1] This quotient was divided by the number of students in the class to arrive at the cost per student. The class size and faculty salary figures were based on the academic year 1967-68 since the data were available for this period, and the assumption was that variations over time are negligible. The class size, faculty salary, and instructional cost per student credit hour figures for each course taught in the College of Education (excluding the Department of Health, Physical Education, and Recreation) during the 1967-68 academic year are presented in Appendix A. If the course was taught more than once during this period, the class sizes and professorial salaries are averages. Since identifying the course numbers could reveal the salaries of individual faculty members, the courses are coded. The costs per student for the appropriate courses were summed to arrive at the total instructional cost for the degree. Algebraically, instructional costs for each degree were derived as in equation (1):

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[1]The salaries of those faculty members who are employed on a twelve-month basis were adjusted to a ten-month base.

(1)

$$IC = \sum_{i=1}^{n} \left(\frac{FS}{(12)(S)} \right)$$

Where: IC = Instructional costs
FS = Faculty salary
S = Number of students in the course
N = Number of College of Education courses in program of study

Faculty Support Costs

The costs of supporting services, such as equipment, secretarial, office space, and supplies and services (see Table 1) were aggregated for each department and allocated

Table 1. Secretary-Faculty Ratios (Sec/Fac), Average Annual Professorial and Secretarial Equipment Costs (Eq/Prof and Eq/Sec), Office Space Allocations, Number of Full-Time Equivalent General Fund Faculty Members (FTEF), Supplies and Services Expenditures Per Full-Time Equivalent General Fund Faculty Member (SS/FTEF), and Secretarial Salaries Per Full-Time Equivalent Faculty Member (Sec Sal/FTEF) by Department, College of Education, Academic Year 1967-68

Department	Sec/ Fac	Eq/ Prof* ($)	Eq/ Sec* ($)	Office Space Sq Ft	FTEF	SS/ FTEF ($)	Sec Sal/ FTEF ($)
Counseling	.3	470	742	3911	25	112	1638
Administration	.5	470	742	3142	16	112	2952
Secondary	.2	470	742	3902	38	112	961
Elementary	.16	470	742	3410	41	112	804

*Communication with members of the College of Education Office of Administrative services indicated the following average equipment allocation per professor: 1 desk - $155; 2 chairs - $95; 2 files - $114; 2 bookcases - $106. The average equipment allocation per secretary is as follows: 1 desk - $160; 1 chair - $50; 1 typewriter - $430; 1 file - $57; and 1 stencil file - $45. These costs were amortized over five years.

Source: Office of the Dean and Office of Administrative Services, College of Education, Michigan State University, January 1969.

among the full-time equivalent faculty members in each department. These faculty support figures were converted to a cost per student per course basis and summed to arrive at a supporting services cost per degree by the following method.

Secretarial equipment and salary expenditures were multiplied by the secretary-faculty ratio in each department to determine what proportion should be allocated to each professor.[2] The number of square feet of building space allowed each department was divided by the number of full-time equivalent general fund faculty members to arrive at a space allocation per professor figure. This figure was multiplied by $5, the estimated rental cost per square foot to determine the costs of providing office space per professor. Since the variation in supplies and services expenditures among departments is negligible, the total supplies and services costs of the College were divided by the number of full-time equivalent general fund faculty members in the College to provide a supplies and services cost figure per faculty member. The assumption is that all professors in a given department are provided with equal amounts of equipment, secretarial services,

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[2]The secretary-faculty ratio for each department was determined by dividing the number of departmental secretaries by the number of departmental full-time equivalent general fund faculty members.

office space, and supplies and services. Also, continuing to operate under the assumption that each professor receives four assignments during each of the three academic quarters, one-twelfth of each of the above figures was divided by the number of students in the course under consideration. Algebraically, this process is described in equation (2):

$$(2) \quad FSC = \sum_{i=1}^{n} \left(\frac{PE}{(12)(S)} + \frac{(SE)(S/F)}{(12)(S)} + \frac{(Sal)(S/F)}{(12)(S)} + \frac{(DOS \div DFTEGFF)(\$5)}{(12)(S)} + \left[\left(\frac{SS}{CFTEGFF} \right) \right] \div \left[(12)(S) \right] \right)$$

Where:

FSC = Faculty Support Costs
PE = Average annual equipment costs per professor
S = Number of students in the course
SE = Average annual equipment costs per secretary
S/F = Secretary-faculty ratio
DOS = Departmental office space allocation (square feet)
DFTEGFF = Number of departmental full-time equivalent general fund faculty members
SS = Annual College supplies and services expenditures
CFTEGFF = Number of College full-time equivalent general fund faculty members
Sal = Average departmental secretary salaries
n = Number of College of Education courses in program of study

Research Costs

The costs of the research phase of the doctoral programs were derived by dividing one-twelfth of the average annual faculty salary in the appropriate department by four, under the assumption that the direction of four completed dissertations during any academic quarter is equivalent to the teaching of one course. In equation form the process is as follows:

$$RC = \frac{FS}{(12)(4)}$$

Where: RC = Research costs of degree
FS = Annual faculty salary

The average departmental salary figures used in the calculations were as follows: (1) Administration and Higher Education - \$11,141, (2) Counseling, Personnel Services and Educational Psychology - \$12,007, (3) Elementary and Special Education - \$11,675, and (4) Secondary Education and Curriculum - \$11,231. These averages were derived from the six highest academic ranks listed in Table 2.

Space Costs

The determination of classroom space costs is a case where the opportunity cost principle is quite apparent. The historical costs of classroom buildings have no relevance. The costs of the space should be considered only

Table 2. Average Ten-Month Salary Figures, by Department and Rank, College of Education, Michigan State University, 1967-68

Rank	Administration and Higher Education	Counseling, Personnel Services & Educational Psychology	Elementary and Special Education	Secondary Education and Curriculum
Professor	16,498	15,914	14,858	14,800
Associate Professor	12,596	13,175	12,193	12,088
Assistant Professor	9,920	10,540	11,593	11,155
Instructor	5,550	--	8,533	8,516
Specialist	--	--	11,200	9,600
Lecturer	--	8,400	--	--
Assistant Instructor	4,200	4,305	4,165	4,200
Graduate Assistant	3,150	2,889	2,873	3,129
Clerical	4,650	4,084	3,986	4,093

Source: Office of the Dean, College of Education, Michigan State University, January 1969

to the extent that the space has value in alternative uses. The annual rental values of comparable space in the Lansing-East Lansing area is the closest approximation of the economic costs incurred in the use of space. On the basis of discussions with members of the Michigan State University

Office of Space Utilization, it was assumed that the average size of a "classroom student station" was 13 square feet, which would rent commercially at $5 per square foot. It was further assumed that the average student station provides 1200 hours of service per year (30 hours per week for forty weeks at 100 percent of capacity). The normal three hour course will consume 30 hours per term or 2.5 percent of the annual space service. Therefore, $1.62 was charged as a space cost to each student in each three hour course taught in a classroom. To arrive at space costs (SC) per degree, this figure was multiplied by the number of three hour courses taken by the student.

Administrative Costs

College administrative costs were allocated to the various courses on the basis of student credit hour production. All salaries and other expenses incurred by the three offices were included in the final cost figures and are presented in Table 3. The expenses of the Dean's Office were allocated over all student credit hours produced by the College, while the expenses of the Graduate Student Affairs Office and the Undergraduate Student Affairs Office were charged off to graduate and undergraduate students, respectively, on the basis of student credit

Table 3. Administrative Expenses: Undergraduate Student Affairs Office (UGSAO), Graduate Student Affairs Office (GSAO), and Dean's Office; Student Credit Hours: Graduate, Undergraduate, and Total; Administrative Costs per Student Credit Hour: Graduate, Undergraduate, Overall; College of Education, Michigan State University, Academic Year 1967-68

Office	Total Expenses	Student Credit Hours	Cost/SCH
UGSAO	$ 67,660	130,920	$ .51
GSAO	42,029	36,743	1.14
Dean's Office	149,186	167,663	.89

Source: Office of the Dean, College of Education, Michigan State University, January 1969.

hours consumed. This method of deriving administrative costs for a given degree can be represented algebraically as follows:

$$AC_G = \frac{\text{GSAO expenses}}{\text{Grad. SCH}} + \frac{\text{Dean's expenses}}{\text{C of E Total SCH}} \times \text{SCH}$$

$$AC_U = \frac{\text{UGSAO expenses}}{\text{UG SCH}} + \frac{\text{Dean's expenses}}{\text{C of E Total SCH}} \times \text{SCH}$$

Where: AC_G = Administrative costs (Graduate students)
AC_U = Administrative costs (Undergraduate students)
GSAO expenses = Total academic year expenses incurred by the Graduate Student Affairs Office
Grad. SCH = Total number of graduate student credit hours produced during academic year
Dean's expenses = Total expenses incurred by Dean's Office during academic year
C of E Total SCH = Total student credit hours produced by College of Education during academic year
UGSAO expenses = Total academic year expenses incurred by the Undergraduate Student Affairs Office
UGSCH = Total number of undergraduate student credit hours produced during academic year
SCH = College of Education student credit hours in student's program

Most degree candidates take courses outside the College of Education. No cost figures were imputed since these costs were external to the College of Education. Therefore, the total cost to the College of Education for any given degree is the sum of the above five categories, that is: TC = IC + FSC + RC + SC + AC.

Where: TC = Total Degree Costs
IC = Instructional Costs
FSC = Faculty Support Costs
RC = Research Costs
SC = Space Costs
AC = Administrative Costs

The cost calculation method presented in this Chapter was used to determine the cost of each of the programs in the sample (Appendix B). These degree costs were used as dependent variables in the regression analysis which is discussed in the next chapter.

CHAPTER V

STATISTICAL ANALYSIS

The method used to derive the costs of the degree programs in the College of Education was presented in the last Chapter. In this Chapter, the total costs (and component costs) of the programs are presented along with the statistical analysis used to test the hypothesis.

College of Education Degree Costs

To say that, on the average, the cost of degree programs offered by the College of Education is X number of dollars would be highly misleading and meaningless due to the wide variety of degree program offerings, and variations in their costs. The programs must be disaggregated with respect to level of study if the cost figures are to have any significance, and further subdivided by curriculum to achieve a greater level of precision.

Table 4 presents the average total cost of degree programs on the three levels under consideration.

Table 4. Space, Administrative, Faculty Support, Instructional, Research, and Total Costs, in Dollars and Percent of Total, by Academic Level, College of Education, Michigan State University, 1967-68

Level	Space		Administrative		Faculty Support		Instruction		Research		Total Costs
	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%	Cost
B.A.	35	5	90	14	20	3	508	78	--	-	653
M.A.	20	3	71	11	59	9	502	77	--	-	652
Ph.D.	24	2	87	6	147	11	901	64	240	17	1399

Source: Calculated from data obtained from the Office of the Dean and the Office of Administrative Services, College of Education, Michigan State University, January 1969

As might be expected, the total cost of the doctorate is the highest of the three programs, being over twice the cost of either of the other two degree categories. The percentage of total costs accounted for by instruction drops by about 17 percent (13 or 14 percentage points) when moving from the B.A. and M.A. levels to the Ph.D. level (from 78 percent and 77 percent for the B.A. and M.A., respectively, to 64 percent for the Ph.D.).

The change in percentage accounted for by instruction is generated primarily by the addition of the research costs category which, on the doctoral level, accounts for 17 percent. The Faculty Support Costs category appears to be an increasingly important cost component as the level of study increases. The trend in faculty support costs is largely the result of the typically smaller class size on the graduate level where the support costs per faculty member for the course under consideration are allocated over a smaller number of students. There is an inverse relation between the level of study and the percentage of total costs accounted for by administrative costs. Since administrative costs were calculated on the basis of the number of student credit hours in the degree program, the relation between administrative expenses and the proportion of total costs is explained by the larger number of College of Education student credit hours in the typical undergraduate program.

Within each program level, variations in cost exist (see Table 5). On the B.A. level, the total cost of a degree in Special Education, on the average, is substantially higher than either of the other two curricula. Two degree candidate requirements in the Special Education program explain the high costs: (1) a series of high-cost courses, and (2) 15 credit hours of in-field student teaching over the normal certification requirement. Total costs of the individual degrees among the several curricula on the M.A. level range from $527 (Agricultural Education) to $805 (College Personnel Work). On the doctoral level, the range of costs of the various degree programs is $326 (Educational Administration - $1,561 to Curriculum - $1,235).

Regression Analysis

To determine if the cost differences among the degree programs on the three levels and the several curricula are statistically significant, and to isolate the factors that explain the variations, the data were subjected to step-wise multivariate regression analysis. The use of this technique in making statistical inferences implies

Table 5. Space, Administrative, Faculty Support, Instructional, Research, and Total Degree Costs, in Dollars and Percent of Total, by Level and Curriculum, College of Education, Michigan State University, 1967-68

Level and Curriculum	Space		Administrative		Faculty Support		Instruction		Research		Total
	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Total Cost
B.A.:											
Jr. High Teach	31	5	80	14	16	3	444	78	-	-	571
Special Ed.	45	5	115	13	30	3	720	79	-	-	910
Elementary Ed	29	6	75	15	14	3	361	76	-	-	479
M.A.:											
Reading Inst.	22	4	58	10	43	7	473	79	-	-	596
Ag. Ed.	15	3	59	11	42	8	411	78	-	-	527
Bus & Dist Ed	18	3	69	10	46	7	551	80	-	-	684
Secondary Ed	18	3	66	12	43	8	422	77	-	-	549
Elementary Ed	22	4	82	14	39	7	421	75	-	-	564
Guid & Pers Serv.	20	3	75	10	48	6	601	81	-	-	744
Ed. Admin.	20	3	74	11	102	15	475	71	-	-	671
Coll. Stud. Pers. Work	23	3	85	11	102	12	595	74	-	-	805
Ed. Psych.	21	3	75	11	77	11	525	75	-	-	698
Curriculum	19	3	69	10	55	8	548	79	-	-	691
Ph.D.:											
Curriculum	22	2	80	6	79	6	820	67	234	19	1235
Guid. & Pers. Serv.	21	2	74	5	140	10	876	64	250	19	1361
Ed. Admin.	24	2	81	5	230	15	994	64	232	14	1561
Elementary Ed	32	2	117	9	73	5	891	66	243	18	1356
Higher Ed	23	1	82	6	213	14	928	63	232	16	1478

Source: Calculated from data obtained from the Office of the Dean and the Office of Administrative Services, College of Education, Michigan State University, January 1969.

the following assumptions with regard to the residuals:[1] (1) they are clustered around a rectilinear (not curved) plane, (2) they are independent of each other, (3) they are uniform in their scatter and, for the small samples, (4) they are normally distributed.[2] A simple method of checking the fulfillment of these assumptions is to plot the residuals against the variables. Three variables (Number of College of Education Student Credit Hours, Average Class Size, and Total Degree Costs) were plotted against the residuals. Observation of Table 6 and Figures 4, 5, and 6 indicates approximately uniform scatter over the range of the variables under consideration, and there is no evidence of curvilinearity. Therefore, it can be concluded that the assumptions of linearity and homoscedasticity have been fulfilled.

Multiple regression analysis measures the joint effect of a specified number of variables on an independent variable. The multiple regression equation represents the

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[1]The residual (z = Y-Yc) gives the variation in degree costs not explained by the multiple regression equation.

[2]William A. Spurr and Charles P. Bonini, <u>Statistical Analysis for Business Decisions</u>. (Homewood, Ill.: Richard D. Irwin, Inc., 1967).

Table 6. Student Credit Hours (SCH), Class Size, Total Cost, and Regression Residuals, by Student Observation, Degree Program Cost Study, College of Education, Michigan State University, 1969

Observation	SCH	Class Size	Total Cost	Residual
1	45	150	496	118.61
2	59	119	643	15.41
3	49	133	461	-13.89
4	58	131	583	6.22
5	55	130	551	16.17
6	86	103	742	-319.42
7	57	130	574	4.76
8	58	131	583	6.22
9	58	116	652	25.28
10	47	172	419	110.89
11	84	79	985	- 3.04
12	84	100	807	-111.13
13	78	111	843	26.65
14	89	77	974	-75.01
15	79	119	812	11.43
16	87	97	995	34.29
17	79	112	844	20.12
18	80	106	910	55.28
19	86	90	1048	74.85
20	82	106	893	-33.43
21	58	157	457	-20.52
22	59	164	539	73.92
23	60	107	591	-74.71
24	46	157	419	71.81
25	57	126	519	-50.86
26	49	145	447	27.27
27	54	128	505	-25.62
28	46	157	419	71.81
29	50	146	435	7.74
30	61	157	459	-51.10
31	39	27	620	- 1.69
32	42	36	552	-54.55
33	36	40	665	139.47
34	42	38	526	-38.37
35	37	28	542	-54.64
36	39	27	620	23.67
37	42	35	670	77.87
38	48	35	637	5.08
39	39	39	673	-68.14
40	31	36	668	-28.69

Observation	SCH	Class Size	Total Cost	Residual
41	21	26	623	113.40
42	31	33	428	-120.92
43	25	38	444	-23.10
44	32	32	510	- 7.44
45	21	3	300	-111.44
46	32	32	512	-15.59
47	35	27	710	97.65
48	25	28	444	-56.40
49	34	37	612	66.64
50	34	20	682	57.21
51	34	21	863	155.55
52	30	32	610	8.00
53	36	32	708	15.45
54	34	31	645	-51.98
55	33	29	632	-60.78
56	34	31	645	-29.14
57	31	30	635	- 9.89
58	33	36	635	-11.63
59	37	35	634	-82.25
60	42	29	842	66.68
61	31	32	541	1.33
62	36	29	680	93.80
63	33	32	541	-20.38
64	31	30	541	- 5.32
65	38	30	423	-88.73
66	34	26	631	38.77
67	36	41	470	-33.10
68	33	32	541	- 5.16
69	36	29	698	94.04
70	33	39	440	-75.24
71	33	39	429	-16.35
72	45	36	591	- 4.82
73	30	37	450	35.64
74	45	36	591	33.23
75	42	41	428	-118.59
76	45	34	702	99.51
77	42	35	666	114.65
78	42	38	590	53.71
79	39	40	557	24.43
80	45	39	543	-42.84
81	30	23	621	-67.65
82	51	25	898	61.49
83	39	33	744	8.64
84	34	30	527	-138.66
85	45	29	837	33.38

Observation	SCH	Class Size	Total Cost	Residual
86	36	35	563	-110.27
87	39	33	744	16.25
88	25	24	897	265.98
89	36	22	771	13.84
90	40	23	846	48.72
91	33	40	573	-108.15
92	45	40	851	- 8.30
93	39	38	705	-91.11
94	36	38	645	-100.77
95	36	37	689	-77.86
96	36	37	659	-107.86
97	36	40	608	-131.11
98	37	41	601	-143.10
99	35	37	642	-114.00
100	32	36	743	-27.19
101	48	31	875	52.84
102	42	24	809	-19.49
103	41	24	808	- 9.63
104	41	24	876	73.59
105	39	27	744	-41.92
106	43	29	794	-13.48
107	39	27	744	-24.16
108	45	26	855	15.80
109	39	30	695	-63.17
110	48	32	851	29.64
111	33	29	764	90.20
112	30	27	532	-90.49
113	43	35	688	-28.76
114	45	31	747	-25.10
115	42	34	760	17.78
116	33	29	764	82.58
117	42	35	714	10.63
118	36	31	720	55.79
119	30	29	599	-42.21
120	42	35	704	-70.41
121	42	28	685	-19.60
122	37	23	753	88.59
123	30	21	656	43.20
124	30	21	755	142.20
125	30	21	656	73.65
126	33	37	616	23.88
127	31	25	641	53.49
128	42	26	789	77.73
129	42	29	740	38.72
130	30	37	614	77.30

Observation	SCH	Class Size	Total Cost	Residual
131	43	26	1292	-29.87
132	39	27	1072	-165.34
133	43	26	1292	8.18
134	36	22	1019	-222.40
135	42	30	1250	-47.70
136	38	10	1102	-218.84
137	30	18	1078	-129.31
138	39	18	1426	138.69
139	43	20	1339	-2.85
140	49	24	1464	70.29
141	39	17	1518	127.08
142	48	19	1641	158.99
143	36	16	1391	29.34
144	38	18	1104	-164.10
145	27	20	1208	-42.58
146	60	25	1559	-23.22
147	38	19	1246	-127.39
148	24	14	1188	-49.97
149	45	19	1365	-69.19
150	36	16	1391	29.34
151	43	18	1581	90.32
152	47	22	1723	202.19
153	48	36	1152	-333.05
154	47	22	1723	202.19
155	40	15	1730	261.91
156	51	19	1726	151.75
157	36	19	1373	-38.31
158	51	19	1726	151.75
159	40	19	1508	53.23
160	36	19	1373	9.89
161	72	30	1477	-49.58
162	45	25	1112	-137.96
163	42	31	1161	-36.40
164	45	25	1112	-137.96
165	61	25	1464	40.25
166	47	22	1281	- 0.67
167	72	30	1477	- 8.98
168	70	35	1581	113.08
169	61	25	1464	88.45
170	72	29	1438	-48.77
171	48	22	1575	43.33
172	48	22	1575	43.33
173	42	23	1388	-75.16
174	49	24	1723	187.12
175	39	19	1409	-34.90

Observation	SCH	Class Size	Total Cost	Residual
176	45	24	1448	-44.42
177	36	18	1402	-12.64
178	30	15	1458	98.53
179	36	18	1402	-12.64
180	39	19	1409	-34.90

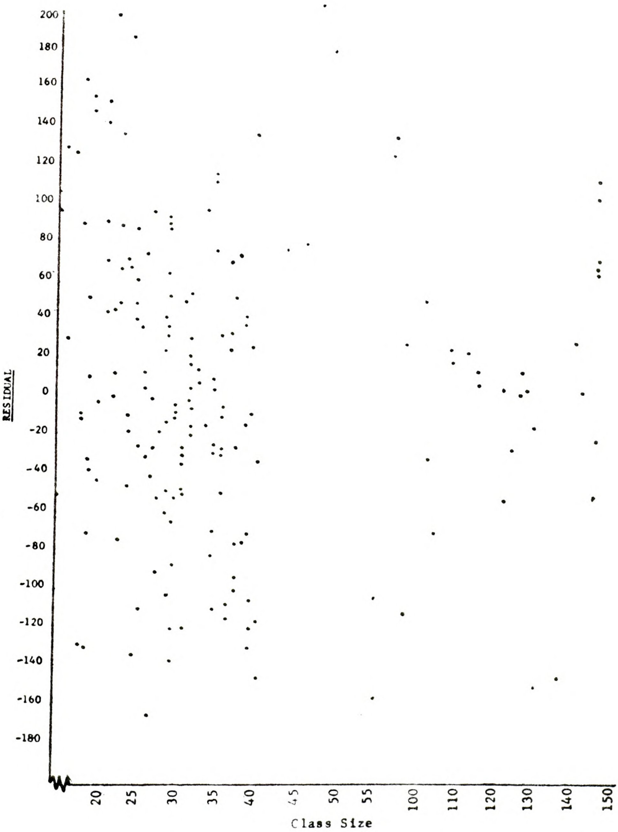

Figure 5. Regression Equation Residuals Plotted Against Average Class Size Variable, Degree Program Cost Study, College of Education, Michigan State University, 1969.

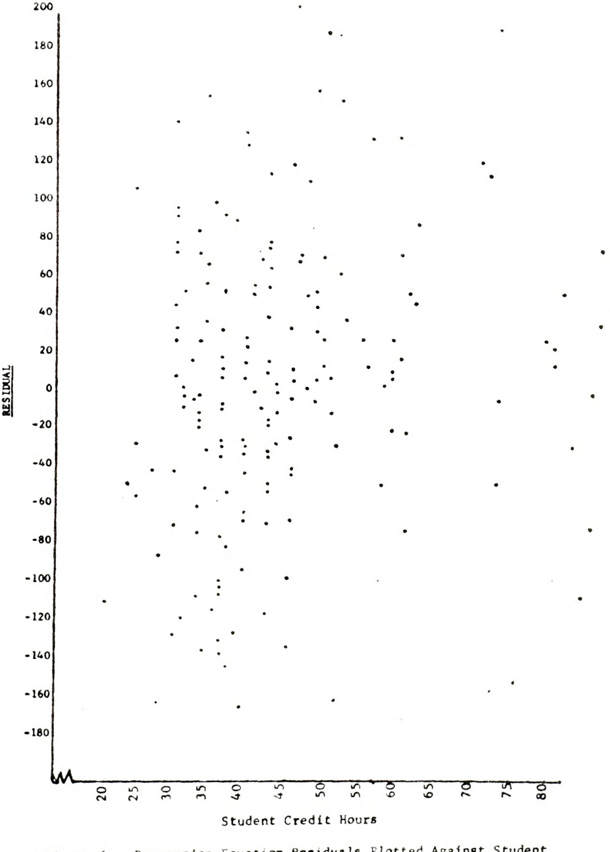

Figure 6. Regression Equation Residuals Plotted Against Student Credit Hours Variable, Degree Program Cost Study, College of Education, Michigan State University, 1969.

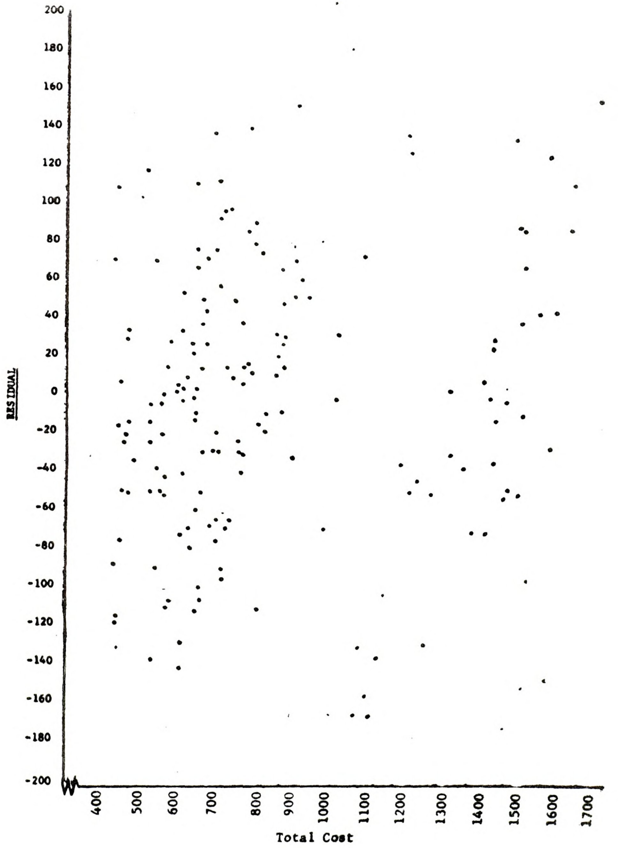

Figure 7. Regression Equation Residuals Plotted Against Total Cost Variable, Degree Program Cost Study, College of Education, Michigan State University, 1969.

influence exerted simultaneously by the independent variables on the dependent variable. In stepwise regression analysis, the independent variables enter the regression equation in the order of ability to reduce the unexplained error sum of squares of the dependent variable. The independent variable which causes the greatest reduction will enter the equation first, the variable causing the next greatest reduction enters second, and so forth until all variables which have a statistically significant effect on the dependent variable have entered the equation.[3]

The regression equation was of the general form

$$Y_c = a + b_1x_1 + b_2x_2 + \ldots + b_nx_n$$

In the terminal step of this analysis (Appendix D) the appropriate regression and standard error coefficients were as follows:

$$Y_c = 421.7 - \underset{(110.9)}{377.6}\, x_1 + \underset{(117.5)}{202.5}\, x_2 + \underset{(32.9)}{136.7}\, x_6 +$$

$$\underset{(26.4)}{149.3}\, x_8 + \underset{(23.8)}{211.5}\, x_9 + \underset{(32.9)}{164.7}\, x_{10} + \underset{(33.6)}{146.1}\, x_{11} + \underset{(26.3)}{66.3}\, x_{12} +$$

$$\underset{(0.8)}{10.0}\, x_{13} - \underset{(0.7)}{3.4}\, x_{14} + \underset{(1.1)}{2.9}\, x_{15} \qquad R^2 = .941$$

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[3]"Statistically significant" as used here means that differences of the magnitude obtained would be expected to occur only rarely if no difference existed in the population. In some cases, statistically significant differences might be found with no corresponding economic significance. An analysis indicating that two different varieties of wheat have statistically significant differences in yield (even at an alpha level of less than one percent) has no economic significance if the difference in average yield is one pound per hundred

Where: Y_c = Cost of degree
x_1 = M.A.
x_2 = Ph.D.
x_6 = Business and Distributive Education
x_8 = Guidance and Personnel Services
x_9 = Educational Administration
x_{10} = Student Personnel Work
x_{11} = Educational Psychology
x_{12} = Curriculum
x_{13} = Number of College of Education Student Credit Hours
x_{14} = Average Class Size
x_{15} = Ratio of Graduate to Total College of Education Student Credit Hours

The regression coefficients are interpreted in the normal manner. For example, the equation states that, on the average, the degree costs will increase by ten dollars with each additional College of Education student credit hour in the program (x_{13}) and decrease by $3.40, on the average, as the average class size (x_{14}) increases by one student. The policy implications of the regression coefficients are discussed in Chapter VI.

The regression equation was significant in explaining variations in total costs at this point with an F value of 243.39. The multiple correlation coefficient was .970;

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acres. Alternatively, a difference of ten bushels per acre might have economic significance even though it was not statistically significant at a given alpha level. The term "significant" when used in this thesis, refers to "statistical significance." (See Lester V. Manderscheid, An Introduction to Statistical Hypothesis Testing, East Lansing: Department of Agricultural Economics, Michigan State University, 1964, p. 29) therefore, an R^2 value of .94 was obtained. That is, 94 percent of the variation in total degree costs is explained by the regression equation. The number of College of Education student credit hours, the ratio of graduate to total student credit hours, and the average class size were found to have statistically significant effects on the costs of degree programs (t values of 11.3113, - 4.7838, and 2.4049, respectively).

The first variable to enter the equation was number two, the dummy variable[4] for the doctoral level of study. The multiple correlation coefficient was .902, so 81 percent of the variation in degree program costs was explained by the Ph.D. level of study when it was the only independent variable considered. The number of College of Education student credit hours was the second variable to enter the equation. These two variables explained 85 percent of the variation in degree costs. Class size was the third variable to enter and, when the three were considered together, they explained 88 percent of the variation in cost.

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[4]Dummy variables are often used to represent qualitative variables in regression analysis. In this thesis, level of study and curriculum were represented by dummy variables with the B.A. level and Elementary Education being the variables which were dropped.

Level of Study and Curriculum Variables

It must be emphasized that contradictions may exist between the whole and the parts in a statistical analysis. As indicated above, the differences in degree costs between the doctoral level and the B.A. level are statistically significant. It does not follow that level of study, in general, is a statistically significant factor affecting degree program costs. To determine if level of study and curriculum were statistically significant cost factors, the following test was used:[5]

$$F = \frac{ESS_1 - ESS_2 \ /d.f.}{ESS_1 \ /d.f.}$$

Where: ESS_1 = Error Sum of Squares of the regression equation including dummy variables for level and curriculum.

ESS_2 = Error Sum of Squares of regression equation excluding dummy variables of factor under consideration (i.e., either level or curriculum).

d.f. = degrees of freedom

In testing for the significance of level of study, the null and alternative hypotheses were as follows:

H_0: $B_1 = B_2 = 0$ (level has no effect)

H_A: $B_1 \neq B_2 \neq 0$ (level has an effect)

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[5] J. Johnston, Econometric Methods (New York: McGraw-Hill, Inc., 1963), pp. 136-137.

Similarly, the null and alternative hypotheses for testing the significance of curriculum differences were as follows:

H_0: $B_3 = B_4 = B_n = 0$ (curriculum has no effect)

H_A: $B_3 \neq B_4 \neq B_n \neq 0$ (curriculum has an effect)

An F value of 391.0 was found in testing for the effects of level differences on cost, and an F value of 11.6 was found when testing for the effects of curriculum differences on cost. Both of these values were significant at the 5 percent level; therefore, the null hypothesis was rejected in both cases. That is, both the level of study and curriculum have a statistically significant effect on degree program costs.

As indicated above, dummy variables were used to isolate the effects of level of study and curriculum on total cost. Both the M.A. and Ph.D. variables were found to be significant at the 5 percent level. This indicates that there was a statistically significant difference in cost between the B.A. level and the M.A. level, and also between the B.A. level and the Ph.D. level, but no information about the relationship between the M.A. and Ph.D. was available. To arrive at an approximation of this relationship, a modified Student t test was used. It was an approximation in the sense that no account was taken of covariance in the equation, so problems of transitivity might arise. The test was of the following form:

$$t = \frac{b_1 - b_2}{S^2_{b_1} + S^2_{b_2}}$$

where: b = regression coefficient
S = standard error

A t value of 3.6 was obtained indicating that a statistically significant difference probably exists between M.A. and Ph.D. program costs at the 5 percent level.

The following curriculum variables were included in the regression equation's eleventh step: Business and Distributive Education, Guidance and Personnel Services, Educational Administration, Student Personnel Work, Educational Psychology, and Curriculum. The t values of each of these variables were significant, indicating that the costs of providing degrees in these areas were significantly different from the cost of a degree in Elementary Education. To determine if differences of statistical significance existed between sets of these variables, the t test described above was applied.

The results of the t test are contained in Table 7 At the 5 percent level, the cost differences between the following sets of degrees were found to be significant: (1) Educational Administration - Business and Distributive

Education, (2) Curriculum - Business and Distributive Education, (3) Educational Administration - Guidance and Personnel Services, (4) Curriculum - Guidance and Personnel Services, (5) Curriculum - Educational Administration, (6) Curriculum - Student Personnel Work, and (7) Curriculum - Educational Psychology.

Table 7. Matrix of t Values Generated by Tests for Significant Differences at 5 percent Level, by Combinations of Degree Programs, Degree Program Cost Study, College of Education, Michigan State University, January 1969.

Department	Bus & Dist Education	Guid & Pers.	Ed Admin	Student Pers.	Ed. Psych
Guidance & Personnel	.30				
Educational Administration	1.85	1.77			
Student Personnel	.63	.38	1.12		
Educational Psychology	.22	.07	1.58	.40	
Curriculum	1.70	2.24	4.14	2.35	1.90

<u>Summary</u>

The general conclusion of this chapter is that the null hypothesis of the thesis was rejected. That is, it was concluded that the following factors were statistically significant at the 5 percent level in explaining differences in degree program costs in the College of Education, Michigan State University: (1) class size, (2) level of study, (3) curriculum, (4) number of College of Education student credit hours in the degree program, and (5) ratio of graduate to total College of Education student credit hours in the degree program.

The policy implications of the degree costs and statistical findings presented in this Chapter are discussed in detail in Chapter VI.

CHAPTER VI

SUMMARY AND IMPLICATIONS

In recent years, the demand for educational services on the university level has increased greatly and every indication is that the trend will continue. Additionally, it is likely that the demand for these educational services will increase at a faster rate than the supply, the major limitation on supply being the budget constraint. Faced with this economic problem, decision makers in institutions of higher learning must allocate their limited resources as efficiently as possible to provide for the attainment of feasible institutional objectives. In order to make intelligent decisions with regard to the allocation of scarce resources, they must know the alternative courses of action that will accomplish institutional objectives, and the economic costs involved in providing each alternative.

The purpose of this study was to provide a basis for obtaining the cost information needed to make sound, economic decisions in the process of allocating educational resources.

Summary

The relevant literature in the area of educational costs was reviewed in Chapter II. This review indicated that most of the previous researchers in this area had either simply divided total expenditures by some unit of educational output or disaggregated the cost data into such general categories that the final unit cost figures were relatively meaningless. In most cases, the costs were simply accounting data that did not reflect the value of resources in terms of alternative uses. The present study attempted to remedy this deficiency.

The costs which must be included in an economic analysis were outlined in Chapter III along with the conceptual framework within which constrained choice problems are solved. Consumer indifference theory was used to demonstrate the method of choosing the point of optimum allocation when resources are limited and wants are insatiable. The isoquant approach to production theory and its application to long run educational resource allocation was reviewed. The opportunity cost principle was outlined and applied to educational costing problems.

Based on the economic principles outlined in Chapter III, the method of determining the costs of educational programs in the College of Education was presented in Chapter IV. The types of costs to be included in an economic analysis as well as the units in which the costs should be measured were determined before the actual costing method was developed. All costs (regardless of the point in time at which they were incurred) that result from adopting a particular course of action must be included. Since the supply function of educational inputs faced by the individual college appears to have relatively few bottlenecks, the major limitation on expanded resource use is the annual budget. Therefore, the dollar was chosen as the unit of measurement in which costs would be presented. The total cost of each degree was found by summing five component cost categories: (1) instructional costs, (2) faculty support costs, (3) research costs, (4) space costs, and (5) administrative costs.

The total costs (and component costs) of the several degree programs in the sample were presented in Chapter V along with the statistical analysis used to test the hypothesis. On the average, the cost incurred by the College of Education in producing a Ph.D. degree ($1399) was about twice the cost incurred in the production of either a B.A. degree ($653) or M.A. degree ($652). When degree cost variations within each level were considered, however, these generalizations lost much of their meaning. The cost of an average B.A. degree in Special Education ($910) was almost twice that of a B.A. degree in Elementary Education ($479), and $105 more than the most costly degree on the M.A. level. The cost ranges within each level of study were as follows: (1) B.A. - $431, (2) M.A. - $278, and (3) Ph.D. - $326.

The hypothesis was that the following factors were statistically significant at the five percent level in explaining degree program cost differences in the College of Education: (1) class size, (2) program level (i.e., B.A., M.A., Ph.D.), (3) curriculum, (4) number of College of Education student credit hours in the degree program, and (5) the ratio of graduate to total student credit hours in the degree program. Each of these factors was found to be statistically significant in explaining cost differences at the five percent level, so the null hypothesis was rejected.

Implications

It was pointed out in Chapter V that a difference exists between statistical significance and economic significance. From an economic point of view, a knowledge of

differences in costs is necessary to determine which alternatives must be given up in order to achieve an objective with other alternatives. The costs derived in this study should be useful to the administrators in making decisions such as determining the number of students to be admitted to degree programs on each of the four levels in each of the curriculum areas. In making decisions of this type, the marginal cost per degree is the relevant cost to be considered. The costs derived in this study were average costs; however, operating under the assumption that no scale economies or diseconomies will result from changing the number of students in a given program with quality constant, average costs may be used. This substitution is possible because a horizontal average cost curve is equal to the curve marginal to it at each level of output. Communication with Dr. Floyd Reeves, a pioneer researcher in the field of educational costs, indicated that no conclusive research results have been published with regard to economies of scale in subunits of institutions of higher learning. Based on his experience, however, he suggested that in the range of operation, very few scale economies are available to an institutional subunit such as the College of Education, if the quality of educational services are held constant. If the student-teacher ratio,

average class size, the quality of faculty, the physical facilities, and supporting services are held constant, the per unit cost changes resulting from institutional size changes should be minimal. This would not necessarily be the case for the entire university due to large expenditures of the sunk cost variety. Some examples of expenditures in this category are those for extracurricular activities, health services, police services, and university administration.

The quality constant condition is of major importance to the assumption of constant costs. If additional students are handled by increasing class size with no corresponding increase in faculty, administrators, or supporting facilities, economies of class size would obviously cause decreases in instructional costs. The regression equation presented in Chapter V reveals that, on the average, degree costs decrease by $3.40 in response to an increase in class size of one student. Therefore, to the extent that the minimization of costs is one of the primary goals of the College, there would be an incentive to increase the size of classes. For the purpose of comparing the costs of degree programs in this study, however, the assumption is that the decision makers are able to overcome this incentive and maintain the size of any given class at a constant level.

The regression equation also indicated that, on the average, costs increased $10 for each additional College of Education credit hour in the degree program. An obvious cost-reducing administrative action would be to cause a decrease in the ratio of College of Education student credit hours to total student credit hours in the average program of study. This action could be implemented without changing the number of degrees produced in any given academic area or reducing the number of student credit hours required for graduation by eliminating courses which are similar to courses presented by other colleges in the University. It would seem that unnecessary duplication might exist in areas such as psychology, sociology, and statistics. Certainly some courses relating specifically to educational research methods, for example, are not only desirable, but necessary for a well-balanced, complete degree program. The courses which should be considered for elimination are those in which general principles are covered, and are already being adequately handled by a department of another college. As indicated in Chapter I, many factors other than those of an economic nature enter into decisions of this type, but it is imperative that administrators be aware of the effect that the luxury of course duplication has on degree costs.

If the decision makers in the College of Education decide that the production of degrees in one academic area should be expanded, the production of degrees in another area (or areas) will have to be reduced assuming a constant budget.[1] The cost figures derived in the present study provide information regarding what benefits (degrees) have to be sacrificed in one academic area to receive a given level of benefits (degrees) in another area. If it is determined that more students in the area of Student Personnel Work are to be admitted to the Master's degree program, and the additional resources required to expand the degree program are to be obtained by reducing the level of degree production in Agricultural Education on the M.A. level, the data presented in Chapter V indicate that for every six student positions removed from agricultural education, about four can be added to the Student Personnel Work degree program without additional resources. Relations of this type can be made between and among all of the degrees for which costs were calculated.

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[1]Personnel in the College of Education are engaged in resource consuming activities other than teaching such as research and public services. In this study only degree programs are considered, but the same analysis would apply in allocating resources among a number of activities.

As indicated in previous chapters, one of the goals of this thesis was to remedy some of the deficiencies found in previous educational cost studies. To the extent that the costs derived in these studies have been inaccurate and have been used in the decision-making process, they might have led to the misallocation of resources. Resource misallocation occurred in the sense that inaccurate and imprecise cost figures do not reflect the true economic value of factors of production, and when inaccurate values are assigned to resources, maximum efficiency is impossible. It is only when an educational institution combines its resources in the most efficient manner that a given number of students can be provided a certain quality education at a minimum cost. Stated alternatively, it is only when resources are combined in the most efficient manner that the maximum number of students can be provided a certain quality of education at a given cost.

The contention is not that the present study has eliminated all of the problems encountered in measuring educational costs and, therefore, provided educational decision makers with the data necessary to obtain optimal resource allocation positions. It is hoped, however, that the methods developed will permit a movement toward the optimum solution, and provide the basis for future research which will allow further movements toward optimality.

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A P P E N D I C E S

Appendix A. Average Class Size, Average Annual (Ten Month) Professorial Salary, Average Professorial Salary Per Course, and Instructional Cost Per Student by Course, College of Education, Michigan State University, Academic Year 1967-68

Coded Course Number	Average Class Size	Salary ($)		Instructional Cost Per Student ($)
		Average Annual	Allocated to this Course	
A	78	8,533	711	9.21
B	22	6,000	500	22.71
C	24	12,088	1007	41.94
D	500	12,088 ÷ 12 12,518 ÷ 3 *	1007 + 4172	10.35
E	20	3,129	1043	52.14
F	46	13,175	1098	23.86
G	110	12,500	1041	9.50
H	97	11,500	958	11.26
I	34	11,231	936	27.51
J	17	12,088	1007	59.22
K	13	11,593	966	74.28
L	46	10,540	878	19.08
M	39	12,007	1000	25.62
N	13	11,500	958	73.68
O	44	11,675	973	22.11
P	21	6,000	500	23.79
Q	27	6,000	500	18.51
R	27	11,675	973	41.10
S	103	11,231	936	9.09
T	20	12,088	1007	50.34
U	112	12,000	1000	30.00
V	37	13,000	1083	29.25
W	99	15,914	1326	13.38
X	381	11,155 ÷ 12 15,645 ÷ 3 *	929 + 3881	12.60
Y	34	11,231	936	27.51
Z	32	13,000	1083	33.84
AA	37	11,155	929	27.57
BB	13	13,175	1097	84.36

Coded Course Number	Average Class Size	Salary: Average Annual	Salary: Allocated to this Course	Instructional Cost Per Student
CC	43	12,000	1000	23.25
DD	31	10,540	878	28.32
EE	35	13,500	1125	32.13
FF	13	12,596	1049	80.70
GG	22	12,007	1000	45.45
HH	28	14,800	1233	44.00
II	27	14,800	1233	45.66
JJ	20	13,500	1125	56.25
KK	25	11,231	936	37.44
LL	32	11,675	973	30.39
MM	25	11,155	929	37.14
NN	16	14,800	1233	77.07
OO	14	9,000	750	53.55
PP	24	14,000	1166	48.57
QQ	93	11,700	975	10.47
RR	23	12,000	1000	43.47
SS	20	14,000	1166	58.29
TT	12	6,500	541	45.06
UU	27	13,000	1082	45.72
VV	35	13,000	1082	31.00
WW	13	12,500	1041	80.07
XX	35	2,889	963	34.35
YY	62	12,000	1000	16.11
ZZ	24	11,800	983	40.95
A[1]	10	12,150	1010	101.98
B[1]	25	11,500	958	38.31
C[1]	10	12,500	1040	103.98
D[1]	12	12,750	1062	88.50
E[1]	7	12,500	1040	148.50
F[1]	20	13,000	1083	54.12
G[1]	10	13,000	1083	108.50
H[1]	12	13,000	1083	90.00
I[1]	15	12,000	983	65.50

*Graduate Assistants' salaries are divided by three under the assumption that one assignment is received per academic quarter.

Source: Office of Institutional Research, Michigan State University, and Office of the Dean, College of Education, Michigan State University, January 1969.

Appendix B. Average Number of College of Education Student Credit Hours (SCH), Graduate/Total College of Education Student Credit Hours (G/T SCH), Component Costs (Space, Administration, Faculty Support, Instruction, and Research), and Total Degree Costs by Individual Degree Candidates, Degree Program Cost Study, College of Education, Michigan State University, 1969.

Observation	SCH	G/T SCH	Average Class Size	Space Costs	Admin Costs	Faculty Support Costs	Instr Costs	Research Costs	Total Costs
1	45	7	150	25	63	11	397	-	496
2	59	5	119	33	82	18	510	-	643
3	49	6	133	26	68	13	354	-	461
4	58	5	131	31	81	15	456	-	583
5	55	0	130	30	77	14	430	-	551
6	86	0	103	46	120	28	548	-	742
7	57	5	130	31	80	15	448	-	574
8	58	7	131	31	81	15	466	-	593
9	58	5	116	31	81	18	522	-	652
10	47	0	172	26	66	10	317	-	419
11	84	0	79	46	117	35	787	-	985
12	84	0	100	46	117	30	614	-	807
13	78	0	111	43	109	26	665	-	843
14	89	0	77	49	124	40	761	-	974
15	79	0	119	43	110	23	636	-	812
16	87	0	97	49	122	29	795	-	995
17	79	0	112	43	110	26	665	-	844
18	80	0	106	44	112	27	727	-	910
19	86	0	90	49	120	33	846	-	1048
20	82	0	106	44	115	27	707	-	893
21	58	0	157	31	81	14	331	-	457
22	59	0	164	31	82	13	413	-	539

Observation	SCH	G/T SCH	Average Class Size	Space Costs	Admin Costs	Faculty Support Costs	Instr. Costs	Research Costs	Total Costs
23	60	0	107	33	84	20	454	-	591
24	46	0	157	25	64	10	320	-	419
25	57	0	126	31	80	16	392	-	519
26	49	0	145	26	68	11	342	-	447
27	54	0	128	29	75	14	383	-	505
28	46	0	157	25	64	10	320	-	419
29	50	0	146	26	70	12	337	-	435
30	61	0	157	33	85	21	320	-	459
31	39	100	27	21	54	50	495	-	620
32	42	93	36	23	59	41	429	-	552
33	36	92	40	20	50	32	563	-	665
34	42	79	38	23	59	39	405	-	526
35	37	100	28	20	52	47	420	-	542
36	39	95	29	21	54	50	485	-	610
37	42	86	35	23	59	42	546	-	670
38	48	76	35	26	67	49	495	-	637
39	39	84	39	21	54	35	363	-	473
40	51	90	36	28	71	50	519	-	668
41	25	100	26	13	50	32	528	-	623
42	31	100	33	16	62	38	312	-	428
43	25	100	38	13	50	35	346	-	444
44	32	81	35	18	64	47	393	-	520
45	21	85	31	11	42	28	229	-	300
46	32	85	32	18	64	47	383	-	512
47	35	100	27	20	70	55	565	-	710
48	25	100	28	13	50	35	346	-	444
49	34	90	37	18	68	37	489	-	612
50	34	100	20	18	68	68	528	-	682

Observation	SCH	G/T SCH	Average Class Size	Space Costs	Admin Costs	Faculty Support Costs	Instr Costs	Research Costs	Total Costs
51	34	90	21	18	68	65	712	-	863
52	30	80	32	16	60	39	495	-	610
53	36	90	32	20	72	46	570	-	708
54	34	100	34	18	68	44	505	-	635
55	33	100	29	18	66	47	501	-	632
56	34	90	31	18	68	44	515	-	645
57	31	90	30	16	62	41	516	-	635
58	33	90	36	18	66	38	513	-	635
59	37	100	35	20	74	43	497	-	634
60	42	93	29	23	84	60	675	-	842
61	31	97	32	16	62	41	432	-	551
62	36	92	29	20	72	51	537	-	680
63	33	100	32	18	66	43	414	-	541
64	31	100	30	16	62	41	422	-	541
65	28	100	30	15	56	41	311	-	423
66	34	100	26	18	68	53	482	-	631
67	36	75	41	20	72	36	342	-	470
68	33	93	32	18	66	43	404	-	531
69	36	100	29	20	72	52	554	-	698
70	33	90	39	18	66	35	321	-	440
71	33	82	39	18	66	30	315	-	429
72	45	86	36	25	90	44	432	-	591
73	30	80	37	16	60	29	345	-	450
74	45	71	36	25	90	44	432	-	591
75	42	86	41	23	84	36	375	-	428
76	45	86	34	25	90	47	540	-	702
77	42	80	35	23	84	43	516	-	666
78	42	78	38	23	84	39	444	-	590

Observation	SCH	G/T SCH	Average Class Size	Space Costs	Admin Costs	Faculty Support Costs	Instr Costs	Research Costs	Total Costs
79	39	90	40	21	78	35	423	-	557
80	45	86	39	25	90	41	387	-	543
81	30	100	23	16	60	46	499	-	621
82	51	70	25	28	99	72	699	-	898
83	39	92	33	21	78	42	603	-	744
84	34	82	30	18	68	39	402	-	527
85	45	86	29	25	90	55	662	-	832
86	36	83	35	20	72	36	435	-	563
87	39	89	33	21	78	42	613	-	754
88	25	100	24	13	50	35	799	-	897
89	36	100	22	20	72	58	621	-	771
90	40	100	23	21	80	60	685	-	846
91	33	82	40	18	66	87	402	-	573
92	48	88	40	26	96	126	603	-	851
93	39	100	38	21	78	108	498	-	705
94	36	92	38	20	72	100	453	-	645
95	36	100	37	20	72	102	495	-	689
96	36	100	37	20	72	102	465	-	659
97	36	92	40	20	72	95	421	-	608
98	37	91	41	20	74	93	414	-	601
99	35	100	37	20	70	102	450	-	642
100	36	100	36	20	72	105	546	-	743
101	48	80	31	26	96	101	652	-	875
102	42	100	24	23	84	114	588	-	809
103	41	100	24	23	82	114	589	-	808
104	41	93	24	23	82	114	657	-	876
105	39	100	27	21	78	94	551	-	744
106	43	93	29	23	86	94	591	-	794

Observation	SCH	G/T SCH	Average Class Size	Space Costs	Admin Costs	Faculty Support Costs	Instr Costs	Research Costs	Total Costs
107	39	92	27	21	78	94	561	-	754
108	45	93	26	25	90	113	627	-	855
109	39	92	30	21	78	85	511	-	695
110	48	81	32	26	96	98	631	-	851
111	33	90	29	18	66	74	606	-	764
112	30	80	27	16	60	72	384	-	532
113	43	72	35	23	86	78	501	-	688
114	45	80	31	25	90	95	537	-	747
115	42	85	34	23	84	80	573	-	760
116	33	93	27	18	66	74	616	-	774
117	42	71	35	23	84	78	519	-	714
118	36	76	31	20	72	76	552	-	720
119	30	90	29	16	60	67	456	-	599
120	42	100	35	23	84	78	519	-	704
121	42	93	28	23	84	62	516	-	685
122	37	92	23	20	74	65	594	-	753
123	30	100	21	16	60	59	521	-	656
124	30	100	21	16	60	59	620	-	755
125	30	87	24	16	60	59	531	-	666
126	33	100	37	18	60	34	504	-	616
127	31	90	25	16	62	50	513	-	641
128	42	93	26	23	84	67	615	-	789
129	42	93	29	23	84	60	573	-	740
130	30	90	37	16	60	34	504	-	614
131	43	100	26	23	86	67	882	234	1292
132	39	92	27	21	78	60	699	234	1092
133	43	84	27	23	86	67	885	234	1295
134	36	92	22	20	72	67	626	234	1019

Observation	SCH	G/T SCH	Average Class Size	Space Costs	Admin Costs	Faculty Support Costs	Instr Costs	Research Costs	Total Costs
135	42	100	30	23	84	57	852	234	1250
136	38	100	10	21	76	162	609	234	1102
137	30	100	18	16	60	69	699	234	1078
138	39	92	18	21	78	70	1023	234	1426
139	43	100	20	23	86	87	909	234	1339
140	49	100	24	26	98	83	1023	234	1464
141	39	100	17	21	78	149	1020	250	1518
142	48	100	19	26	96	165	1104	250	1641
143	36	100	16	20	72	167	882	250	1391
144	28	100	18	15	56	108	675	250	1104
145	27	100	20	15	54	88	801	250	1208
146	60	95	25	33	99	157	1020	250	1559
147	38	100	19	21	76	134	765	250	1246
148	24	100	14	13	48	112	765	250	1188
149	45	93	19	25	90	154	846	250	1365
150	36	100	17	20	72	167	886	250	1395
151	43	100	18	23	86	246	994	232	1581
152	47	100	22	27	94	230	1140	232	1723
153	48	100	36	27	96	140	657	232	1152
154	47	100	23	27	94	230	1150	232	1733
155	40	100	15	21	80	274	1123	232	1730
156	51	100	19	26	99	283	1086	232	1726
157	36	100	19	20	72	200	849	232	1373
158	51	100	19	26	99	283	1076	232	1716
159	40	100	19	21	24	216	1015	232	1508
160	36	80	19	20	72	200	849	232	1373
161	72	100	31	39	144	85	976	243	1487
162	45	100	25	25	90	55	699	243	1112

Observation	SCH	G/T SCH	Average Class Size	Space Costs	Admin Costs	Faculty Support Costs	Instr Costs	Research Costs	Total Costs
163	42	100	31	23	84	45	766	243	1161
164	45	100	26	25	90	55	689	243	1102
165	61	100	25	33	122	85	981	243	1464
166	47	100	22	26	94	78	840	243	1281
167	72	83	30	39	144	85	966	243	1477
168	70	91	35	39	140	70	1089	243	1581
169	61	80	24	33	122	85	991	243	1474
170	72	82	29	39	144	88	924	243	1438
171	48	100	22	27	96	230	990	232	1575
172	48	100	24	27	96	230	980	232	1565
173	42	100	23	23	84	193	846	232	1388
174	49	100	24	27	98	211	1155	232	1723
175	39	100	19	21	78	217	861	232	1409
176	45	100	24	25	90	198	903	232	1448
177	36	100	18	20	72	211	867	232	1402
178	30	100	15	16	60	211	939	232	1458
179	36	100	18	20	72	211	867	232	1402
180	39	100	20	21	78	217	871	232	1419

Appendix C. Matrix of Simple Correlation Coefficients, from Multivariate Regression Analysis, Degree Program Cost Study, College of Education, Michigan State University, 1969

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1															
2	-.693	1														
3	-.271	-.150	1													
4	.216	-.150	-.058	1												
5	.216	-.150	-.058	-.058	1											
6	.216	-.150	-.058	-.058	-.058	1										
7	.216	-.150	-.058	-.058	-.058	-.058	1									
8	-.039	.175	-.085	-.085	-.085	-.085	-.085	1								
9	-.200	.388	-.108	-.108	-.108	-.108	-.108	-.158	1							
10	.216	-.150	-.058	-.058	-.058	-.058	-.058	-.085	-.108	1						
11	.216	-.150	-.058	-.058	-.058	-.058	-.058	-.085	-.108	-.058	1					
12	-.059	.175	-.085	-.085	-.085	-.085	-.085	-.125	-.158	-.085	-.085	1				
13	-.545	.036	.689	-.056	-.249	-.161	-.184	-.148	-.091	-.019	-.105	-.157	1			
14	-.378	-.369	.351	-.066	-.089	-.088	-.079	-.199	-.211	-.109	-.082	-.186	.549	1		
15	.424	.343	-.539	.081	.113	.102	.119	.169	.250	.103	.044	.174	-.689	-.943	1	
16	-.622	.902	.030	-.171	-.217	-.113	-.201	.184	.456	-.035	-.104	.099	.208	-.401	.351	1

1 M.A.
2 Ph.D.
3 Special Education
4 Reading Instruction
5 Agricultural Education
6 Business and Distributive Education
7 Secondary Education
8 Guidance and Personnel Services
9 Educational Administration
10 Student Personnel Work
11 Educational Psychology
12 Curriculum
13 College of Education Student Credit Hours
14 Class Size
15 Graduate/Total Student Credit Hours
16 Total Degree Costs

Appendix D. Printout of Eleven Steps of Stepwise Multiple Regression Analysis, Degree Program Cost Study, College of Education, Michigan State University, 1969

Step Number 1 Enter Variable 2
Standard Error of Estimate = 160.635
Multiple Correlation Coefficient = 0.902
Goodness of Fit, F (1,178) = 781.2175
Constant Term = 651.5693

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
2	747.1508	26.7313	27.9503	0.9024

Step Number 2 Enter Variable 13
Standard Error of Estimate = 147.113
Multiple Correlation Coefficient = 0.919
Goodness of Fit, F (2, 177) = 483.3261
Constant Term = 447.1672

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
2	741.7893	24.4978	30.2797	0.8959
13	4.7222	0.7956	5.9350	0.1756

Step Number 3 Enter Variable 14
Standard Error of Estimate = 120.675
Multiple Correlation Coefficient = 0.946
Goodness of Fit, F (3, 176) = 507.8908
Constant Term = 404.9010

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
2	642.8428	22.7218	28.2918	0.7764
13	9.3707	0.8210	11.4125	0.3484
14	- 2.9858	0.3200	- 9.3302	-0.3063

Step Number 4 Enter Variable 9
Standard Error of Estimate = 110.167
Multiple Correlation Coefficient = 0.956
Goodness of Fit, F (4,175) = 466.0889
Constant Term = 376.0509

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
2	596.2890	22.1404	26.9321	0.7202
9	144.7795	24.0718	6.0144	0.1455
13	9.7541	0.7522	12.9658	0.3627
14	- 2.9649	0.2921	-10.1477	-0.3042

Step Number 5 Enter Variable 8
Standard Error of Estimate = 106.314
Multiple Correlation Coefficient = 0.959
Goodness of Fit, F (5, 174) = 403.1676
Constant Term = 384.9497

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
2	577.9395	21.9252	26.3596	0.6980
8	100.8201	27.0293	3.7300	0.0854
9	169.4817	24.1555	7.0162	0.1703
13	10.0635	0.7307	13.7721	0.3742
14	- 2.8887	0.2826	-10.2184	-0.2964

Step Number 6 Enter Variable 10
Standard Error of Estimate = 102.942
Multiple Correlation Coefficient = 0.962
Goodness of Fit, F (6, 173) = 360.4418
Constant Term = 337.7097

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
2	591.2601	21.5592	27.4248	0.7141
8	110.2506	26.3067	4.1909	0.0934
9	176.6885	23.4774	7.5258	0.1775
10	123.9532	34.9394	3.5476	0.0765
13	9.7998	0.7114	13.7749	0.3644
14	- 2.6663	0.2808	-9.4950	-0.2735

Step Number 7 Enter Variable 6

Standard Error of Estimate = 100.463

Multiple Correlation Coefficient = 0.964

Goodness of Fit, F (7,172) = 325.7691

Constant Term = 313.6789

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
2	599.2850	21.1979	28.2708	0.7238
6	106.2115	34.1972	3.1058	0.0656
8	120.8854	25.9003	4.6673	0.1024
9	185.0806	23.0706	8.0223	0.1860
10	137.2834	34.3668	3.9946	0.0848
13	9.9886	0.6969	14.3321	0.3714
14	- 2.5686	0.2758	-9.3119	-0.2635

Step Number 8 Enter Variable 11

Standard Error of Estimate = 97.904

Multiple Correlation Coefficient = 0.966

Goodness of Fit, F (8, 171) = 301.4061

Constant Term = 290.3834

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
2	610.0286	20.9326	29.1425	0.7368
6	122.3294	33.7096	3.6289	0.0755
8	132.5016	25.5037	5.1953	0.1122
9	194.2015	22.6653	8.5682	0.1951
10	153.3275	33.8695	4.5270	0.0947
11	106.6365	33.5404	3.1793	0.0658
13	10.0546	0.6795	14.7969	0.3739
14	- 2.4246	0.2726	-8.8941	-0.2487

Step Number 9 Enter Variable 12
Standard Error of Estimate = 95.860
Multiple Correlation Coefficient = 0.967
Goodness of Fit, F (9,170) = 280.3919
Constant Term = 253.6898

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
2	595.7973	21.0777	28.2666	0.7196
6	143.0605	33.7749	4.2356	0.0883
8	159.9924	26.7183	5.9881	0.1355
9	222.5375	24.2576	9.1738	0.2236
10	171.4272	33.7475	5.0796	0.1058
11	126.0691	33.5202	3.7609	0.0778
12	77.2341	26.6976	2.8929	0.0654
13	10.4268	0.6776	15.3867	0.3877
14	- 2.3050	0.2701	-8.5337	-0.2365

Step Number 10 Enter Variable 1
Standard Error of Estimate = 94.578
Multiple Correlation Coefficient = 0.968
Goodness of Fit, F (10, 169) = 259.8017
Constant Term = 530.1026

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
1	-184.1617	77.5581	- 2.3745	-0.2467
2	411.2477	80.4555	5.1114	0.4967
6	138.3057	33.3835	4.1429	0.0854
8	147.9406	26.8453	5.5108	0.1253
9	219.4546	23.9685	9.1559	0.2205
10	171.4688	33.2963	5.1497	0.1059
11	126.4967	33.0726	3.8248	0.0781
12	66.9675	26.6932	2.5087	0.0567
13	9.2345	0.8361	11.0443	0.3434
14	- 3.8240	0.6930	- 5.5179	-0.3923

Step Number 11 Enter Variable 15

Standard Error of Estimate = 93.268

Multiple Correlation Coefficient = 0.970

Goodness of Fit, F (11, 168) = 243.3946

Constant Term = 421.6934

Var	Coeff	Std Dev Coeff	t Value	Beta Coeff
1	-377.5770	110.9851	- 3.4020	-0.5059
2	202.4992	117.5971	1.7219	0.2445
6	136.6665	32.9279	4.1504	0.0844
8	149.2520	26.4788	5.6366	0.1264
9	211.4653	23.8687	8.8595	0.2125
10	164.7210	32.9545	4.9984	0.1017
11	146.0646	33.6138	4.3453	0.0902
12	66.3350	26.3246	2.5198	0.0562
13	10.0035	0.8843	11.3113	0.3720
14	- 3.3843	0.7074	-4.7838	-0.3472
15	2.8647	1.1911	2.4049	0.2683