# Economic Returns to Technical Education at Oklahoma State Tech

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## Introduction

Oklahoma State Tech (OST) was organized in 1946 to provide technical-vocational education for men and women. Enrollment is open to a high school or non-high school graduate who is at least seventeen and one-half years of age.

This study estimates the economic benefits accruing to individuals and society from investment in two years of technical schooling (post high school) at Oklahoma State Tech located at Okmulgee. The specific objectives are to: (1) determine costs incurred by individuals and society, (2) determine economic benefits accruing to individuals and society, and (3) compute internal rates of return resulting from investment in the different fields of study offered at OST.

For several reasons, it is important to determine the economic payoff from technical education. The public is investing large sums of capital in technical schools, and it needs measures of the payoff from this investment compared to alternative uses for limited public funds.

Individuals also face the decision whether to invest in technical training or elsewhere, and estimates of personal returns from the various forms of schooling can help individuals to use their limited funds more wisely.

Technical education has been suggested as one opportunity to equip disadvantaged youth for productive employment. OST lies in the Ozark region of eastern Oklahoma. The region is generally characterized by low income especially among rural people and minority elements such as American Indians. Because the school is strategically located to attract disadvantaged youth, the payoff from the school takes on even greater significance.

In response to the rapid scientific and technological advancement, society is not only concerned with exploring and transmitting new knowledge, but also with recognizing the needs of a dynamic economy.

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Various training programs have been enacted to promote economic development and to avoid unemployment resulting from structural change in a particular industry, occupation, or geographic location.

The frequent return of rural workers to their disadvantaged regions and the high unemployment rate among the youth can be partially explained by the lack of training. Without additional training, many of these people will not develop their full potential for economic advancement.

## Past Studies

Several studies have focused on the economics of technical education. Arthur J. Corazzini (1966) conducted a study of costs and benefits of general high school vocational training in Worchester, Massachusetts. He found that the public per pupil cost of vocational education for males, whether at the high school or post high school level, was 2.3 times that of regular high school education. His starting-wage data revealed that vocational graduates earned slightly higher wages than untrained regular high school graduates. He argued that the wage differentials would decrease over time because a high school graduate would have acquired as much on-the-job training as that of the vocational graduate. Since the wage differentials would not increase over time, the initial advantage enjoyed by the vocational graduate would be erased, making vocational investment unprofitable.

The study also attempted to evaluate the role of vocational education in preventing high school dropouts and its role in increasing the mobility of workers. The study showed that the program was "marginally profitable" only if the vocational graduate was considered to have been prevented from dropping out of school. In conclusion, the author was pessimistic about the economic payoff from vocational education in Worchester. A New York City study of vocational education also reached pessimistic conclusions about the economic returns from vocational training (Taussig, 1968).

Another study (Carroll and Ihnen, 1967) estimated costs and returns for investments in two years of post-secondary, technical schooling for graduates of Gaston Technical Institute in North Carolina. The sample was forty-five high school graduates who did attend the technical school and forty-five "paired" high school graduates who did not attend the technical school. The estimated social rate of return on investment in technical educaton was 16.5 percent if per capita real earnings would increase over time at the rate of 2 percent per year. The social rate of return was reduced to 11.7 percent when no growth in the initial income advantage of the technical school graduates was assumed.

In a mail questionnaire study, Kaufman and others (1967) evaluated the money returns to vocational education in Pennsylvania. The results showed that during the first year after graduation, the vocational-technical graduates earned a net (adjusted for socio-demographic factors) of $800 more than the non-college academic graduates, and the first group was employed about 2 months more than the latter. Vocational-technical graduates had, on the average, earned $480 per year more than the non-college graduates during the six year period after graduation. The estimated average internal rate of return to the vocational-technical curriculum was 29 percent, assuming that the net annual benefit stream of $480 is constant in perpetuity.

A more recent mail questionnaire study (Dupree, 1968) was conducted in Oklahoma to estimate the benefits to technical education. The study was limited to 1967 graduates of three post high school technical institutes and to technical graduates of five Oklahoma junior colleges. The sample consisted of 220 observations.

The projected lifetime income of this group was based on average salaries for six months after graduation from technical school. The results showed 25 and 35 percent rates of return to society and individuals, respectively, resulting from investment in technical education. The Oklahoma study like other studies was weakened by a short history of earnings.

Rates of return on investment in technical education were computed from data provided by 190 graduates of the Winona Area Technical School in Minnesota (U. S. Department of Labor, 1966). The school, located in a rural area, was selected to give insight into rates of return from training under the Manpower Development and Training Act (MDTA). Median social rates of return based on 1960-65 graduates ranged from 9 percent for the automotive repair technican program to 36 percent for the general office clerk program. The average social rate of return over all fields was approximately 20 percent.

The total cost per trainee at the Camp Kilmer Job Corp Center, a technical school training disadvantaged youth, ranged from $6,412 to $18,750 (Cain and Somers, 1967, p. 43). To earn a 5 percent return on total investment, former trainees would need to receive salaries from $7 to $20 per week above salaries of persons with similar backgrounds but without the training. The target seemed to be potentially attainable based on a separate 1964-65 study of former MDTA trainees. The study revealed that Negroes on the average were earning $13 per week more than they earned on their pre-training jobs (Cain and Somers, 1967, p. 29). Whites, however, were earning only $4 more per week after training. While the above data on the Job Corps and MDTA trainees are not comparable and one cannot make statements about absolute profit-

ability, it is interesting to note that the investment in training of Negroes in this instance was relatively more profitable than investment in whites. It should be kept in mind that these were retraining programs, often dealing with hard-core unemployables who might be expected to have a low return on retraining investments.

Boris (1964) compared earnings of Connecticut workers retrained under MDTA and state programs with earnings of a control group of persons who qualified for retraining but did not receive it. The results, based on a sample of 373 workers, showed that retraining contributed $500 annually to gross earnings per worker.

Main (1968) reports the results of a later nationwide evaluation of institutional (not on-the-job) training of the MDTA program. About 1,200 former MDTA trainees were interviewed in 1966, more than a year after training, along with a control group of 1,060 other persons. The net effect of completing MDTA training was estimated to be $10 per week in family income. This is similar to results of the Connecticut study by Boris. Main concluded, however, the MDTA training did not help people to get better paying jobs, but it did help them to obtain more full-time employment (Main, 1968).

An interview study of 879 persons in West Virginia from 1959 through 1964 provided the basis for estimating rates of return on retraining courses sponsored by the Area Redevelopment Act and The Area Vocational Training Program (Stormsdorfer, 1968). The former was a federal program, the latter a program of the government of West Virginia. The social rate of return on investment in retraining was estimated to be 90 percent for males and 64 percent for females. Nontrainees, selected from the unemployed files at the local employment office, were the control group. Judging from data on education and work experience, it is doubtful that the control group adequately represented the earnings of the retrained group if they had not been retrained.

Cain (1967) used two approaches to estimate the benefit-cost ratios from social investment in the Job Corps. One was based on improvements in educational attainment, coupled with Giora Hanoch's estimates of the relationship between education and income; the other was based on the 1967 survey of excorpsmen and persons who applied for the Corps but did not participate (Cain, 1967). Whether the "no-show" group was a realistic control group is questionable. The uncertainties of the data were so great that even the "best" estimate, a 5 percent rate of return on investment in the Job Corps, is none too reliable.

## Limitations of Past Research

The above review shows conflicting rates of return resulting from investment in vocational-technical education. Several factors help to explain the wide variation in results among the evaluation studies.

First, many studies of vocational education contain very limited data about school graduates — no more information than a placement job record. Additional information about the individual (such as health, abilities, family background, etc.) is needed to estimate the relationship between income and education net of the effect of the other variables.

Second, differences in the rates of return are partly attributed to the use of inappropriate control groups. Many factors significantly affect earnings and employment, and differences in the performance of two groups may be attributed to the students' background instead of the effects of vocational training. The ideal comparison is between homogenous groups (with similar geographic, social and economic backgrounds) which differ only because one group does not have technical training.

Third, past research relied primarily on earnings data immediately following training. Starting salaries were used to project future income benefits by assuming that the difference in starting income between the experimental group and the control group persists over a lifetime. The earning difference may in fact increase the first few years past graduation, but then may decline in future periods as vocational skills become obsolete.

Fourth, one might anticipate that programs to train or retrain disadvantaged youth would display low economic returns. However, estimated rates of return for these programs do not appear to be uniformly low, and do not account for the wide variation in estimated rates of return to investment in technical training.

Finally, the rates of return found in the above studies differ by regions. It is possible that union hiring and apprenticeship practices which give inadequate credit to prior training explain the low returns in the East, where labor unions are strong. Clearly there is need for additional research on the returns from technical education.

## Features of This Study

This study complements past research in several ways. First, most of the past studies were made in the North and East. This study focuses on training in a technical school located in a low income area of the Southwest.

Second, this study uses new concepts of control groups to measure foregone earnings. One control group is high school (non-college bound)

graduates in the Southern United States, and the second group is comprised of persons with a socio-economic background similar to that of Oklahoma State Tech graduates but without the latter's technical training. The earnings of the second control group are estimated by the OST graduates themselves.

Third, while this study like several previous studies relies on earnings data from a mail questionnaire, a follow-up sample is used to correct for sample bias. Those who respond first may be financially better off than non-respondents. Information from the follow-up group was used to adjust downward the income reported by the initial group of respondents.

Finally, and most important, in this study the payoff from technical education is based on earnings data covering 21 years, a substantially longer period than considered in previous studies. This study will show that the age-earnings patterns over time of former vocational students do not conform to assumptions used in most past studies.

## Procedure

The study procedure is briefly summarized. Data from a mail survey are used in multiple regression equations to determine age-earnings patterns, corrected for selected socio-economic factors, of former students at OST. The net contribution of technical training is estimated as the difference between earnings over time of former Tech students and a control group of persons similar in characteristics but without Tech training. Estimates of costs are then computed and include foregone earnings of students while in school based on control group earnings. Also included are costs of instruction, administration, buildings and equipment obtained from administration records. Finally, the rate of discount (return) is computed which makes the cost of training equal to net lifetime benefits.

## Data

Before turning to the characteristics of the data, the structure and fields of specialization at OST are reviewed. Tech operates on a trimester plan, three 16-week terms. Students are able to complete a field of specialization in two years or less. Students generally spend four hours each day in shops and another two hours in general education subjects related to the particular occupation.

For the purpose of this study, the major programs offered have been grouped into the following occupational fields: automotive, building trades, commerce, diesel, drafting, electronics and electricity, food and cullinary arts, refrigeration, printing, and a final category composed of

all other fields. The category "others" consists of the following fields: dry cleaning, watch making, landscaping and general farming.

Table 1 shows the number of full-time student equivalents, by major field of study, for the fiscal years 1947-1968. Automotive was the largest field with a total enrollment of 5,474 students, followed by electronics and electricity with 4,127, and diesel with 3,446 students. The number of students in 1968 was more than 4 times that of 1947, and the number of students in the past nine years was greater than that in the first 13 years. Commerce and refrigeration enrollments increased markedly between the periods 1947-1959 and 1960-1968.

## Method of Obtaining Data

A mail questionnaire was used to obtain data on personal monthly earnings on each of the fields listed in Table 1 for the period since the respondent graduated from OST. The questionnaire also included characteristics which can affect earnings such as age, race, grades, family factors (marital status, parent's education and occupation, size of family), major area of specialization, additional training, present occupation and location, and unemployment. A copy of the questionnaire can be found in the study (Shallah, 1970) on which this publication is based.

A list of former students was obtained from school officials. The bias from excluding persons with no addresses is indeterminate.[1] The mailing list contained 4,123 addresses, 800 of whom were 1966 and 1967 graduates excluded from the study because it was felt that they did not have enough earnings data beyond graduation. The sample of women was too small to make a reasonably reliable analysis, so they were excluded from this study.

A total of 3,323 letters were mailed. Out of this total, 99 were returned because persons moved and left no forwarding addresses. The net total of 2,898 graduates received the questionnaires. Out of this total, 471 persons responded to the first mailing, making the response rate 16 percent. An additional 80 incomplete questionnaires were received.

Follow-up letters were then mailed to 600 non-respondents selected on a random basis — every tenth person was chosen from the non-respondents' mailing list (which included persons who returned incomplete schedules in the first mailing).

Out of the 600 additional mailed letters, 121 complete questionnaires were received, making the rate of response from the second mailing list 20 percent. The follow-up was used to reduce bias due to missing data.

[1]On the one hand it can be argued that some students were not enthusiastic about keeping contact with OST because their training did not contribute to their economic advancement. As such, the results are biased upward. On the other hand, it may be that students who are geographically mobile lost contact with OST. If mobility leads to higher incomes, then the omission of this group biases the results downward.

**Table 1 Number of Full-Time Student Equivalents at Oklahoma State Tech by Major Field of Study, 1947-1968**

| Year | Automotive | Building Trade | Commerce | Diesel | Drafting | Electronics | Food | Printing | Refrigeration | Others | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1947 | 109 | 4 | 36 | 68 | 12 | 65 | 10 | 9 | 68 | 44 | 425 |
| 1948 | 129 | 13 | 43 | 83 | 33 | 96 | 38 | 19 | 66 | 106 | 626 |
| 1949 | 208 | 27 | 52 | 109 | 49 | 125 | 69 | 34 | 71 | 238 | 982 |
| 1950 | 329 | 34 | 41 | 131 | 48 | 150 | 89 | 41 | 59 | 351 | 1273 |
| 1951 | 302 | 31 | 34 | 127 | 47 | 124 | 69 | 39 | 31 | 274 | 1079 |
| 1952 | 300 | 22 | 42 | 91 | 39 | 117 | 46 | 35 | 18 | 292 | 1002 |
| 1953 | 114 | 16 | 43 | 91 | 46 | 125 | 13 | 39 | 30 | 166 | 683 |
| 1954 | 136 | 16 | 58 | 158 | 67 | 208 | 32 | 40 | 37 | 110 | 862 |
| 1955 | 186 | 22 | 72 | 213 | 101 | 289 | 41 | 59 | 52 | 134 | 1169 |
| 1956 | 166 | 22 | 73 | 159 | 124 | 257 | 33 | 62 | 62 | 119 | 1077 |
| 1957 | 138 | 17 | 78 | 125 | 139 | 229 | 30 | 55 | 58 | 107 | 976 |
| 1958 | 194 | 11 | 79 | 119 | 160 | 234 | 29 | 53 | 62 | 109 | 1050 |
| 1959 | 158 | 13 | 86 | 117 | 92 | 227 | 27 | 50 | 62 | 82 | 914 |
| 1960 | 213 | 17 | 76 | 128 | 139 | 229 | 27 | 53 | 71 | 92 | 1045 |
| 1961 | 253 | 11 | 77 | 141 | 126 | 215 | 27 | 68 | 44 | 81 | 1053 |
| 1962 | 262 | 9 | 82 | 169 | 127 | 195 | 36 | 64 | 81 | 79 | 1104 |
| 1963 | 287 | 9 | 122 | 174 | 138 | 201 | 49 | 71 | 93 | 78 | 1222 |
| 1964 | 308 | 15 | 140 | 178 | 156 | 197 | 45 | 79 | 120 | 103 | 1341 |
| 1965 | 330 | 54 | 171 | 230 | 159 | 226 | 75 | 72 | 128 | 80 | 1525 |
| 1966 | 391 | 75 | 220 | 287 | 176 | 221 | 87 | 84 | 148 | 83 | 1772 |
| 1967 | 402 | 62 | 275 | 278 | 205 | 207 | 94 | 86 | 139 | 83 | 1831 |
| 1968 | 379 | 53 | 339 | 270 | 192 | 230 | 88 | 72 | 136 | 64 | 1823 |
| 1947-59 | 2469 | 247 | 737 | 1591 | 957 | 2206 | 526 | 534 | 665 | 2132 | 12117 |
| 1960-68 | 2825 | 305 | 1502 | 1855 | 1418 | 1921 | 528 | 649 | 960 | 743 | 12706 |
| 1947-68 | 5474 | 552 | 2239 | 3446 | 2375 | 4127 | 1054 | 1183 | 1625 | 2875 | 24832 |

**Table 2 Numbers of Questionnaires Received and Income Observations by Major Field of Study.**

| Major Field of Study | No. of Questionnaires | No. of Three-Year Average Income Observations |
|---|---|---|
| Automotive | 83 | 272 |
| Commerce | 31 | 99 |
| Diesel | 102 | 328 |
| Drafting | 83 | 241 |
| Electronics | 122 | 428 |
| Food | 21 | 80 |
| Printing | 23 | 70 |
| Refrigeration | 41 | 122 |
| Others | 30 | 107 |
| Total | 536 | 1747 |

In total, 592 complete questionnaires were received, making the overall response rate 17 percent. However, 536 questionnaires were used in the study after excluding 56 persons who attended another college or university after graduation from Oklahoma State Tech (Table 2). These persons were omitted from the analysis because their return would be confounded with the return from investment in college education. The omission of these persons is likely to bias the results of this analysis slightly upward since their technical training was not necessarily useful to their careers.[2]

## Earnings Data — The Dependent Variable

The individual monthly income figures since graduation from OST were deflated, converted into annual dollar income, and adjusted for unemployment. The average hourly earnings of production and non-supervisory workers was chosen for deflating the data (cf. U. S. Department of Labor, 1968, p. 63). The group includes mechanics, draftsmen, repairmen, teachers, and laborers, and is representative of the occupational fields in this study.

The use of time series introduces a possible bias resulting from the choice of a deflator. The magnitude and direction of bias is determined by the accuracy of the deflator in measuring the change in the general wage level of workers over time.

The alternative to using time-series data is to employ cross-sectional data. The latter may introduce more serious bias and statistical inefficiency resulting from the use of few observations.

[2]Out of the 57 persons who attended college after graduation from OST, only six majored in the same field in which they specialized at OST.

The income figures used in this study cover only wages and salaries. Other incomes such as welfare payments, interest and rents were excluded to avoid attributing to schooling special factors such as family wealth, inheritance and transfer payments.

From the yearly income figures that were derived, a simple three-year average income (1948-50; . . . 1966-1968) was computed and used in the analysis. This procedure lost little data, since the respondents frequently reported their income in intervals of one or more years, and reduced the number of dummy variables (defined later) in the earnings regression function.

## The Benefits

Two functions were used to relate earnings to OST training and other characteristics of individuals. The first, called the *age-earnings function,* expresses earnings as a function of age and other characteristics including age at completion of OST. The latter variable, age at completion of OST, at least partially compensates for work experience prior to technical schooling which contributes to earnings after graduation. Data revealed that over half of all students in the sample graduate at age 22 or over. The majority had worked in an occupation before attending OST, although the exact nature of that experience was not ascertained.

The second equation, called the *experience-earnings function,* expresses earnings as a function of the years of experience since OST and other characteristics including age at completion of the technical training. The latter variable partially accounts for differences in previous experience which contribute to earnings after graduation but which should be separated from the influence of OST training. The age-earnings function emphasizes the effect of age on earnings, with an adjustment for pre-OST experience. The experience-earnings function emphasizes the effect of post-OST experience on earnings with an adjustment for graduation age (which reflects pre-OST experience). Since there is no *apriori* basis for rating one formulation as superior to the other, the results of both are included. It would have been desirable from a theoretical standpoint to include a complete set of variables for both age and experience in the estimated equation. From a practical standpoint, this formulation was precluded because of the high correlation between age and experience.

### Estimates of the Earnings Function

Multiple regression is used to separate the effects of education and other variables, so that the net effects of education can be isolated.

Earnings, the dependent variable, is a function of race, marital status, physical condition, field of study, and numerous other independent (explanatory) variables.

The functional form used to express the age-earnings equation is apparent in Table 3 and of the age-experience equation in Table 4. Each equation is linear in the coefficients. The mathematical association of earnings with age, which enters the equation as 15 dummy variables, is not a straight line, however.

Where a factor is represented by one or more dummy variables, one segment is omitted to avoid singularity. Using age as an example, each age category except 20-22 is included as a separate independent variable. When observations are recorded on earnings and other data applicable to former students when he was 23 to 25 years of age, a 1 is entered under the variable 23-25, zeros elsewhere. When data are recorded for the same person when he was 59-61 years of age, a 1 is entered under the variable 59-61, zeros elsewhere. The constant term is applicable to the age segment 20-22 omitted from the dummy variables.

A similar procedure applies to other dummy variables. If a former student majored in commerce, a 1 is entered under the variable "commerce". A zero is listed for other majors under the commerce variable.

The constant term, $4496 in Table 3, is the estimated earnings of an OST graduate who was 20-22 years of age, white, married, who received average grades, was corrected for follow-up sample bias, physically healthy, was an only child, majored in automotive, whose father was a farmer or laborer, who graduated between the ages of 18 and 24, was a high school graduate, was working in a job related to his major field of study, and who was not presently in the military.

The age-earnings profiles to be discussed later are found by adjusting the constant, $4496, for the major field of study and for age by the coefficients in Table 3. The remaining variables were at levels specified above.

The interpretation and structure of the experience-earnings function shown in Table 4 are similar to those of the age-earnings function discussed above, except for the experience variable which replaces the age variable.

## 1948-1965 Period

Tables 3 and 4 give estimates of coefficients and their standard errors for the two earnings functions for 1948-1965, with three-year average earnings in 1959 dollars as the dependent variable. The results indicate that white graduates earn $1,081 [$1,021] more yearly than the non-white graduate.[3] The considerable difference between the two groups may be

**Table 3 Estimates of the Age-Earnings Function: 1948-1965 Students of Ages 20-64. (in Dollars)**

| Variable | Coefficient | Standard Error |
|---|---|---|
| Age | | |
| 20-22[1] | | |
| 23-25 | 263 | 176 |
| 26-28 | 991** | 189 |
| 29-31 | 1259** | 172 |
| 32-34 | 1842** | 233 |
| 35-37 | 1700** | 260 |
| 38-40 | 1458** | 314 |
| 41-43 | 1363** | 359 |
| 44-46 | 688 | 442 |
| 47-49 | 944 | 611 |
| 50-52 | —72 | 669 |
| 53-55 | —887 | 869 |
| 56-58 | —2047** | 993 |
| 59-61 | —1602 | 1387 |
| 62-64 | —1843 | 1700 |
| Race | | |
| White[1] | | |
| Non-white | —1081** | 342 |
| Marital Status | | |
| Married[1] | | |
| Single, Divorced | —922** | 206 |
| Grade Average | | |
| Above average | 380** | 119 |
| Average[1] | | |
| Follow-up Letter | | |
| Yes[1] | | |
| No | 185* | 148 |
| Physical condition | | |
| Disabled | —1015** | 221 |
| Healthy[1] | | |
| Size of family[1] | —90** | 26 |
| Major Field of Study | | |
| Automotive[1] | | |
| Commerce | 668** | 283 |
| Diesel | 687** | 198 |
| Drafting | 1041** | 214 |
| Electronics | 543** | 187 |
| Food | 1446** | 311 |
| Printing | 145 | 324 |
| Refrigeration | 916** | 264 |
| Others | 1178** | 281 |
| Father's Occupation | | |
| Farmer, Laborer[1] | | |
| Professional | 310** | 150 |
| Others | 55 | 152 |
| Graduation Age | | |
| 18-24[1] | | |
| 25 and over | 247* | 150 |

**Table 3 (Cont'd.)**

| Variable | Coefficient | Standard Error |
|---|---|---|
| High School Graduate | | |
| Yes[1] | | |
| No | —464** | 168 |
| Present Job | | |
| Related to major[1] | | |
| Not related to major | —651** | 227 |
| Remotely related to major | 40 | 286 |
| Military Service | | |
| Yes | —5573** | 443 |
| No[1] | | |
| Constant term | | |
| (Automotive majors) | 4496 | |
| $R^2$ | .249 | |
| F ratio | 16.24** | |
| Number of Observations | 1747 | |

*Significant at the .05 level.
**Significant at the .01 level.
[1]This element of the set enters into the intercept term since the partial regression coefficient in a subset represents the deviation from the other element in the subset.

attributed to either discrimination in the labor market or to differences in productivity, or to both. Married graduates earn $922 [$857] more than single or divorced graduates.

The use of average grades at least partly adjusts for intelligence and ability. The coefficient shows that graduates with above average grades earn $380 [$406] more than those with average grades.

Respondents of the follow-up letters earn $185 [$265] less than those who responded to the first mailing. The respondents to the follow-up letters may represent more closely the earnings of the average OST graduate. Those who respond first may be on the average financially better off than the others and are more eager to report. In subsequent calculations of rates of returns, the earnings reported by respondents were adjusted downward for this bias on the basis of data from the follow-up study.

Disabled persons whose physical or mental handicaps prevent them from earning full-time pay earn $1,015 [$1,223] less than those with no disability.

Size of family, measured by the number of children in the family in which the respondent was raised, helps to explain the variation in

[3]The figures in brackets are coefficients derived from the experience-earnings function while the figures preceeding it are coefficients from the age-earnings function.

**Table 4 Estimates of the Experience-Earnings Function: 1948-1965 Students with 1-21 Years of Experience. (in Dollars)**

| Variable | Coefficient | Standard Error |
|---|---|---|
| Years of Experience | | |
| 1-3[1] | | |
| 4-6 | 524** | 146 |
| 7-9 | 1142** | 168 |
| 10-12 | 1484** | 204 |
| 13-15 | 1480** | 255 |
| 16-18 | 912** | 341 |
| 19-21 | 633 | 471 |
| Race | | |
| White[1] | | |
| Non-White | —1021** | 340 |
| Marital Status | | |
| Married[1] | | |
| Single, Divorced | —857** | 206 |
| Grade Average | | |
| Above Average | 406** | 119 |
| Average[1] | | |
| Follow-up Letter | | |
| Yes[1] | | |
| No | 265* | 147 |
| Physical Condition | | |
| Disabled | —1223** | 218 |
| Healthy[1] | | |
| Size of Family[1] | —93** | 26 |
| Major Field of Study | | |
| Automotive[1] | | |
| Commerce | 778** | 281 |
| Diesel | 719** | 197 |
| Drafting | 1113** | 215 |
| Electronics | 540** | 187 |
| Food | 1416** | 311 |
| Printing | 161 | 323 |
| Refrigeration | 935** | 263 |
| Others | 982** | 284 |
| Father's Occupation | | |
| Farmer, Laborer[1] | | |
| Professional | 327** | 149 |
| Others | 130 | 151 |
| Graduation Age | | |
| 19-22[1] | | |
| 23-25 | 894** | 144 |
| 26 and over | 1230** | 150 |
| High School Graduate | | |
| Yes[1] | | |
| No | —551** | 168 |

**Table 4 (Cont'd.)**

| Variable | Coefficient | Standard Error |
|---|---|---|
| Present Job | | |
| Related to major[1] | | |
| Not related to major | —603** | 227 |
| Remotely related to major | —169 | 284 |
| Military Service | | |
| Yes | —5533** | 440 |
| No[1] | | |
| Constant Term | | |
| (Automotive majors) | 4049 | |
| $R^2$ | .253 | |
| F Ratio | 20.74** | |
| Number of Observations | 1747 | |

*Significant at the .05 level.
**Significant at the .01 level.
[1]This element of the set enters into the intercept term since the partial regression coefficient in a subset represents the deviation from the other element in the subset.

income among graduates. The significant coefficient indicates that a student from a large family tends to earn a lower income.

The socio-economic status of the parents can be expected to influence the economic progress of their son. The father's occupation was included to account for this effect. The occupation variable was divided into three subclasses: (1) farmers and laborers, (2) professional (doctor, lawyers, minister, and teacher), and (3) others (salesmen, skilled workers, military, etc.). The coefficients show that a typical graduate whose father's occupation was classified as professional earned $310 [$327] more than those whose fathers were farmers and laborers.

"High school graduate" describes whether or not an individual received a high school diploma. The significant coefficient indicates that those who graduated from high school earned an income of $464 [$551] more than those who did not.

Majors who are working in an area relative to their specialization earned $651 [$603] more than those who are working in an occupation dissimilar to their OST training.

The military service coefficient indicates that OST students forego $5,573 [$5,533] a year while they are in the service. This variable takes into consideration the effect of variation in income among majors resulting from the time spent in the military.

Finally, the major-field-of-study variable measures the net benefits accruing to the different occupational fields.[4] Automotive students earned less on the average than others, while food majors earned $1,446 [$1,416] more than the automotive students. The difference in earnings among the various groups is attributed to the supply and demand for the different occupations as well as to other factors such as individual competence and quality of training.

Having examined the effects of the joint variables that were used in both functions, we now discuss those variables that were entered differently in the two regressions. The age effects are shown in Table 3. Earnings increase with age and reach a peak at 32-34 years of age and then decline steadily until 47-49, where they increase slightly. Beyond that interval, earnings drop sharply.

The age variable may have biased the graduation age coefficient due to its significant interaction with that variable. The graduation age coefficient, $247, is small and significant only at the five per cent level in the age-earnings equation, while the same coefficient was larger and significant at the one percent level in the experience-earnings equation. This difference is perhaps explained by the fact that age at graduation is the only variable that represents age in the experience-earnings equation, while present age as well as graduation age are present in the age-earnings equation.

The experience variable indicates that persons with 10-12 years of working experience past graduation from OST earned $1,484 more than those who had 1-3 years of experience, and that there is almost no difference in earnings between those with 10-12 and 13-15 years of experience (Table 4). However, beyond 15 years of experience, earnings drop rather sharply. The coefficient of persons with 19-21 years of experience is based on only 26 observations (out of a total of 1,747). The interpretation and use of this coefficient will be discussed in the following section on age-earnings profiles.

The coefficients of determination ($R^2$) indicate that the set of variables in Table 3 and 4 explained about one-fourth of the variance of the individuals' earnings. The unexplained variation is attributed to errors in the data, unaccounted for interaction among variables, and missing

[4]In addition to the above variables that were chosen for the final analysis, the following were considered but coefficients were insignificant:

a) Parent's education. Years of school completed by parents may affect their children's background and outlook and reflect the transmission of the parent's motivation to send their children to college and of their knowledge of market information.

b) On-the-job training. The variable was considered a type of investment in human capital. Its unimportance may be explained by the difficulty in distinguishing between normal work experience and on-the-job training.

c) Location of present job. The variable was used to show the effects of working in places where there are more opportunities. The hypothesis that those who worked in large cities, such as Oklahoma City and Tulsa, earn more than those who stayed in rural areas (Ozark region) was not confirmed.

variables. Missing variables include complete measures of ability, intelligence, motivation, and attitudes toward work. The $R^2$'s, though low, are in line with those obtained in other studies predicting individual human behavior.

The F-test is applied to determine the significance of the entire regression equation. Both F-values, 16.24 and 20.74, are significant at the one percent level which means that a high probability exists that earnings are related to the linear combinations of the inhdependent variables.

## 1960-1965 Period

The above earnings of the different occupational fields were for the 1948-1965 period, and the relative earnings could have shifted markedly among fields over time. This point is examined by estimating the earnings function of recent graduates.

The estimated earnings function (experience-earnings equation only) for 1960-65 students provides a more realistic measure of the current earnings in various fields, but the job history is shorter and observations fewer. Table 5 shows the estimated coefficients and their standard errors of the earnings function for 1960-65 students with 1 to 9 years of post-OST working experience.

The rankings in earnings of the different occupations changed for the 1948-1965 and the 1960-1965 students. For 1948-1965 students, food majors ranked number 1 in earnings followed by "others", drafting, refrigeration, diesel, commerce, electronics, printing, and finally automotive. Considering only the 1960-1965 data, drafting majors had the highest earnings followed by electronics, diesel, refrigeration, "others", commerce, food, and finally printing. In recent years, the relative demand for such fields as automotive, diesel, drafting, and electronics has increased, while the relative opportunities in the other fields, such as food and printing, appear to have declined.

The difference in relative earnings of the different occupations between the two groups (1948-1965 and 1960-1965 students) may be due to differences among occupations in chances for advancement. For example, the questionnaires revealed that many of the food majors either held administrative jobs or had their own private business.[5] Food majors, unlike (say) draftsmen, may not have to compete with engineers and other college graduates for management positions, and may find admin-

[5]It is possible that certain majors begin with low (high) earnings and end high (low). This is demonstrated in the shape of individual field profiles from the regression equations estimated separately for each field with data only for that field. For example, "other" majors had the highest starting salaries but had the fourth lowest earnings at the end of the profile; and electronics majors began with the fourth best earnings and ended with the highest earnings. The single equation that estimates earnings for all fields with a dummy variable for each field does not show this, since it forces the age-earnings profiles to differ among fields by a constant. The individual regression equations were not used due to the small number of income observations for each major field of study. The age-earnings profiles estimated for each area of study were judged to be unreliable.

**Table 5 Estimates of the Earnings Function: 1960-1965 Students with 1-9 Years of Experience. (in Dollars)**

| Variable | Coefficient | Standard Error |
|---|---|---|
| Years of Experience | | |
| 1-3[1] | | |
| 4-6 | 312** | 133 |
| 7-9 | 722** | 177 |
| Race | | |
| White[1] | | |
| Non-White | —838** | 297 |
| Marital Status | | |
| Married[1] | | |
| Single, Divorced | —821** | 182 |
| Grade Average | | |
| Average[1] | | |
| Above Average | 270** | 126 |
| Follow-up Letter | | |
| Yes[1] | | |
| No | —277** | 151 |
| Physical Condition | | |
| Disabled | —1681** | 284 |
| Healthy[1] | | |
| Size of Family[1] | —88** | 30 |
| Major Field of Study | | |
| Automotive[1] | | |
| Commerce | —20 | 307 |
| Diesel | 756** | 203 |
| Drafting | 854** | 211 |
| Electronics | 760** | 203 |
| Food | —227 | 404 |
| Printing | —584* | 335 |
| Refrigeration | 557** | 262 |
| Others | 5 | 315 |
| Father's Occupation | | |
| Farmer, Laborer[1] | | |
| Professional | —98 | 161 |
| Others | —89 | 160 |
| Graduation Age | | |
| 18-22[1] | | |
| 23-25 | 645** | 152 |
| 26 and over | 517** | 186 |
| High School Graduate | | |
| Yes[1] | | |
| No | —160 | 188 |
| Present Job | | |
| Related to major[1] | | |
| Not related to major | —450** | 227 |
| Remotely related to major | —382 | 404 |

**Table 5 (Cont'd.)**

| Variable | Coefficient | Standard Error |
|---|---|---|
| Military Service | | |
| Yes | —4645** | 453 |
| No[1] | | |
| Constant Term (Automotive majors) | 4253 | |
| $R^2$ | .312 | |
| F-Ratio | 14.59** | |
| Number of Observations | 797 | |

*Significant at the .05 level.
**Significant at the .01 level.
[1]This element of the set enters into the intercept term since the partial regression coefficient in a subset represents the deviation from the other element in the subset.

istrative positions quite accessible. Food majors may have low earnings in early years, but high earnings as they move into positions of management and proprietorship. The 1960-1965 earnings, which are based on the maximum of nine years of earnings following graduation from OST, may give a misleading picture of the lifetime earnings potential of food majors.

OST administrators felt that automechanics majors have the highest current earnings, although the results of this study do not show this. This inconsistency may be explained by the fact that the automotive category used in this study includes not only automechanics majors but also autobody, autotrim, autoparts and service station management; and there is no way to find out the portions of this automotive sample allocated to each of the above. It follows that automechanics majors could have high earnings, but this is obscured by averaging their earnings with those from the other autofields.

## Age-Earnings Profiles

The net contribution of technical training to earnings is measured by the difference in earnings between a control group and former OST students. The procedure is to construct age-earnings profiles of former OST students from results of the regression equations in Tables 3, 4 and 5 with appropriate correction for socio-economic variables. The profiles for the control groups described below are substracted from the profiles of former OST students to derive the *net* contribution of technical training to earnings for each age. Two control groups are chosen to represent how OST graduates would have performed had they not attended technical school.

## U. S. South Control Group

The first control group is white males in the Southern United States and is from 1959 census data. This control was selected because Oklahoma State Tech is located in a low income area which is more like the South than like other census regions. The plotted profile in Figure 1 shows that earnings rise continually and reach a peak of $5,737 at the age of 54. An advantage of the census control is the large number of observations on which it is based. In addition to the lack of exact geographic comparability, a disadvantage is that the income data of the census control group were not adjusted for some socio-demographic factors which affect earnings and employment. Thus earnings differences between OST graduates and the control group cannot be attributed solely to technical training but must, in part, be attributed to the individual's background and personal characteristics.

## Questionnaire Control Group

The second control group is the graduate's own estimate of how much more (less) do other persons in his community earn with similar

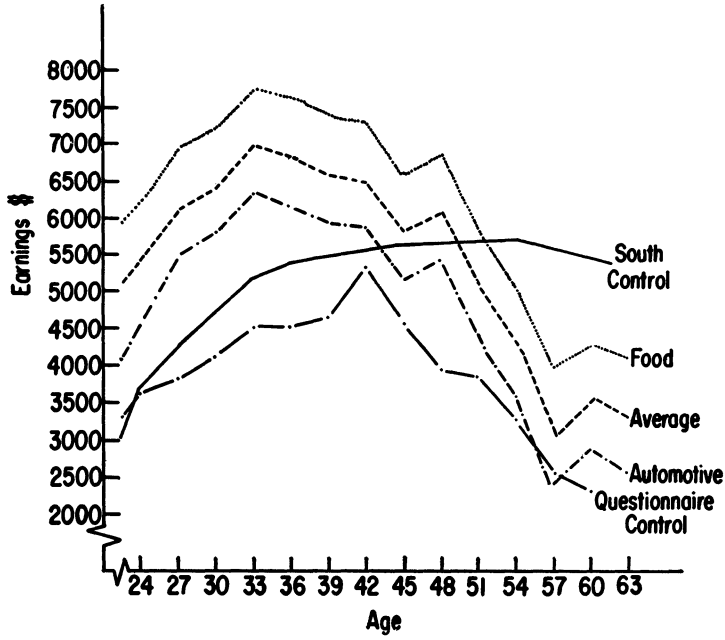


**Figure 1. Age-Earnings Profiles for 1948-1965 Students by Major Field of Study and Two Control Groups—Age-Earnings Method**

age and background, but without his technical education. Based on the respondents answers, an age-earnings profile was constructed and plotted in Figure 1. The data, as were earnings data from OST training, were deflated to 1959 dollars to be comparable with the 1959 census data. The general shape of the profile indicates that earnings increase gradually at first and increase markedly approaching age 42, at which age earnings reach a maximum, then drop sharply beyond that age. It is apparent in Figure 1 that the questionnaire profile was lower than that of the U. S. South profile after 25 years of age.

A major advantage of the control age-earnings profile obtained from the former OST students is that it is specific to the relevant population. But it is based on substantially fewer observations than the census profile. However, former OST students may have little knowledge of what persons without this training may be making and may be unusually subjective in making the estimate, giving answers that result in a control group age-earnings profile that is biased downward. In short, it is believed that there is not much basis for selecting one over the other profile. Thus both control groups were used to measure the earnings differential of those with and without technical education.

## Age-Earnings Method

Using the age-earnings equation results, ten age-earnings profiles were constructed. Nine correspond to the different occupational groups and one to the average OST graduate.

Only the lowest and highest age-earnings profiles of the different occupations were plotted in Figure 1. These represent automotive majors and food majors. The profiles of the other occupations were not plotted in order to avoid crowding the graph. Their shape is identical to the automotive profile; they differ from the automotive profile in height only. The detailed age-earnings schedule for each occupation as well as the other information relating to Figure 1 are presented elsewhere (Shallah, 1970, Table XXI).

Figure 1 indicates that between the ages of 22 and 33 earnings increase gradually and continuously. After age 33, earnings decrease until age 45 and increase slightly at age 48, then decline rather sharply beyond that age.

Peak earnings are reached at a rather early age. This may be explained by the nature of technical education which requires constant updating of knowledge and skills. It is presumed that the more specialized the skills of an individual, the more obsolete becomes his original training over time. The fact that only one-fourth of the respondents acquired additional training since graduating from OST may have contributed to the decline in earnings at a relatively young age.

Earnings drop rather sharply beyond the age of 48. The gradual decline between ages 33 and 45 can be attributed to decreased stamina, dexterity, flexibility or possible unwillingness on the part of some graduates to change jobs for fear of losing seniority or pensions (cf. Morgan, *et al.*, 1962, p. 50). The sharp decline in earnings beyond age 51 is believed to be attributed to early graduates who were frequently physically handicapped and to a lower quality of training in the early years of the school.

A major assumption used in this study is that the estimated age-earning profiles will follow the same age-earning schedule as that of the control group starting at the point where the respective constructed profiles intersect the control group profile. In other words, the difference in net earning between Tech graduates and the control are considered to be zero beyond the point where the two profiles cross one another. Beyond age 51, expected earnings of the average OST graduate are assumed to be the same as those of a high school graduate in the Southern U. S. when the latter is used as the control group.

The assumption that earnings of OST graduates do not fall below earnings of high school graduates is defended on several grounds. First, early OST graduates were frequently handicapped, were without a high school education and in general were from a different statistical population than the more recent graduates. Second, sampling error may play a role in the data for older ages, where few observations were available. Finally, it seems unlikely that high school graduates with OST training would earn significantly less than a high school graduate without the training.

## Experience-Earnings Method, 1948-1965 Students

The experience-earnings method to construct lifetime earnings emphasizes net benefits accruing to experience after graduation from OST. The coefficients of the experience variables in Table 4 were used to construct the age-earnings profiles from the experience-earnings function. The profiles were assumed to commence at the median age of graduation (22) in this sample. For example, earnings of those with 1-3 years of experience are related to ages 23-25 and earnings of those with 19-21 years of experience are related to ages 41-43.

Figure 2 shows the plotted age-earnings profiles for food, automotive and the average student. The first two represent the highest and lowest profiles, respectively. Earnings increase gradually and reach a peak between the ages of 33 and 36. (This compares to age 33 in the age-earnings method.) The experience-earnings method has the disadvantage of lacking income data beyond age 42. This is due to the number of years of experience acquired by the first graduates since the school started. Those

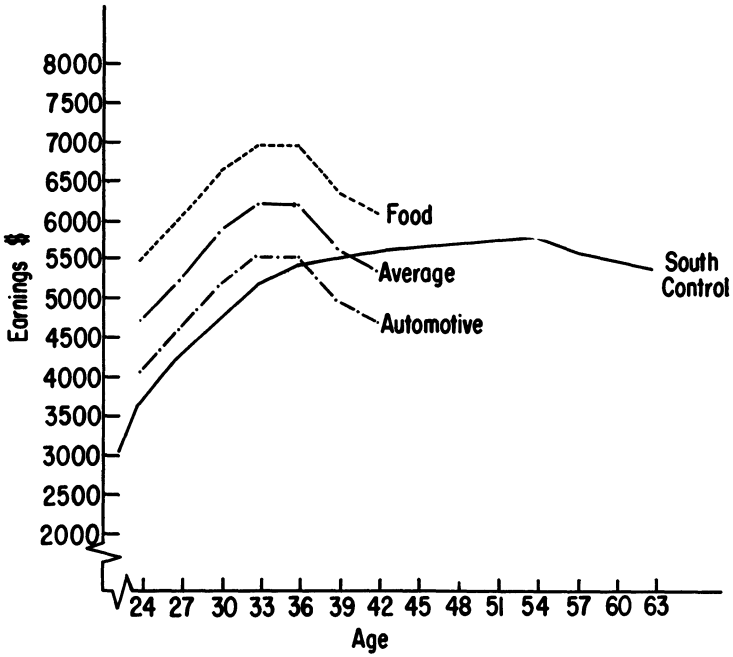


**Figure 2. Age-Earnings Profiles for 1948-1965 Students by Major Field of Study and Two Control Groups — Experience-Earnings Method**

who graduated in 1947 (first graduating class) have a maximum of 21 years of working experience (1947-1968).

The questions raised in the previous section about the reliability of the estimated earnings of the older graduates apply also for the experience-earnings method. The estimated earnings at age 42 are not statistically reliable because they are based on only 17 observations from 1947-1949 students.

To determine the effect of 1947-1949 students' earnings on the shape of the profile, another regression equation was estimated excluding the latter group. The general shape of the profiles did not change. Earnings declined beyond age 35. However, the decline in earnings between ages 36 and 39 was not as steep as that when the 1947-1949 graduates were included in the analysis.

It was assumed again that the respective constructed profiles will follow the age-earnings schedule of the control group starting at the point where the two intersect. The profile of the average graduate will assume the same shape as that of the high school graduate in the South-

ern U.S. beyond age 42. The automotive profile will be that of the control group starting at age 39.

## Experience-Earnings Method, 1960-1965 Students

The experience-earnings function for 1960-1965 students estimates earnings for a maximum period of nine years. The median graduation age for this group was 20 so that earnings are estimated up to age 29. In order to estimate earnings beyond age 29, the profile of the 1948-1965 average graduate was used as a basis for projections.

Earnings of 1960-1965 drafting graduates at age 27 were estimated to be $5,550 and of 1948-1965 graduates at the same age were $5,231. The difference between the two values ($319) was added to each age-group of the latter profile to project earnings of drafting graduates for the ages 29-42. The same procedure was followed for projecting age-earnings of graduates of the other occupations.

Figure 3 shows that drafting majors replaced food majors in having the highest profile and printing majors now have the lowest profile.

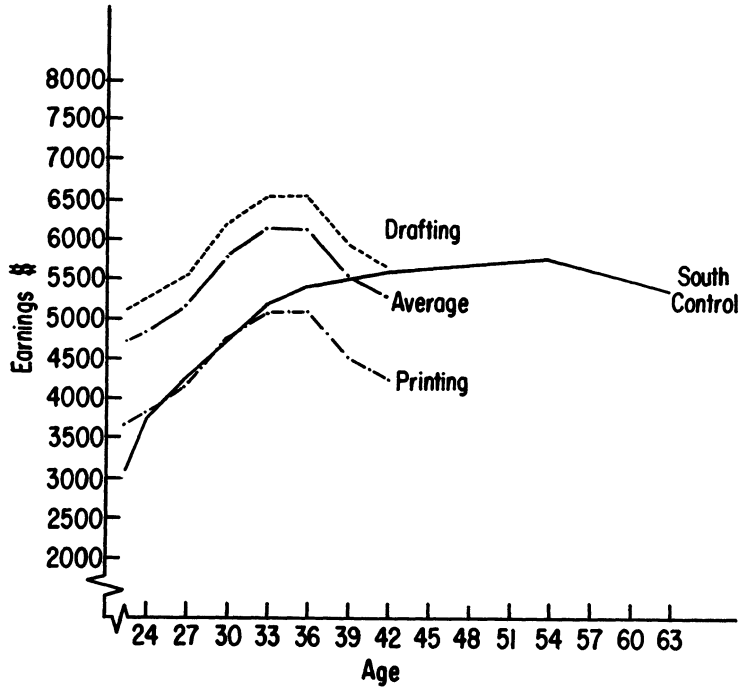


**Figure 3. Age-Earnings Profiles for 1960-1965 Students by Major Field of Study and South Control Group — Experience-Earnings Method**

## The Costs

This section presents two components of costs of schooling at OST. One is *private costs,* the costs to the individual student. The second is *social costs,* the costs of OST schooling to society. The private costs consist of direct cash expenses for such items as books and tuition plus indirect costs in the form of earnings foregone by OST students while attending school. The social costs include the school, such as teachers' and administrators' salaries, interest and depreciation on physical property as well as the private cost mentioned above.

The private cost is used later to compute a *private* rate of return, which indicates the economic payoff to the individual as a result of his technical education. The social cost is used to compute the *social* rate of return, a measure of the payoff to society from investment in technical education.

Average annual private and social costs per student by major field of study and for the average over all fields are summarized in Tables 6 and 7. Detailed calculations are shown elsewhere (Shallah, 1970).

The major component of private costs is the opportunity cost measured by foregone earnings while attending OST. Earnings of a control group (high school graduates in the South in Tables 6 and 7) are used to compute foregone earnings. Students in some fields complete their schooling in less than two years. Their costs in the second year are offset by earnings during the second year following completion of technical training.

**Table 6 Average Annual Private and Social Costs for 1948-1965 Per Student by Major Field of Study, Experience-Earnings Method. (in Dollars)**

| Major Field of Study (1) | First Year Costs | | | Second Year Costs | | | |
|---|---|---|---|---|---|---|---|
| | Private[1] (2) | Public (3) | Social (4) | Private[2] (5) | | Public (6) | Social (7) |
| Automotive | 3141 | 1022 | 4163 | 3465 | | 1022 | 4487 |
| Commerce | 3096 | 1136 | 4232 | 2310 | (701)[3] | 758 | 1459 |
| Diesel | 3151 | 1140 | 4291 | 3465 | | 1140 | 4605 |
| Drafting | 3131 | 832 | 3963 | 3465 | | 832 | 4297 |
| Electronics | 3146 | 1012 | 4158 | 3465 | | 1012 | 4477 |
| Food | 3096 | 1741 | 4837 | 1155 | (—2489)[3] | 580 | —1909 |
| Printing | 3096 | 1576 | 4672 | 2310 | (907)[3] | 1050 | 1957 |
| Refrigeration | 3141 | 941 | 4082 | 3465 | | 941 | 4406 |
| Others | 3141 | 1238 | 4379 | 1155 | (—2199)[3] | 413 | —1786 |
| Average | 3131 | 1104 | 4235 | 3465 | | 1104 | 4569 |

[1]Foregone earnings of $2661 (South control age 21, 22) plus expenses paid by individual.
[2]Foregone earnings of $3030 (or fraction thereof, if training completed in less than two years) plus expenses paid by individual.
[3]For indicated fields, training completed in less than two years. The estimate in parenthesis is the entire cost of training in the second year *less* earnings while on the job following graduation but accruing in the second year.

Because the age-earnings equation for 1948-1965 (Table 3) gave different estimates of earnings following graduation than did the experience-earnings equation (Table 4), the costs in the second year differ slightly between the two estimates. Only the estimates for the experience-earnings method are shown (Table 6) because of the small differences in costs that resulted from the two approaches. Foregone earnings constituted $2661 of the first-year private costs in Table 6. The remaining costs, which averaged $470, were expenses paid by the typical student for supplies, tuition and other items. Living expenses are not included, since they are assumed to occur whether or not the student is attending school. Total private costs the second year are negative for food and "other" majors, because earnings following graduation (but accruing in the second year) more than offset other costs.

Public costs include the expense of instruction, administration, equipment and miscellaneous items not paid by the student. These costs range from $1741 for food majors to $832 for drafting majors, and average $1104 for the first year.

Total social costs are the private cost plus the public cost and average $4235 over all students.[6] The social costs do not vary widely among fields. They range from $3963 for drafting majors to $4837 for food majors the first year. All costs are expressed in 1959 dollars to make

[6]Inclusion of tuition fees plus the cost of instruction and administration results in some double counting in social costs. This double counting is believed to be offset by other bias, such as underevaluation of school property, some of which was donated or acquired on concessional terms. The extent of the underevaluation is difficult to pinpoint.

**Table 7 Average Annual Private and Social Costs for 1960-1965 Per Student by Major Field of Study, Experience-Earnings Method. (in Dollars)**

| Major Field | First Year Costs | | | Second Year Costs | | | |
|---|---|---|---|---|---|---|---|
| of Study | Private[1] | Public | Social | Private[2] | | Public | Social |
| (1) | (2) | (3) | (4) | (5) | | (6) | (7) |
| Automotive | 2825 | 1022 | 3847 | 3096 | | 1022 | 4118 |
| Commerce | 2780 | 1136 | 3916 | 2064 | (629)[3] | 758 | 1387 |
| Diesel | 2835 | 1140 | 3975 | 3096 | | 1140 | 4236 |
| Drafting | 2815 | 832 | 3647 | 3096 | | 832 | 3928 |
| Electronics | 2830 | 1012 | 3842 | 3096 | | 1012 | 4108 |
| Food | 2780 | 1741 | 4521 | 1032 | (—1652)[3] | 580 | —1072 |
| Printing | 2780 | 1576 | 4356 | 2064 | (841)[3] | 1050 | 1891 |
| Refrigeration | 2825 | 941 | 3766 | 3096 | | 941 | 4037 |
| Others | 2825 | 1238 | 4063 | 1032 | (—1800)[3] | 413 | —1387 |
| Average | 2815 | 1104 | 3919 | 3096 | | 1104 | 4200 |

[1]Foregone earnings of $2345 (South control age 20, 21) plus expenses paid by individual.
[2]Foregone earnings of $2661 (or fraction thereof, if training completed in less than two years) plus expenses paid by individual.
[3]For indicated fields, training completed in less than two years. The estimate in parenthesis is the entire cost of training in the second year *less* earnings while on the job following graduation but accruing in the second year.

them comparable to the earnings data for subsequent calculations of the rate of return.

The costs in Table 7 applicable to 1960-1965 students differ in two respects from those for 1948-1965 students. First, the graduation age is 21 for 1960-1965 students rather than 22. This results in lower foregone earnings — earnings of 21 year olds are less than those of 22 year olds. Second, the earnings predicted for students who complete their training in less than two years are computed from the equation in Table 5 whereas those in Table 6 were computed from the equation in Table 4. The two equations, of course, gave different estimates of earnings of students who graduated in less than two years and these earnings were subtracted from actual costs to obtain the net cost in the second year. This results in negative costs for food and "other" fields in Table 7 as in Table 6. The costs, expressed in 1959 dollars, are slightly lower in Table 7 than in Table 6.

## Rates of Return

The rate of return measures the value of technical education to individuals and to society. The rate of return was defined earlier as that interest rate which equates the discounted present value of the additional income flows with the discounted present value of the cost outlays. It is the rate of interest which could be paid on funds used to pay costs of technical schooling and just break even on the investment.

The following estimated rates of return reflect only the monetary benefits of technical schooling and they are not adjusted for mortality and taxes. The possible bias from failure to adjust for mortality and taxes is not likely to be large.[7]

### Private Rates of Return

Table 8 shows the private rates of return by major field of study for 1948-1965 students using the two estimation procedures, and for 1960-1965 graduates using only the experience-earnings method for estimating lifetime earnings.

The private rates of return for the different occupations using the 1948-1965 graduate data and the age-earnings method range from a low of 14.0 percent for automotive majors to a high of 61.0 percent for food majors. Costs have an important influence on the internal rate of return. The age-earnings profile of diesel students is $19 higher than that of

[7]Hines, *et al.* (1970) estimated that the private rate of return to white male college graduates in the U. S. was 13.6 per cent, before and after adjustment for mortality. The social rate of return was 9.7 per cent before adjustment for mortality and 9.6 after adjustment. The tax-adjusted and unadjusted private rates of return were 13.6 and 13.2 per cent, respectively. The social rate of return was 9.7 per cent before and after adjustment for taxes.

**Table 8 Average Private Rates of Return by Major Field of Study and Two Estimation Procedures, 1948-1965 and 1960-1965 Students. (in Percent)**

| Major Field of Study and Control | 1948-1965 Students | | 1960-1965 Students |
|---|---|---|---|
| | Age-Earnings Method | Experience-Earnings Method | Experience-Earnings Method |
| South Control Group | | | |
| Automotive | 14.0 | negative | 5.8 |
| Commerce | 31.4 | 19.9 | 10.6 |
| Diesel | 24.0 | 13.1 | 21.4 |
| Drafting | 28.6 | 19.5 | 23.2 |
| Electronics | 22.1 | 9.9 | 21.5 |
| Food | 61.0 | 44.6 | 9.7 |
| Printing | 22.0 | 8.6 | negative |
| Refrigeration | 27.0 | 16.7 | 17.7 |
| Others | 54.2 | 33.5 | 21.4 |
| Average | 23.6 | 12.1 | 14.8 |
| Questionnaire Control Group | | | |
| Average | 24.1 | 13.1 | 15.6 |

commerce students at each age-group interval; yet the rate of return for the latter group is 7.4 percentage points greater than for the former group (using the age-earnings methods). This is due to the lower costs for commerce students. Private costs per diesel student totaled $6,616 during their two year stay at OST, while private costs per commerce student totaled only $5,406 less earnings on the job the third tri-mester.

The high rate of return for food graduates, 61.0 percent, is attributed to low cost combined with high earnings. Food students incurred the lowest costs among the occupational groups while attending OST and their age-earning profile was the highest.

The private rate of return for an average graduate is 23.6 percent based on the age-earnings function and the Southern U. S. high school graduate control profile. Based on the control profile constructed from the questionnaire, an average student receives 24.1 percent return on his investment. The generally lower profile of the questionnaire control group provides more years of net benefits. Using the control profile of the South, it was assumed that benefits beyond age 51 are zero.

Rates of return from the age-earning method are higher than those from the experience-earning method, but the different occupations retain the same ranking. The experience-earnings function indicated that benefits to technical education were not apparent beyond age 42 (compared to age 51 in the age-earnings function). In addition, rates were lower for the experience-earnings function because the age-earnings procedure attributed to age some of the earnings that could be attributed

to job experience gained before attending OST. On the other hand, the experience-earnings method may underestimate earnings that properly belong to the interaction of maturity and technical training.

The last column in Table 8 shows the estimated rates of return from the projected lifetime earnings of 1960-1965 graduates. The estimates are a more reliable guide for future schooling investment decisions than the 1948-1965 rates of return, which are of more *historic* interest than of *predictive* value.

The average 1960-65 graduate earns 14.8 to 15.6 percent on his investment in technical education; the average 1948-1965 graduate earns 12.1 - 13.1 percent. The results suggest that 1960-1965 automotive majors earn 5.8 percent return on their investment as compared to a negative rate of return based on 1948-1965 data. Other occupational groups showing an increase in the rate of return include diesel, drafting, electronics and refrigeration. The remaining 1960-1965 occupational groups showed a decrease in their estimated returns.

In short, private investment in technical education appears to be generally very productive. Except for automotive and printing in the experience-earnings method, the private rates of return compare favorably with the average private rates of return to college education and to investment in non-human forms of capital.[8]

## Social Rates of Return

The interpretation of the social rates of return is the same as that of private rates except that the former is measuring the economic gain to society from public and private investment in technical education. The social rates of return to the different occupational groups and to the average dollar invested in technical education are calculated from the same age-earnings profiles as used for private returns and from social schooling costs such as shown in Tables 6 and 7. The estimated social rates are necessarily lower than the estimated private rates because the costs are greater to society than to individuals, while the monetary benefits (net earnings differentials) are considered to be the same for both society and the individual.

The estimated social rates of return that were derived from the age-earnings method range from a low of 9.6 percent return for automotive to 39.6 percent for food (Table 9). The rate of return for the average student was 17.5 and 19.1 percent using the U. S. South and questionnaire control group, respectively.

[8]Hines, *et al.* (1970) estimated the average private rate of return for white college graduates in the U. S. to be 13.6 per cent. Giora Hanoch (1967, p. 322) estimated the private rate of return for college graduates in the South to be 10.1 per cent. George S. Stigler (1963) shows typical rates of return for private industry averaging around 10 per cent.

**Table 9 Average Social Rates of Return by Major Field of Study and Two Estimation Procedures, 1948-1965 and 1960-1965 Students. (in Percent)**

| Major Field of Study and Control | 1948-1965 Students | | 1960-1965 Students |
|---|---|---|---|
| | Age-Earnings Method | Experience-Earnings Method | Experience-Earnings Method |
| South Control Group | | | |
| Automotive | 9.6 | negative | 1.4 |
| Commerce | 23.0 | 13.6 | 4.4 |
| Diesel | 17.8 | 8.2 | 14.4 |
| Drafting | 23.1 | 15.0 | 17.4 |
| Electronics | 16.7 | 5.7 | 15.1 |
| Food | 39.6 | 28.0 | .1 |
| Printing | 13.7 | negative | negative |
| Refrigeration | 21.1 | 12.1 | 12.0 |
| Others | 39.0 | 23.2 | 12.7 |
| Average | 17.5 | 7.4 | 8.6 |
| Questionnaire Control Group | | | |
| Average | 19.1 | 11.9 | 11.2 |

Investment in automotive and printing resulted in a negative return and investment in electronics in a 5.7 percent rate of return based on experience-earnings data (Table 9). The rates indicate that investment in automotive, printing and electronics did not cover costs to society if six percent interest is assumed to be the cost of funds invested in these fields.

Rates of return to social investment in other fields of study ranged from a low of 8.2 percent in diesel to a high of 28.0 percent in food.

The last column shows the estimated social rates of return for the different occupations based on projected lifetime earnings of 1960-1965 students. Investment in drafting yielded the highest rate of return, 17.4 percent, among the fields considered. Investment in automotive and printing yielded 1.4 percent and negative rates of returns, respectively. The social rates of return from investment in automotive, diesel, drafting, and electronics were higher for 1960-1965 graduates than for 1948-1965 graduates.

The social investment in technical education averaged over all fields for the 1948-1965 graduates was justified on economic efficiency grounds. The rates of return represent only the direct monetary gains from technical education; rates would be higher if they included the value of training as a consumption good. The automotive field rate of return may be biased downward by failure to account for each component of the automotive field — an aggregation problem discussed earlier.

The estimated private and social rates of return from the age-earning procedure are higher than the rates of return from the experience-earn-

ings procedure. No final choice of method is made and hopefully the two approaches bracket the true figure.

## Summary and Conclusions

This study evaluated the economic benefits accruing to individuals and society from investment in the different fields of study at Oklahoma State Tech, Okmulgee. The specific objectives were to determine: (1) costs incurred by individuals and society, (2) economic benefits accruing to individuals and society, and (3) internal rates of return resulting from investment in technical education.

The basic earnings data used for this study are individual records from mail questionnaires sent in 1968 to males who were students of Oklahoma State Tech between 1948 and 1965. Multiple regression techniques were employed to separate the effects of schooling from other influences on earnings.

The first year private costs per 1948-1965 student ranged from a low of $3096 for commerce, food and printing majors to a high of $3151 for diesel majors.[9] In addition to the above costs, social costs included public expenditures for teachers' salaries and general school expenses plus depreciation and interest charges on buildings and equipment. The first year total social costs per 1948-1965 student ranged from $3963 to $4837 for drafting and food majors, respectively. The first year social costs for 1960-1965 majors ranged from a low of $3647 for drafting to a high of $4521 for food majors.

The internal rates of return were found by solving for the discount rate at which the present value of training costs, including foregone earnings, just equaled the present value of net earnings.

The private rates of return for 1948-1965 students ranged from a low of 14.0 percent [negative returns] for automotive to a high of 61.0 [44.6] percent for food majors.[10] The average private rates of return were 23.6 [12.1] and 24.1 [13.1] percent, using U. S. South and questionnaire control groups, respectively. For the same years and the South control, the social rate of return ranged from 9.6 percent [negative returns] for automotive majors to a high of 39.6 [28.0] percent for food majors.

Based on projected lifetime earnings of 1960-1965 students, the investment in drafting gave the highest private rate of return, 23.2 percent, and social rate of return, 17.4 percent, among the different fields.[11] The average private rates of return over all fields for the 1960-1965 period were 14.8 and 15.6 percent using the South and questionnaire control

[9]The quoted costs are based on the experience-earnings method and are in 1959 dollars.
[10]The figures in brackets represent the estimated rates of return from the experience-earnings method and the figure preceding it represents the return from the age-earnings method.
[11]Based on experience-earnings method.

groups, respectively. Corresponding social rates of return averaged 8.6 and 11.2 percent for the two control groups.

According to the results obtained in this study, social and private investment in several fields of technical education gave high rates of return. The average social rates of return from aggregate investment in all fields of technical education at OST ranging from 7 to 19 percent compare favorably with the average return generally estimated for other forms of education and for non-human capital.

Apart from productivity gains, other benefits could also justify expansion of educational resources in technical programs in Oklahoma. Since Oklahoma State Tech is located in a low income area (Ozark region), and since the technical training program successfully raised the earning capacity of its trainees, then investment in technical education should be an attractive alternative for upgrading skills and reducing the incidence of underemployment. The training program might be expanded, through public financial aid, to include more people from low income areas.

This does not necessarily imply that investment in vocational education should be expanded along traditional lines. The age-earnings profiles showed that technical graduates reach peak earnings at an earlier age than do persons with other forms of education (high school or college graduates). More emphasis might be placed on courses which delay the drop in earnings and which increase opportunities for Tech graduates to advance into management and administrative positions. Furthermore, it was found that the profitability of various fields is shifting over time, and the training fields need to be adjusted to these trends.

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