THEORETICAL AND EMPIRICAL PROBLEMS IN THE ANALYSIS
OF THE ECONOMIC COSTS OF VOCATIONAL EDUCATION

Ernst W. Stromsdorfer, Teh-wei Hu, and Maw Lin Lee,[*]
The Pennsylvania State University

A. Introduction.

Within recent years there has been increasing interest in analyzing the economic costs and benefits of vocational education.[1] Yet this entire discussion has largely been carried on either in an informational vacuum or in contexts where gross analytic errors have been made. For instance, there is a general lack of awareness that, in order to make efficiency judgments, the extra or marginal costs to vocational education must be related to the extra or marginal costs of vocational education. Often, programs of a given cost are asserted by their detractors to be "too expensive" while the program advocates see these same costs as evidence of "high quality." Such assertions are in error. Other analyses utilizing benefits either do not relate costs to benefits or else measure gross instead of net benefits of vocational education. No valid policy statements can be made from such analyses, yet the policy statements are made.

Compounding these problems is the fact that rudimentary data needed to make decisions at a relatively gross level generally do not exist. This is due in part because it is not reasonable to expect a school district to expend resources to collect data it either sees no use for or has not been educated to use. There is also the problem that the data needs of decision makers at different levels in the educational system do not coincide since the problems which face different levels do not coincide. It has not always been accepted or perceived that the financial and educational system data being collected ought to coincide with the needs of educational decision making. Finally, the acceptance of rational economic analysis of the educational process if relatively recent.

This paper describes the cost data availability, needs and problems encountered in an attempt by the authors to perform an economic evaluation of vocational-technical education.[2] Cost analysis is used to illustrate data problems. Next, an evaluation is presented of national cost data on vocational education from the standpoint of the needs of economic analysis. This data is used to illustrate the econometric problems involved in attempting to employ it in cost benefit analysis.

B. Problems in Cost Analysis.

All costs must be considered as opportunity costs. Any complete analysis of costs should measure both social and private costs, and, in some cases, the costs of governmental units.

Under social costs, the following should be considered:

1) Current costs, which include such factors as teachers' salaries, heat, light, and other variable costs;
2) Capital costs of sites, buildings, and equipment;
3) Cost correction factors such as sales tax and property tax correction factors;
4) Costs from nonschool system support;
5) Earnings foregone while students are undergoing education;
6) Incidental costs to students associated with school attendance;
7) Job search costs; and
8) On-the-job training costs.

Under private costs the following should be considered:

1) Earnings foregone while the student is undergoing education;
2) Incidental costs associated with school attendance;
3) Job search costs; and,
4) On-the-job training costs.

None of these costs are conceptually different. They are listed separately because each has measurement problems peculiar to it.

Total, average, and marginal costs should be measured. These costs should be related to specified production functions. The production functions should incorporate those input variables which affect their determination and structure, such as class size, or number and quality of teachers. Cost-benefit analysis is concerned with the making of decisions which allocate resources efficiently, so that the main concern of this analysis is with the determination of marginal, or extra costs of producing an additional unit of output. Problems of cost determination occur with respect to measurement of total and average costs of a given output or set of outputs when joint costs occur.

The Joint Cost Problem. Joint costs occur within two contexts. First, the problem exists at a given point in time when a specific educational input or facility produces two or more distinct educational outputs. Second, the problem occurs over time, when a facility is consumed during the investment or training process by successive cohorts of students representing either the same or a different type of output.

Fortunately, the occurrence of joint costs does not affect the determination of marginal costs. And, since efficient investment decisions between two or more alternative projects are made on the basis of marginal costs, the presence of joint costs presents no basic problem to cost-benefit analysis.

In actual practice, however, costs which are joint are frequently allocated among different programs. Not only is such allocation always arbitrary in nature, but it is unnecessary. When joint costs occur, the total cost of the set of programs or outputs combined can be measured. Then, their combined benefits must equal their combined total costs. But total _average_ costs to each of the programs simply cannot be measured accurately in any economic sense.[3]

Consider the following: Both vocational and nonvocational training occurs in a comprehensive senior high school. In this school certain costs are directly attributable to a given program in vocational education, such as the extra costs of electricity to run the power tools of the machine

shop or the extra wiring installed in the shop room. However, the building itself needs a given electrical system to feed electricity to all the various classrooms and shops. This cost outlay serves both the vocational and nonvocational students. Given that a decision has been made to install a machine shop in that school, no part of the common cost of constructing the basic school building should be included as a cost offset to the benefits flowing from the machine shop. The correct allocation of these common costs to the machine shop operation, and by extension, the costs of training students as machinists, is simply, zero. This is so because, within the limits of the feasible range of output in the school, the use of the common facilities by the students taking machinist training does not reduce the ability of the other students in the school to use the same common facilities. Thus, joint inputs are similar to a public good which anyone can consume as much as he wishes without reducing the consumption of that good by others.

In this regard, then, Handbook II, Financial Accounting for Local and State School Systems, is in error.[4] It advocates the proration of such inputs as administration, attendance and health services, transportation services, operation of plant, maintenance of plant, fixed charges, food services and student body activities and community services, all of which are joint in nature or have joint components.

Current Costs. Some current costs will be specific and some will be joint. Given a comprehensive school which produces more than one type of product or provides different types of specialized training, typical joint costs could involve the items listed above. Even if, as with the school lunch programs, students were charged a fee which reflected the cost of providing lunch to each of them, differences in marginal cost between different students would not necessarily be affected, if, as is often the case, a flat fee would be charged to each student. Of course, one would attribute as a cost of education only those costs involved in food preparation and serving which would be over and above what the student would normally incur were he not in school.

Controversy exists over whether or not such in-school programs as attendance and health services and community services represent aspects of the educational process. In some respects these programs are similar to other public health and social services and an argument could be made for including such expenditures in their respective community-wide programs. However, there are interaction effects between the state of one's health, nutrition, and quality of life and the educational and learning processes. So, total exclusion of such expenditures in an accounting of the costs of education may not be warranted, since these programs do facilitate the educational process. A case could be made, however, to attribute the increased effectiveness of the educational process brought about by such things as health expenditures as a benefit accruing from the health program. Our judgment would be to exclude these expenditures whenever possible and recognize that in their presence, the benefits accruing to the educational process per se are overestimated.

Specific costs could involve such matters as the cost of the shop or classroom teacher, the cost of supplies and books associated with a given educational curriculum, or maintenance or janitorial services associated with each curriculum. Clearly, the cost accounting problems associated with maintaining a separation of the joint and specific cost aspects of a given input are severe. Thus, to some extent, a counsel of perfection is being recommended.

Capital Costs. Social (and private) capital costs are fundamentally no different in nature than social (and private) current costs, and what follows should not be construed as suggesting so. To the extent that costs are categorized, this is done because each type presents different measurement problems. Capital costs can be broken down into four different elements:

a) Site acquisition costs;
b) Capital improvements to the site;
c) Physical plant and building costs; and,
d) Equipment costs.

Serious measurement problems stem from several physical and institutional factors. Two of the most important factors are: (1) The physical plant of the school usually has an economic life longer than the period of training for any given educational cohort; (2) the services of this capital stock are not easily valued in market terms.

Four possible treatments for valuing this capital exist. First, one can argue that once the capital stock exists, especially the physical plant and buildings, it becomes specific to the educational process and thus has no alternative use in the short run. This is a tenuous assumption, though, for it is easy to discover alternative uses for such capital stock. Thus, the value of the educational physical plant is not zero, but since it is not a perfect substitute for competing uses, the value of the competing uses, such as the rent of a hospital, does not reflect the exact opportunity cost of using the physical plant for educational purposes.

Second, historical costs of building construction and site acquisition can be used, but these historical costs are irrelevant since they have no necessary bearing on the present opportunity costs involved in using any capital stock.

Third, the use of replacement costs is a possible measure of capital costs. However, it is obvious that often it would cost more to exactly replace a building than the current economic value of the building. The use of replacement costs would over-value the capital resource, given a rising price level and assuming no compensating technological change in construction technique.

Fourth, an estimate of current assessed valuation could be used to arrive at a measure of the capital costs. However, the valuation standard used becomes critical. In actual practice, the valuation standard amounts to a combination of historical costs adjusted by a price index of replacement cost so that this measure is no better than the replacement cost measure. Unfortunately, this is essentially the practice followed in two of the three cities in this study which do report assessed values of their buildings and physical plants for purposes of fire insurance.

In short, it is not obvious what price resulting among these four choices should be attached to the capital inputs to get a measure of the opportunity costs.

The Capital Recovery Factor. Once the economic value of the capital in use has been measured, a problem remains with the measurement of the rate at which the given capital stock is consumed over the course of the investment process. Two courses of action have been suggested for use. One is to attempt to measure an imputed rent and depreciation to the capital stock by making analogies with respect to what amount of rent the capital item would yield if it were being employed in the private sector of the economy. This rent will include interest and depreciation. But this procedure is subject to a great deal of arbitrariness and uncertainty. Thus, a great deal of judgment is involved in adjusting the estimated shadow prices so that they more closely reflect the true opportunity costs.[5]

An alternative technique for estimating the rate of capital use lies in employing the "capital recovery factor" (CRF). The application of this technique automatically accounts for both interest and depreciation.

The capital recovery factor is that factor which "...when multiplied by the present value of capital costs, is the level [average] end-of-year annual amount over the life of the project necessary to pay interest on and recover the capital costs in full."

The formula is as follows:

$$c = C_0 i(1+i)^n / (1+i)^n - 1,$$

where c is the capital recovery factor (annual capital cost); C_0 is the present value of capital in use; i is the social opportunity cost rate of capital or investment funds; and n is the number of years over which benefits (of the capital in question) are returned, that is, the project life. In some respects this technique is no less arbitrary than that which imputes rent and depreciation. Apart from the problem of establishing the present value of the capital in use, essentially arbitrary judgments must be made with respect to the values of n and i.

Additional problems exist with the use of this technique. The first is that the CRF does not necessarily indicate the amount of capital used in any given year. It only states the level annual amount needed to recoup the principal and social opportunity cost, that is, interest, given the project life. Second, more than one cohort of students may utilize a given capital item during the life of that item. Here again is the familiar joint cost problem.

Site Costs. Site costs and capital improvements to sites are affected by the joint cost problem, unless, of course, a given site or site improvement is uniquely related to a given output. The site itself is indestructible in most cases since the productivity of the site is not reduced by its use by students. However, the site does have an economic cost since it is productive. An interest charge to estimate the social opportunity cost should be paid, but not a depreciation charge, since, from society's standpoint, the site does not depreciate. This cost should be covered by the benefits gained from the educational process; otherwise, more efficient uses for the site may be foregone, resulting in a loss to total welfare. However, these site costs cannot be sensibly prorated among different educational cohorts.

A serious problem with estimating site costs lies in that such costs are inextricably mixed with the costs of capital improvements to the sites. It is impossible to determine how much of the purchase price of a site is a function of the value of pure rent and how much of it is due to the site improvement.

Cost from Nonschool System Support. Care must be taken to ascertain whether or not the various school systems are subsidized by any branch of the local or state government. Such cost items must be included into total costs. While the school systems of two cities of this study, cities A and C below, do not receive any substantial support from the cities in which they are located, city B receives one-third of its support in this fashion. For this and other reasons the cost data for this school system cannot be used effectively.

Imputation of Indirect Taxes. Some economists argue that adjustments should be made for the fact that school systems do not pay indirect or real estate taxes. Hence a school dollar commands more resources in the market place than does a dollar spent by a private individual.[6] Thus, true social opportunity costs are understated.

However, one can argue equally well that the output from a dollar spent by a school is understated relative to the output from a dollar spent by individuals and firms because normal profits are not charged by the school administration. Thus, adjustments must be made for a downward bias in benefits as well as a downward bias in costs. The present study does neither.

C. Cost Estimations: Three Cities.

Two questions are of interest in an economic analysis of vocational-technical education. First, what are the differences in cost, especially marginal cost, between the vocational-technical curriculum and the different curricula of the comprehensive high school? Second, within the vocational-technical curriculum, what are the relative net economic benefits among the various vocational skill areas? Two sets of cost data are needed to answer these questions.

Vocational Curriculum Costs. Numerous data problems present themselves when comparing the vocational-technical curriculum of the vocational-technical senior high school against the college preparatory, general, and other curricula which are outputs of the comprehensive senior high school.[7]

Inclusions and omissions of cost items such as maintenance cost items are usually uniform within a city school district, but not among school districts. It was not possible to make the necessary adjustments to allow uniform comparison of differential costs among cities.

City A had published cost records but no detailed definitions of cost items included or excluded from the data presented. Nor was it possible to determine these factors for earlier years. Cross-section data by type of senior high school was available through fiscal year 1959-60

but discontinued thereafter. The 1959-60 data is noncomparable in undetermined, but apparently not critical, ways relative to the earlier years. City B had only limited time series data. About one-third of the educational expenditures for this city were aggregated within the city budget. After the 1957-58 school year, average daily attendance by type of senior high school was not kept for this city. Only scattered information on such educational characteristics as class size existed. Cost analysis for this city simply could not be performed. The school district is developing a new program-planning-budgeting system; but due to the budget categories used, no economic analysis of curricula or courses within this school system can be performed.

City C publishes cross-section data by type of senior high school. About 98% of instructional, 75% of operational and 50% of maintenance costs are reported. This city was the only one which had cross-section data by type of school on important structural variables such as median and average class size, or teacher quality. The existence and quality of this data appeared to be in large part the result of the efforts of a few interested at the school district level. Table 1 presents the comparisons of current operating expenditures divided by average daily attendance for the three cities. Because of the fore mentioned dissimilarities in the data, it is not valid to compare these three sets of costs.

TABLE 1

CURRENT OPERATING EXPENSES/AVERAGE DAILY ATTENDANCE FOR SENIOR HIGH SCHOOLS IN CURRENT DOLLARS[a]

	CITY A		CITY B		CITY C		
Fiscal Year	Comprehensive	Vocational-Technical	Comprehensive	Vocational-Technical	Comprehensive	Vocational-Academic[c]	Vocational-Technical
46-47	212	274	217	415	194	119	198
47-48	239	291	280	613	246	151	250
48-49	262	308	318	697	264	155	250
49-50	282	311	309	797	278	166	256
50-51	277	316	320	900	314	200	320
51-52	340	368	349	868	338	187	328
52-53	363	404	351	925	356	175	362
53-54	395	402	378	1,039	363	175	375
54-55	400	471	379	857	380	192	391
55-56	404	489	388	919	405	231	440
56-57	431	528	421	985	420	210	414
57-58	462	587	425	989	429	263	360
58-59	442	607	430[b]	621[b]	444	246	386
59-60	417	702	397[b]	626[b]	498	268	426

Notes:

[a]The use of average daily membership (ADM) or average daily enrollment (ADE) would yield smaller average current cost figures. The reader is cautioned against making unwarranted inter-city or inter-year comparisons of either "quality" or "costliness." These data in themselves imply nothing concerning economic efficiency. These figures are based on current operating expenses and ADA reported separately for each type of senior high school, by city, for the combined ADA of 10th, 11th, and 12th grades.

[b]These figures are based on estimated ADA.

[c]Graduates from this type of high school have, as defined in this study, a curriculum major in both the academic and the vocational-technical curriculum.

Estimated Cost Functions. Equations (1) and (2) describe the statistical functions of total and average current costs. These functions are:

(1) $TC = A_0 + A_1X_1 + A_2X_2 + A_3X_2^2 + A_4X_3$
$$+ A_5X_3^2 + U_1$$

(2) $AC = B_0 + B_1X_1 + B_2X_2 + B_3X_2^2 + B_4X_3$
$$+ B_5X_3^2 + U_2$$

The variables used are defined as follows:

TC = Total current expenditures in dollars.

AC = Average current expenditures in dollars.

X_1 = 1 for vocational-technical schools.

   = 0 otherwise, i.e., comprehensive schools.

X_2 = Average daily attendance (ADA, comprehensive schools).

X_3 = Average daily attendance (ADA, vocational-technical schools).

X_4 = Average teacher salaries (total teacher salaries divided by the number of teaching teachers) in dollars.

X_5 = Student-teacher ratio: average daily attendance divided by the number of teachers for city A. Average class size for city C.

U_1, U_2 = Random disturbance terms.

X_1 is introduced to provide different intercepts for comprehensive and vocational-technical schools. Average daily attendance squared is introduced to account for the nonlinear nature of the cost functions. The cost functions are based on the school as the unit of observation. The functions are estimated for the 1956-60 fiscal years.

Equations (1) and (2) amount to implying a state of homogeneity for the quality of education. This assumption, however, is not quite realistic since the quality of education does vary from one school to another. This difference in quality may be assumed to be associated with the costs of instruction. It is therefore useful to modify Equations (1) and (2) to allow for quality differentials in instruction. The concept of the quality of education, however, is an abstract one. It is difficult if not impossible to measure. It is argued, however, that class size and teacher salaries reflect, in part, the quality of education. The reasoning behind this argument is that in a school with relatively small-sized classes, a teacher can devote a relatively large amount of attention to each student. Furthermore, the importance of teacher quality to educational quality is beyond debate. It is assumed that the

level of salaries reflects the quality of teachers. This argument is based on the fact that salary level depends on merit, experience and education received by teachers. Also, in a competitive labor market, a teacher's salary may reflect his productivity.[8]

For city A, the estimated results for total current costs are as follows:

(1) $TC = 145,624 - 266,472X_1 + 284.09X_2$

(61,678) (97,946) (68.45)

$+ .0062X_2^2 + 686.88X_3 - .0782X_3^2$

(.0180) (139.41) (.0577)

$+ 30,018 (1957) + 102,169 (1958)$

(30,740) (30,154)

$+ 95,264 (1959) + 234,486 (1960)$.

(30,196) (31,075)

$\bar{R}^2 = .89$ SEE = 94,641   N = 99

The estimated results for city A for total costs (current plus capital) are as follows:

(2) $TC' = 125,315 - 147,652X_1 + 368.02X_2$

(55,262) (66,807) (60.00)

$- .0125X_2^2 + 640.16X_3 - .0542X_3^2$

(.0156) (106.61) (.0494)

$+ 45,969 (1957) + 63,332 (1958)$

(29,088) (28,789)

$+ 77,840 (1959) + 164,813 (1960)$.

(29,157) (30,051)

$\bar{R}^2 = .91$ SEE = 93,029   N = 99

For city C, the estimated results for total current costs are as follows:

(3) $TC = 203,711 + 17,753X_1 + 189.83X_2$

(87,301) (63,096) (76.60)

$+ .0161X_2^2 + 211.50X_3 + .0377X_3^2$

(.0135) (81.22) (.0149)

$- 19.484 (1957) + 13,947 (1958)$

(35,845) (35,180)

$+ 59,431 (1959) + 151,560 (1960)$.

(33,869) (33,011)

$\bar{R}^2 = .95$ SEE = 82,676   N = 70

Capital costs were not available for city C.

$\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom; SEE is the stan-

dard error of the estimate; N is the number of observations; and the numbers in parentheses below the partial regression coefficients are the standard errors.

Table 2 presents estimations of marginal costs by current expenditures and total expenditures (capital plus current) for an additional student in ADA in city A. For city C, marginal costs are presented only for current expenditures for an additional student in ADA. Marginal costs for the vocational-technical schools are higher than marginal costs for comprehensive schools in both cities. The major reason for differences in marginal costs between the two types of schools lies in differences in teachers salaries and average class size or student-teacher ratio and not in differences in capital costs as one might ordinarily expect. Capital costs do have an effect on marginal costs, however. As Table 2 shows, marginal costs at average ADA for the comprehensive senior high school in city A rise from $304 to $312 when capital costs are included. For vocational-technical schools in city A marginal costs at average ADA rise from 464 to 485.[9]

By differentiating the average cost function with respect to ADA, setting its partial derivative to zero, and solving for the level of output at which average cost is a minimum, one can estimate the optimal scale of operation for two types of senior high school.

The level of ADA at which average cost is minimum is as follows:

	Comprehensive	Vocational-Technical
City A (1)	2,957	2,295
(2)	3,350	1,958
City C	3,191	3,339

If the statistical results derived in this study are reliable, the optimal scale of comprehensive senior high schools is about 3,000. The inclusion of capital costs in city A raises the optimal size of comprehensive senior high schools by approximately 400 students. The small number of observations for the vocational-technical senior high schools (approximately 15) cast some doubt on the degree to which inferences can be made concerning economies of scale for these schools. The inferences made here are also limited by the fact that we are concerned mainly with total current costs. Capital costs, an important component in the economies of resource use, are excluded from the analysis for city C.

Further Qualifications. The study encompasses only the fiscal years 1956-60. Cost data for the two types of senior high school in the two cities were pooled for these years. The assumption was that the underlying production function for each type of school in each city did not change over this period of time so that the estimated coefficients of the pooled equations give a better representation of the marginal costs than would equations estimated for each separate year. Cost functions based on current costs were used due to the fact that the value of capital in use was so arbitrarily determined and because of the joint cost problem of the capital with respect to cohorts over time.

Other problems with these cost data remain. First, total current costs include expenditures on additions, renovations and repairs to buildings which are in the nature of capital improvements and which vary from year to year. This variation gives rise to differences in the estimated rela-

TABLE 2

MARGINAL CURRENT COSTS BY AVERAGE DAILY ATTENDANCE FOR VOCATIONAL-TECHNICAL AND COMPREHENSIVE
SENIOR HIGH SCHOOLS, FISCAL YEARS 1956 THROUGH 1960, CITIES A AND C, IN DOLLARS

Year and City		Comprehensive			Vocational-Technical	
	Avg. ADA	Marginal Costs at Avg. ADA	Marginal Costs by Linear Approximation	Avg. ADA	Marginal Costs at Avg. ADA	Marginal Costs by Linear Approximation
City A (1)	1,917	304	307	1,426	464	504
1956-60 (2)	1,917	312	321	1,426	485	525
City C 1956-60	2,917	270	285	2,316	386	409

Notes:
    For city A, row (1) represents marginal costs by current expenditures; row (2) represents marginal costs by current plus capital expenditures.

tionships between yearly cross-sections. Second, the size of sample used in this study is small particularly for the vocational-technical schools. The observations thus do not include schools of all possible sizes. Under such circumstances any addition or deletion of one school could result in a major shift in the slope of the statistical cost functions.

Costs by Vocational Skill. Only city A had usable cost data by vocational skill. For this type of cost data, the very existence of which is dependent on the capriciousness of administrative accounting requirements, only teachers salaries comprise the average variable costs measured. The skill categories are very broad since individual courses had to be aggregated to generate sufficient observations for analysis. This results in a loss of precision in attempts to judge relative costs and benefits among skills. Table 3 indicates the estimated marginal teacher salary costs for an additional student in ADA by skill category.

The marginal costs range from a low of $106 for woodworking to a high of $415 for the food service skill. No marginal cost for the building trade group is evaluated because, for the functions estimated, total teacher salaries were not significantly related to average daily attendance.

D. Cost Estimations: National Data.

The only source of vocational cost data at the national level comes from the Annual Report on Vocational and Technical Education which is compiled from state reports. Neither the Digest of Educational Statistics nor the Statistics of State School Systems provide cost data for vocational education.[10]

The data published in the Annual Report on Vocational and Technical Education have the following shortcomings. First, enrollment data is published which does not standardize attendance by any index such as average daily attendance. Second, although enrollment by classes, grades, broad vocational specialty and states is provided,

costs are not provided on the basis of the same breakdown. Federal funds are broken down but not state and local. Also, for the above breakdown federal funds are on an allotment basis and not on an actual expenditure basis, which makes them unusable for cost analysis. The result of these shortcomings is that any attempts to estimate marginal costs by the seven categories shown in Table 4 is confounded by the fact that the enrollment figures represent diverse types of output. As a result of these shortcomings we are estimating expenditure and not cost functions.

The statistical function of total expenditures is as follows:

$$TC = D_0 + D_1 Z_1 + D_2 Z_1^2 + D_3 Z_2 + D_4 Z_3 + U_4$$

The variables used are defined as follows:

TC = total costs (current and capital) in dollars.

Z_1 = total enrollment.

Z_2 = time trend for the fiscal years 1949-50 through 1964-65, with the exception of 1951-52, which is missing.

Z_3 = 1 for the 1964-65 fiscal year.

   = 0 otherwise, i.e., all other fiscal years.

Table 4 presents the estimated coefficients. These coefficients represent marginal expenditures for the weighted average of the types of enrollment for an additional unit of enrollment and do not represent marginal costs. Marginal costs cannot be estimated with this data since the unit of observation is the state and not a school or school district. The school or school district is the appropriate production unit. A state is simply a political construct and a meaningful production function for the provision of vocational education cannot be specified for it.

TABLE 3

MARGINAL TEACHER SALARY COSTS BY COURSE BY AVERAGE DAILY ATTENDANCE FOR THE
POOLED FISCAL YEARS 1961-1967, EXCLUSIVE OF FISCAL YEAR 1966, IN DOLLARS

Course	Avg. ADA	Marginal Costs at Avg. ADA	Marginal Costs by Linear Approximation
Food Service	89	415	247
Mechanics	170	203	194
Woodworking	74	106	116
Clothing and Fabrics	115	144	161
Electric and Electronics	88	155	202
Agriculture and Horticulture	117	267	260
Personal Service	111	248	260

TABLE 4

TOTAL EXPENDITURE FUNCTIONS FOR FEDERALLY SUBSIDIZED VOCATIONAL EDUCATION PROGRAMS
FOR THE POOLED FISCAL YEARS 1950-1965, EXCLUSIVE OF FISCAL YEAR 1952, IN DOLLARS

Vocational Program	z_1	z_1^2	z_2	z_3	I	SEE	$\bar{R}^2$
Total Programs	478** (35)	.00087 (.00092)	359,682** (27,832)	3,805,419** (504,683)	-2,748,606** (302,057)	3,057	.72**
Agriculture	618** (21)	-.00622 (.00186)	50,845** (5,115)	48,627** (92,795)	-146,200** (53,753)	563	.80**
Distribution	295** (14)	-.02301** (.00179)	16,808** (1,617)	112,447** (29,168)	-103,277** (16,368)	176	.57**
Health	1,627** (223)	.94807** (.32407)	4,997 (5,946)	121,775** (45,327)	-59,928 (68,319)	246	.52**
Home Economics	413** (19)	-.00577** (.00112)	51,799** (6,622)	-8,946 (119,368)	-391,096** (69,140)	724	.73**
Office	223 (151)	.02372** (.00625)	---@	---@	439,007 (290,536)	1,292	.89
Technical	1,960** (293)	-.16855** (.04556)	12,180 (113,842)	508,801 (291,982)	-126,540 (1,593,582)	1,106	.42**
Trades and Industry	820** (49)	-.00858 (.00449)	46,465** (10,484)	945,493** (189,883)	-462,819** (111,652)	1,153	.69**

Notes:
    Numbers in parentheses are the standard errors for the respective partial regression coefficients.

    I is the intercept. SEE is the standard error of estimate. $\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom. * Significant at the .05 level of significance.

    ** Significant at the .01 level of significance. @ Observations exist for the 1964-65 fiscal year only.

The expenditure and enrollment data analyze how individual states differ in terms of their expenditures on vocational education. The expenditure functions are therefore estimated to relate specific types of expenditures to enrollment in a given program. Marginal expenditures at average enrollment were not estimated since the meaning of enrollment reported in the data is not clear.

The estimates in Table 4 show that both the intercepts and slopes of the expenditure functions differ from one program to another. In particular, in programs such as health and office training programs, the marginal costs increase at an increasing rate while marginal expenditures on agriculture, distribution, home economics, technical, and trade and industry programs, increase at a decreasing rate. The difference in marginal expenditures between programs is at first glance quite surprising. But it should be noted that the expenditure data include capital expenditures for buildings and equipment. For programs which are in an early stage of development, these expenditures may constitute such a large proportion of a state's total expenditure on the particular type of programs. Thus, marginal expenditures are quite different among programs but we have no data to discover why they differ.

Refined data are necessary to analyze the factors associated with the above discrepancies. From the viewpoint of efficient allocation of resources, such refined and reliable data are necessary so that cost and production functions of education can be studied in order to gain optimal efficiency in educational production.

E. Conclusions.
    If the federal government, and, by extension, our society, wishes to pursue a more rational course with respect to investment in the human agent, then adequate data must be collected based on sound cost accounting principles and guided by agreed upon objectives and definitions of output to measure those objectives. A national census as represented by the Statistics of State School Systems is not workable. It is too costly and too time consuming given the very limited quality and quantity of cost data collected. It would seem to be much more reasonable to establish a statistically representative national sample of school

districts and collect detailed cost data based upon the school as the unit of observation. Within the school, costs should be collected both on a broad curriculum and course or skill basis. Finally, the data should be collected by persons skilled in this endeavor rather than left as it now often is, to a clerk or a secretary at the local school level. As matters stand now, only the grossest type of economic analysis of vocational education can be performed.

FOOTNOTES

* This paper is based in part on a larger study of vocational education being undertaken at the Institute for Research on Human Resources. See Jacob J. Kaufman, Teh-wei Hu, Maw Lin Lee, and Ernst W. Stromsdorfer, An Analysis of the Comparative Costs and Benefits of Vocational versus Academic Education in Secondary Schools, U.S. Office of Education, Project No. O.E. 512, Grant OEG-1-6-000512-0817. Mr. Norman Kalber performed the necessary calculations. The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

[1] See, for instance, U.S. Senate Committee on Labor and Public Welfare, Subcommittee on Employment and Manpower, Hearings, The Nation's Manpower Revolution, Part 6, 88th Congress, 1st Session, October 16, 17, 18, 22, 23, 24, and 25, 1963.

[2] See Jacob J. Kaufman, Teh-wei Hu, Maw Lin Lee and Ernst W. Stromsdorfer, An Analysis of the Comparative Costs and Benefits of Vocational versus Academic Education in Secondary Schools, Preliminary Report, U.S. Office of Education, O.E. 512, October 1967.

[3] See, for instance, Jack Hirshliefer, et al., Water Supply: Economics, Technology and Policy, (Chicago: University of Chicago Press, 1960), pp. 93-94, and Roland McKean, Efficiency in Government Through Systems Analysis, (New York: John Wiley and Sons, 1958), pp. 44-46.

[4] See U.S. Department of Health, Education, and Welfare, Office of Education, Financial Accounting for Local and State School Systems, OE-22017, Records and Reports Series: Handbook II, (Washington: U.S. Government Printing Office, 1965), Chapter 8, "Prorating Expenditures." Other needless confusion and error exists in this document. For instance, the category of Fixed Costs actually contains variable cost items as social security payments and insurance payments. These are more properly allocated to their specific categories such as Administration and Instruction.

[5] For a general discussion of the problem of imputing opportunity costs to resources employed in the public sector see Roland N. McKean, "The Use of Shadow Prices," in Samuel B. Chase, Jr., Editor, Problems in Public Expenditure Analysis, Studies of Government Finance, (The Brookings Institution: Washington, D.C., 1968).

[6] See Fritz Machlup, The Production and Distribution of Knowledge in the United States, (Princeton: Princeton University Press, 1962), pp. 101-102.

[7] These curricula are defined in Kaufman, et al., op. cit., Appendix I.

[8] By assuming that teachers salaries and class size are proxy variables for the quality of education, the total current cost function was modified as follows:

$$TC = C_0 + C_1X_1 + C_2X_2 + C_3X_2^2 + C_4X_3 + C_5X_3^2 + C_6X_4 + C_7X_5 + U_3.$$

The result was to raise the estimated marginal costs somewhat. It appeared that the class size variable everadjusted for economies of scale. The estimated equations are reported in Jacob J. Kaufman, et al., A Cost-Effectiveness Study of Vocational Education, October, 1968. (Forthcoming)

[9] Capital costs are based on historical costs inflated by the Boeckh construction cost index. An n of 60 and an i of 10% are assumed in using the capital recovery factor. For comprehensive senior high schools in city A current costs average $797,910 over the 1956-60 period while capital costs average $57,340 over the period. For vocational-technical schools in city A, the respective costs are $668,810 and $56,000.

[10] See, for instance, U.S. Office of Education, Vocational and Technical Education, Annual Report, Fiscal Year 1965, OE-80008-65, (Washington: USGPO); U.S. Office of Education, Statistics of State School Systems, 1963-64, OE-20020-64, (Washington: USGPO); and, U.S. Office of Education, Digest of Educational Statistics, 1966, OE-10024-66, (Washington: USGPO).