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ECONOMICS *of* HIGHER EDUCATION

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HEALTH, EDUCATION, AND WELFARE
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Foreword

THE IDEA for this publication emerged from a meeting of a group of economists called by the Office of Education more than a year ago. The Office of Education is indebted to the eminent economists who gave so willingly of their time as a public service to make this publication possible. They have joined with the Office of Education in suggesting not only the range of economic problems on which initial research has been done and implications of that research for higher education but also the areas in which additional research is needed.

Our joint interest and concern throughout has been to stimulate additional research efforts, as well as to make some recent findings available to those concerned with policy and administration in higher education. Through continued research in the economics of higher education, the accomplishment of the task ahead of providing quality higher education for greatly enlarged numbers of young people will be facilitated. The importance of this task cannot be overestimated.

STERLING M. MCMURRIN,
Commissioner of Education.

Contents

Tables

CHAPTER 1. COLLEGE AND UNIVERSITY ENROLLMENT: PROJECTIONS

CHAPTER 2. SOCIAL AND ECONOMIC DETERMINANTS OF THE DEMAND FOR EDUCATION

CHAPTER 2 SOCIAL AND ECONOMIC DETERMINANTS OF THE DEMAND FOR EDUCATION—Continued

CHAPTER 3. THE NEED FOR PROFESSIONAL PERSONNEL

CHAPTER 4. HEALTH MANPOWER: AN ILLUSTRATION

CHAPTER 4. HEALTH MANPOWER: AN ILLUSTRATION—Continued

CHAPTER 5. NATIONAL REQUIREMENTS FOR SCIENTISTS AND ENGINEERS: A SECOND ILLUSTRATION

CHAPTER 7. RISE IN THE CAPITAL STOCK REPRESENTED BY EDUCATION IN THE UNITED STATES, 1900–57

CHAPTER 8. EDUCATION AND ECONOMIC GROWTH

CHAPTER 9. INCOME AND EDUCATION: DOES EDUCATION PAY OFF?

CHAPTER 9. INCOME AND EDUCATION: DOES EDUCATION PAY OFF—Continued

CHAPTER 10. THE NATION'S EDUCATIONAL OUTLAY

CHAPTER 11. STUDENT HIGHER EDUCATION AND FACILITIES OF COLLEGES AND UNIVERSITIES: PROJECTIONS

CHAPTER 13. THE FEDERAL GOVERNMENT ROLE IN HIGHER EDUCATION

Chapter 14. State Financing of Higher Education

Chapter 15. Corporate Support of Higher Education

Chapter 17. Educational Expenditures and the Income Tax

Chapter 18. Research and the Financing of Higher Education

CHAPTER 18. RESEARCH AND THE FINANCING OF HIGHER EDUCATION—Continued

CHAPTER 19. FINANCING OF HIGHER EDUCATION IN THE UNITED STATES AND IN GREAT BRITAIN

Editor's Note

IN THE PAST FEW YEARS an important beginning has been made toward defining and exploring the major issues in the economics of higher education. The research of economists covers a wide range of problems, from that of the Nation's requirements for college-trained people, to detailed questions of financing. Perhaps no single area of this work offers larger promise than that of research on education as an investment in people.

The work that has already been done on educational investment permits a reinterpretation of educational outlays, viewing these outlays, at least in part, as additions to our national wealth.

New questions are being raised about the relative amounts of physical capital formation and formation of human capital and their relative contributions to economic growth. Preliminary findings suggest that education has contributed importantly to economic growth in the past and that large returns can be expected in the years ahead.

At the suggestion originally of Dr. Herbert S. Conrad, Coordinator of Higher Education Research, the Division of Higher Education has sought through this volume to bring together important contributions about the economics of higher education for the use of educators and others concerned with the formulation of educational policy.

The caliber of the contributors and their work are evidence of the vitality and strength of higher education, for these busy people gave willingly of their time and professional skills to furnish important new materials for consideration in the development of educational policy. Their deep concern and interest in furthering higher education made the task of the editor, assisted by Lanora G. Lewis, a gratifying experience.

The enthusiasm of educators and administrators who read early drafts of the chapters heightened the expectation that the volume would serve as a bridge between the work of the economist and that of the educational community.

The Division sought, too, to provide through this publication a working tool for the economist turning anew to research on higher education. This volume is a summary of a substantial segment of earlier research and opens up new questions for inquiry on a broad range of macroeconomic problems. Part I of the volume concerns

the demands of students for higher education and of the Nation for high-talent manpower. Part II presents the fundamentals of a theory of investment in people through education. It includes consideration of the essential differences and similarities between investment in people and investment in physical capital, an assessment of the educational stock of the labor force—both in terms of original cost and in terms of replacement—and estimates of the volume of resources allocated to education and the return on this investment. Part III deals with the financing of higher education and covers a wide range of sources of funds, public and private. Part IV describes briefly the ongoing research in the economics of higher education and outlines the range of issues which require still further study.

Manuscripts for this volume were received in the spring of 1961. Considerable research has been completed since that date and new information has become available. These new research findings and data, for the most part, are not reflected in the volume. Of particular interest are the papers on investment in human capital to be included in the August 1962 Supplement to the *Journal of Political Economy* and John Vaizey's *The Economics of Education*.

The content of the essays and the views expressed are solely the responsibility of the authors. No attempt was made to gain uniformity of opinion. One of the assets of this collection of works is the stimulation it provides through the posing of yet unresolved issues. The Division hopes that this publication will encourage the further research which is required to gain a common understanding of the facts involved and to reconcile divergent points of view.

SELMA J. MUSHKIN,
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Introduction

*Homer D. Babbidge, Jr.**

THE NATION is facing up to rapidly increasing demands for college and university education. In the academic year 1960–61 alone, college enrollments advanced 6 percent over those of the previous year, and the impact of the post-World War II population explosion is just beginning to be felt. Year after year for the next two decades we can expect that a growing number of qualified young people will seek opportunities for a college education. And this growth will be accelerated by the advancing aspirations of young people and the insatiable appetite of a complex society for college graduates.

In a democratic society there is really no choice but to accommodate the educational demands of the people. Individual colleges and universities may be able to resist those pressures, but in the aggregate they have no choice but to grow larger or more numerous, or both. Where there is a choice—and it is a vitally important one—it is in the quality of higher education. Quality will be maintained only if educational resources grow commensurately with enrollment increases.

There have been other periods in our national history when we have effected a large proportionate growth in enrollments in colleges and universities. Philip Lindsley, then president of the University of Nashville, observed in 1829 that "Colleges rise up like mushrooms in our luxuriant soil." "A settler could hardly encamp on the prairies," said a western observer of the period, "but a college would spring up beside his wagon." Between 1840 and 1860 the number of permanent—or surviving—colleges in the United States doubled. It is altogether probable that college enrollments doubled in the single decade immediately preceding the Civil War. Americans—and their churches in particular—wanted college facilities in quantity, and they got them.

But quality suffered. Lindsley described the "mushrooms" of his period as "promising to work cheap; and to finish off and graduate, in double-quick time, and in the most approved style, all who may come to them." Subsequent students of the period incline to support his contention that, though they "all claim to be equal at least to old Harvard and Yale," they were not deserving of the name college.

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The problem that confronts us now is, of course, vastly different in many respects. We face not a sudden, short-term growth, but a vast and continuing increase in enrollments. Shall we pay for this quantitative growth, as we have in the past, through a lowering of quality? And if we should manage to *maintain* quality in the face of numbers, shall we be able to effect a positive improvement in quality—the need for which no reasoning man can question? And will our institutions, on top of all this, be able to add the programs, do the research, provide the ideas needed to cope with the inevitable demands of a changing and growing society?

Just as the challenge ahead is unprecedented, so in all probability must be the approaches to meet it. Conventional methods are not likely to suffice, and temporary, ad hoc adjustments will not. There is a real need for refreshing reexamination of our methods for providing quality higher education in quantity. To gain these new perspectives, educators are drawing not only on their own professional capabilities but also on the skills of other disciplines, of which economics is one.

Economists have only recently turned their attention to higher education, but the issues they are raising offer a promise of new insights into the financing of higher education. While educational policy must necessarily be determined in the light of larger educational and social considerations, and not by costs and economic benefits alone, it is amply evident that the application of economic techniques holds promise of educational benefits.

Economists, as I read the writings represented in this volume, are emphasizing higher education as a means of developing human resources. They are attempting to assess the amount of investment made to achieve such development, and the yield to the individual, to industry, and to society. This emphasis, while in no way denying other aims of education, throws new light on the significance of the vastly enlarged outlays which will be required to provide high quality education for the mounting census of young people in the decades ahead. The problem is thus put in a new light; instead of "spending" resources we are devoting resources to an investment, which in fact contributes to the replenishment and enlargement of our national resource base.

The economist, in turning his special tools of analysis to the field of education, has inquired first—by the tests customary to him: How much should be spent on higher education? The first question necessarily raises a number of others and on the solution of these depends the answer to the larger question of what education's economic function really is. Education at one and the same time is a number of things, and there is no reason to believe that the economist is not aware

of the social benefits that accrue from the educational process, or of the fact that education is an imperative foundation of our democratic processes, as well as a source of enjoyment, of satisfaction, and of enrichment. But he is principally concerned with its economic function. In the words of the economist, education is a consumer good as well as an investment. As a means of acquiring skills and abilities, it is an investment for the individual, which yields him a material return. But it is also a means of developing human resources so that a whole society can benefit from the contributions made to a space exploration, to cancer research, to the solution of metropolitan transportation problems, or to new methods of teaching and learning.

Starting from that single dimension of education as training for a pursuit (and fully aware of the limitations imposed by the singling out of a single product), the economists, as I read their essays, ask a series of additonal questions. What has been the contribution in the past of investment in education to economic growth? What is its potential contribution in the future? The work of Prof. Theodore Schultz, and the major contributions of others he has encouraged, are addressed in part to these questions.

Acceptance of higher education as an investment cannot but lead to a reexamination of the problems involved in financing our colleges and universities. Economists are providing a framework of reasoning about education, which helps to explain on going financial practices. Higher education traditionally has been financed in a diversified way by many types of contributors. State and local communities, churches, wealthy individuals, alumni, business, industry, and students and their families have all contributed to the financial support of higher education. These contributors acknowledge by their financial support the benefits that they derive from a strong system of colleges and universities. Communities that get better citizens, churches that get clergy, businesses that get better employees—all share in the costs of the productive machinery, along with the student who, whether he pays a tuition fee or not, makes a major outlay for college in terms of forgone earnings (see Marion B. Folsom, ch. 12 of this publication).

Economic analysis suggests possible new financial practices as well, including, for example, new financial institutions to facilitate student borrowing for higher education. Consideration of the differences in risks or burden involved in such borrowing, by students from low income families and by those from high income families, leads in turn to consideration of the need for scholarship programs as supplements to other student aids (see Richard S. Eckaus, ch. 8, and William Vickrey, ch. 16, of this publication).

The theme of investment that runs through the writing of the several contributors to this volume thus provides a framework for

understanding better the patchwork-quilt system of financing higher education that we have had in the past, and it suggests new instruments for and methods of dealing with these problems. The proposal for a reexamination of the tax treatment of educational expenditures (viewing these expenditures as a capital outlay, which might be amortized or written off over a period of years, much as we now provide for the writing off of the costs of physical capital outlays) illustrates another possibility that follows from economic analysis (see Richard Goode, ch. 17 of this publication).

The volume as a whole makes clear that the economist's method of analysis, when applied to the problems of higher education, can provide those responsible for educational policy with additional yardsticks and guidelines for action. The analytical work of economists thus can yield a new set of facts to be considered by those responsible for programing higher education—facts to be weighed along with noneconomic considerations in meeting the complex issues that press upon us.

In a very real sense, the intellectual strength of this Nation may well depend, among other factors, on a better understanding and application of the economics of higher education. It is to be hoped therefore that the authors of this volume will continue their interest in higher education and, by their example, stimulate others.

Part I

COLLEGE-TRAINED PERSONNEL: SUPPLY AND DEMAND

CHAPTER 1

College and University Enrollment: Projections

*Louis H. Conger, Jr.**

PROJECTIONS of college and university enrollment provide essential information for National, State, and institutional long-range planning. Planning for facilities, staffing, and financing depends in substantial measure on the potential numbers of applicants for college and university places. Legislatures, administrative agencies, and many other private and public groups need projections of the demand for college education as a guide to steps that must be taken ahead of time if able young people are to have an opportunity for an education.

Projections of the demand for college and university places cannot be made precise, but they can still provide an adequate tool for planning purposes. What is needed is a reasonable estimate or range of estimates as a framework for policy decisions.

The demand for college education—the number of potential applicants for college places—is the controlling factor in future enrollments. There is reason to assume that the availability of college places will be accommodated to the demand. The forces that compel and facilitate accommodation of supply to numbers of applicants are many and powerful. Our history from colonial times to the present evidences our nationwide concern with educational opportunities and with broadening these opportunities. Recent events have served to strengthen this concern.

Our national interest clearly lies in a highly educated populace. In this complex world we can maintain leadership only through quality of the people, not through sheer numbers. Our democratic society emphasizes higher education as a ladder for social mobility and increased opportunity. For the individual higher education provides economic benefits, social status, and personal development. Both individual and national interest combine with a long historical tradition to form a commitment to education that will not be diverted without a major restructuring of the place of higher education in our society.

The projections of demand for places presented here indicate, however, that the task ahead of providing educational facilities, teaching

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staffs, and the financial base for adequate plant and staffing is formidable. If we fail in this task, actual enrollments will fall short of the figures projected.

GENERAL NATURE OF THE PROJECTIONS

Long-range projections of college enrollment for the Nation are essentially based on a projection of the population by age, and a projection of college enrollment rates applied to the projected population by age.

In addition to the three projections of *total* college enrollment, the present report also introduces a tentative projection of full-time enrollments of college and university undergraduate students and students working for the first professional degree, thus providing a more nearly adequate guide to planning than has heretofore been available.

The projections on total enrollment shown here represent estimates of the number of persons enrolled in the fall of the year in institutions of higher education for degree-credit courses. The figures are a continuation of the series of statistics on opening enrollment collected by the Office of Education from institutions of higher education each fall, which are similar to enrollment data collected by the Bureau of the Census each October in the course of a nationwide sample survey of households. Three projections are shown:

Projection I—trend projection—is based on the trend of age-specific college enrollment rates during the 1950's as determined through fitting an exponential curve [1] to the data for the 1950–60 base period, and then applying these to the population by age groups. The population and enrollment rate data in the base period are taken from the annual October surveys of school enrollment conducted by the Bureau of the Census (Series P-20). The projected population is the same in all three projections and corresponds to Census Bureau projections of the population,[2] with minor adjustments.

Projection II—fathers' attainment projection—introduces on an experimental basis a projection of college and university attendance of sons and daughters based on the estimated educational attainment of their fathers. This projection in effect extends the application of the constant-rate principle by introducing an allowance for one of the many causal factors affecting college attendance rates. Various

[1] The type of curve fitted to the data on enrollment rates affects the projected enrollments to some extent. For example, straight lines fitted to the enrollment rates of the base period would have resulted in a higher projected enrollment than did the exponential curves actually used in these projections.

[2] U.S. Department of Commerce, Bureau of the Census. Current Population Reports. *Population Estimates. Illustrative Projections of the Population of the United States, by Age and Sex, 1960 to 1980.* Series P-25, No. 187 (Nov. 10, 1958).

studies, including the study by Brazer and David presented later in this volume, indicate the singular importance of educational attainment of parents in determining the college attendance of their children. The method of translating the increasing educational attainment of fathers into projections of demand for college places for their children 18 to 24 years of age is presented in a later section of this chapter.

Projection III—constant-rate projection—continues 1958–60 enrollment rates into the future, without change.

FUTURE PROSPECTS

Which projection is going to be closest to the future event? One answer might be: "It doesn't matter for policy planning, because the increases under any of the projections are sufficiently large to require the same kind of planning." A more usual answer is: "That projection whose basic assumptions hold true in the future." The term "projection" itself, and even more the term "illustrative projection," connotes a mathematical working out of specified assumptions rather than a forecast or prediction. Thus the original question is not answered directly but is shifted to another level. The question becomes: "Which set of basic assumptions is going to come true?"

These several projections provide the user of the information with an idea of the variations under different circumstances. In general, the constant-rate projection serves mainly to illustrate the effect of population change. Because various forces have in the past expanded enrollment beyond that caused by population increase alone, this projection results in a relatively low set of figures. Projection II, based on the enrollment of young people as affected by the educational attainment of their fathers, takes account of one factor among many, but this projection too results in low figures relative to the trend because of the other factors that have operated to increase the attendance rates during the period 1950–60. The trend projection assumes that whatever causal factors determined the attendance rates in the past will continue to operate equally in the future.

College and university enrollment in the future will be affected by many factors that are difficult to foresee. Therefore, while the three projections may provide a guide to the changing demand for college places, they do not necessarily set the limits, either on the high side or on the low side of what may be experienced. We in the United States could alter our educational policies and move in the direction of England's policies and those of some other nations so as to restrict college opportunities sharply. Or, as seems more likely, we could plan to allocate sufficient resources to provide higher educational opportunities to an even larger proportion of our young adults than is projected by extrapolation of the experience of the 1950's.

OPENING ENROLLMENT, PAST AND PROJECTED

Enrollments for degree credit in colleges and universities totaled 3.6 million in the fall of 1960 (in 48 States and the District of Columbia—see table 1). According to projection I, the *trend* projection, they are expected to rise to 6.9 million by 1970 and to 8.6 million by 1975. To meet this demand, institutions of higher education will have to accommodate an average of 335,000 additional students each year over the 15-year period. Soon after 1970, colleges and universities will have twice as many students as they had in 1960 if existing trends in attendance rates continue.

According to the *constant-rate* projection, which takes account only of changes in college-age population, fall college enrollment is expected to increase about half as much as in the *trend* projection; namely, an increase of 2.4 million students from 1960 to 1975, or an average increase of 157,000 per year.

TABLE 1.—Fall enrollment 1950–1960 and projections 1965, 1970, 1975, by sex, 48 contiguous States and District of Columbia

[In thousands]

Year	Total	Men	Women
1950	2,281	1,560	721
1951	2,102	1,391	711
1952	2,134	1,350	784
1953	2,231	1,423	808
1954	2,478	1,590	888
1955	2,695	1,770	925
1956	2,918	1,911	1,007
1957	3,037	1,985	1,052
1958	3,226	2,092	1,134
1959	3,365	2,154	1,211
1960	3,570	2,249	1,321
PROJECTION I. TREND PROJECTION			
1965	5,203	3,414	1,789
1970	6,936	4,608	2,328
1975	8,588	5,755	2,833
PROJECTION II. FATHERS' ATTAINMENT PROJECTION			
1965	4,649	3,037	1,612
1970	5,940	3,929	2,011
1975	7,067	4,700	2,367
PROJECTION III. CONSTANT-RATE PROJECTION			
1965	4,222	2,837	1,485
1970	5,188	3,461	1,727
1975	5,921	3,989	1,932

SOURCE: 1950–60 Office of Education annual surveys of opening enrollment in institutions of higher education.

If enrollment rates for persons aged 18–24 are adjusted in accordance with the changes in the educational attainment of fathers (projection II), the projected demand is intermediate between that of projection I and III. Under this estimate, fall college enrollment in projection II is expected to increase about three-quarters as much as in the *trend* projection, with the result that 1960 enrollment is doubled by 1975 instead of shortly after 1970 as in the *trend* projection.

Some perspective can be gained on the magnitude of the educational task before colleges and universities through a comparison of the rates of growth during the decade of the 1950's with the projected growth. Between 1950 and 1960, degree credit enrollment in the colleges and universities rose 1.3 million, from 2.3 million to 3.6 million, or almost 60 percent. In a single year, 1959 to 1960, enrollments increased 6 percent. Over the period 1950–60 the enrollment increases averaged 129,000 students a year, and if we start the comparison from 1951 (because of the decline between 1950 and 1951) the growth in number of students averaged 163,000 a year.

Little of the enrollment increase in recent years is explained by population growth. For example, if college attendance rates had not increased but had remained constant from 1950–52 to 1958–60, the number of men enrolled would have increased by only 8 percent, and the number of women by less than 1 percent. During this 8 years of change, however, the number of male and female students rose by about 40 percent.

POPULATION CHANGES—PAST AND PROJECTED

As a consequence of the sharp rise in births after World War II, increases in the number of persons of college attendance age will be much larger in the years ahead than in the past decade. The numbers of young people reaching 18 years of age, the usual age of high-school graduation, thus can be expected to rise in proportion to the post-World War II birth rates.

The rise in total college-age population is more difficult to pinpoint. Because there is no simple definition of college-age population, it is hard to give a meaningful answer to the question frequently raised, "What percentage of the college-age population is attending college?" A definition of college-age population limited to those in the age group 18 to 21 years, or even 18 to 24 years, leaves out many students in colleges and universities. The age span of students ranges from a few as young as 15 years of age to persons of retirement age. Table 2 shows that in the 1950's, among persons 16 to 34 years of age enrolled in colleges or universities, about 25 percent of the men and 12 percent of the women were 25 to 34 years of age. On the other hand, the population aged 16–34 is much too extensive to be used as a

"college age" population for comparison with enrollments because it includes many persons whose formal education has been terminated for years and some who have neither the ability nor the inclination to do college work.

TABLE 2.—Percentage distribution of college students 16–34 years of age, by age group and sex, 48 contiguous States and District of Columbia: 3-year averages, 1952–60

3-year average,[1] by sex	Total, 16–34 years	16–17 years	18–19 years	20–24 years	25–29 years	30–34 years
MEN						
1952–54	100	5	27	41	20	6
1955–57	100	4	27	41	22	7
1958–60	100	4	30	40	19	8
WOMEN						
1952–54	100	11	41	36	6	7
1955–57	100	10	41	36	8	5
1958–60	100	10	45	32	8	5

[1] Ages as of October each year; averages for several years are averages of the individual years included. Details may not add to totals because of rounding.

SOURCE: Based on Bureau of the Census surveys of school enrollment (Series P–20).

One way to describe the relationship of college enrollment to population is to cite the percentage of persons in particular age groups that are enrolled in college; such data are reported annually by the Bureau of the Census and are discussed in a later section of this chapter. Another way is to summarize the overall effect of population changes by applying standard attendance rates to the changing population, as is done here in the constant-rate projection (projection III).

The extent to which population growth affects the projected figures may be gaged from the *constant-rate projection*. When the *trend* projection is set against the *constant-rate projection*, we find that in the *trend* projection, 47 percent of the total growth in enrollment from 1960 to 1975 is attributable to an increase in the number of persons aged 16–34, and the remainder is attributable to increased enrollment rates.

ENROLLMENT RATES, PAST AND PROJECTED

In the period 1958–60, almost one-third of the men 18 to 19 years of age in the United States and one-quarter of the women in this age group were attending college (see table 3). In 1950–52, the comparable percentages among the 18- and 19-year-olds were 21 percent for the men and 15 percent for the women. Enrollment rates for each of the age groups, except the 16–17 year group, increased markedly between 1950 and 1960.

TABLE 3.—Percent of the civilian noninstitutional population age 16 to 34 enrolled in college in selected years, 1950–60, and projections, 1965, 1970, 1975, by age and sex, 48 contiguous States and District of Columbia

Year by sex [1]	16–17 years	18–19 years	20–24 years	25–29 years	30–34 years
MEN					
3-year averages:					
1950–52	3.5	20.7	14.2	4.7	[2] 1.3
1958–60	3.3	22.7	19.3	8.4	3.0
PROJECTION I—TREND PROJECTION					
Projection years:					
1965	3.3	39.2	22.9	10.6	4.0
1970	3.3	43.7	25.1	11.9	4.7
1975	3.3	47.5	27.0	12.9	5.2
PROJECTION II—FATHERS' ATTAINMENT PROJECTION					
1965	3.3	25.6	21.2	8.4	3.0
1970	3.3	37.9	23.0	8.4	3.0
1975	3.3	39.8	24.3	8.4	3.0
PROJECTION III—CONSTANT-RATE PROJECTION					
1965, 1970, 1975	3.3	22.7	19.3	8.4	3.0
WOMEN					
3-year averages:					
1950–52	4.4	15.1	4.1	0.5	[2] 0.5
1958–60	4.2	22.2	6.8	1.6	1.0
PROJECTION I—TREND PROJECTION					
Projection years:					
1965	4.2	26.0	8.6	2.4	1.2
1970	4.2	28.9	9.7	2.8	1.4
1975	4.2	31.4	10.5	3.2	1.5
PROJECTION II—FATHERS' ATTAINMENT PROJECTION					
1965	4.2	24.4	7.6	1.6	1.0
1970	4.2	26.4	8.3	1.6	1.0
1975	4.2	28.2	8.8	1.6	1.0
PROJECTION III—CONSTANT-RATE PROJECTION					
1965, 1970, 1975	4.2	22.2	6.8	1.6	1.0

[1] Ages as of October each year; averages for several years are averages of the individual years included.
[2] 1953 figure.

SOURCE: 1950–1960 Bureau of the Census surveys of school enrollment (Series P–26).

The percentage of the population attending college is highest for the 18–19-year age group, and enrollment rates drop off successively to a rate of 3.0 percent for men aged 30–34 and 1.0 percent for women. Of the youngest group, 16–17 years, only a small number are enrolled in college; most boys and girls of that age are still in secondary school.

The effect on college enrollment rates of the Veterans' Administra-

tion program under the GI bill of rights cannot be worked out in detail because no one knows how many of the students attending would have enrolled in the absence of such a program. An idea of the upper limit to the possible effect of this factor may be supplied by making the assumption, admittedly extreme, that none of the beneficiaries under the program in November 1960 (numbering 180,000) would have been in college except for the opportunity provided by that program. Then the maximum reduction brought about by omitting such students from the constant-rate projection would be 300,000 in 1975, or about 5 percent of the 5.9 million students projected for that year. Corrections in projections I and II would be even slighter, since the omission of such beneficiaries during the entire base period would give a sharper rise to the upward trend of enrollment rates.

FULL-TIME ENROLLMENT—PAST AND PROJECTED

For purposes of planning it is advantageous to have more detail than is provided by a projection of total degree-credit college enrollment as given in the preceding tables. The most generally useful breakdown, among those that are feasible at the national level, appears to be that of full-time versus part-time enrollment because of the importance of this distinction in estimating the requirements for college faculty, facilities, and finances to handle the enlarged enrollment. For example, part-time students do not necessitate new facilities proportionate to the numbers enrolled, and for evening students no new facilities may be needed. Accordingly, a tentative projection of enrollment of full-time undergraduates and graduates working for the first professional degree is developed here. The term "tentative" is used to describe this projection because the available historical data upon which to base the projection are themselves scanty.

The projected figures in table 4 are a continuation of the series of statistics on full-time enrollment at the undergraduate and the first professional level[3] as collected by the Office of Education in 1953, 1954, 1955, 1957, and 1959. Full-time students are defined as those registered for at least 75 percent of the credits required for graduation in the normal number of semesters or terms. Full-time graduate students other than those at the first professional level are not included in the projection because they are missing in the trend data; however, we know that in the fall of 1959 this omitted group of full-time students included about 130,000 graduate students (resident degree-credit students) who were not enrolled for the first profes-

[3] In addition to those enrolled for bachelor's degrees, first professional degrees in such fields of medicine and dentistry (M.D. and D.D.S.), law (LL.B.), theology (B.Th), library science (M.L.S.), and social work (M.S.W.) which normally require more than 4 years of post-high-school education for completion.

sional degree. Had these been added to the full-time undergraduate and first professional students, the 1959 figure would have increased by 6 percent.

One very important question is whether the expected growth in full-time enrollment is parallel to that for total enrollment. If not, the changes in total enrollment are not a reliable guide to the changes in the educational load on the colleges and universities. The findings are, however, that projected full-time enrollment (undergraduate and first professional) as a percentage of projected total opening enrollment varies only moderately—from the 65 percent observed in 1959, dropping only to 60 percent by 1975 in the *trend* projection and rising to 68 percent in the *constant-rate* projection (see table 4). The rise in this percentage in the case of the *constant-rate* projection is due to the relatively greater weight of the population of the younger ages in future years, as compared with the population of the older ages. Full-time enrollment is concentrated in the younger age group.

TABLE 4.—Full-time undergraduate and first professional enrollment, fall of selected years 1953–1959 and projections, 1965, 1970, 1975, by sex, 48 contiguous States and District of Columbia

[Enrollment in thousands]

Year	Total		Men		Women	
	Number	As percent of opening enrollment	Number	As percent of opening enrollment	Number	As percent of opening enrollment
1953	1,563	70	1,002	70	561	68
1954	1,681	68	1,100	69	581	66
1955	1,852	69	1,234	70	617	67
1957	2,010	66	1,333	67	678	64
1959	2,189	65	1,409	65	781	64
	PROJECTION I—TREND PROJECTION					
1965	3,389	63	2,240	66	1,149	64
1970	4,354	63	2,908	63	1,446	62
1975	5,138	60	3,447	60	1,691	60
	PROJECTION II—FATHERS' ATTAINMENT PROJECTION					
1965	3,091	67	2,032	67	1,059	66
1970	3,843	65	2,554	65	1,289	64
1975	4,395	62	2,923	62	1,472	62
	PROJECTION III—CONSTANT-RATE PROJECTION					
1965	2,937	68	1,938	68	999	67
1970	3,522	68	2,367	68	1,155	67
1975	3,906	67	2,685	67	1,281	66

Details may not add to totals because of rounding.

Full-time undergraduate and first professional enrollment is shown in projection I to increase by 2.9 million, from 2.2 million in 1959 to 5.1 million in 1975, or an average of 184,000 per year. From 1959

to 1970 the number doubles. The increase in full-time enrollment in projection III is 1.8 million, or an average of 111,000 per year—an increase of 81 percent. Of the total increase from 1959 to 1975 in projection I, 60 percent is attributable to population growth.

As was previously mentioned, younger college students predominantly attend full time: older ones, part time. For example, as shown in table 5 (based on census data for all full-time college students 16 to 34 years of age) about 90 percent of the students aged 16–17, 18–19, and 20–21 attend full time, but only 17 percent of those aged 25–34. Table 5 also shows that only 12 percent of the full-time men students are older than 24, but 64 percent of the part-time. Even more striking is the difference in the ages of women attending full and part time; only 3 percent of the full-time women students are over 24 years of age, but 44 percent of the part-time.

TABLE 5.—Full-time college enrollment (all levels) as percent of total college enrollment, and age distribution of full-time and part-time college students, by sex, 48 contiguous States and District of Columbia: 1958–60

Year,[1] sex, and full-time or part-time status	Total 16–34	16–17 years	18–19 years	20–24 years	25–29 years	30–34 years
	FULL-TIME COLLEGE ENROLLMENT (ALL LEVELS) AS PERCENT OF TOTAL COLLEGE ENROLLMENT					
Average, 3 years, 1958–60:						
Men	72.7	94.7	92.7	81.8	[2] 40.2	[2] 17.5
Women	77.3	89.1	92.1	76.2	[2] 20.9	[2] 17.4
	PERCENTAGE AGE DISTRIBUTION OF FULL-TIME AND PART-TIME COLLEGE STUDENTS 16–34 YEARS OF AGE					
Average, 3 years, 1958–60:						
Men:						
Full-time	100.0	5.4	39.1	43.5	10.1	1.9
Part-time	100.0	.8	7.0	28.2	39.9	24.1
Women:						
Full-time	100.0	12.2	54.3	30.3	2.0	1.2
Part-time	100.0	2.7	15.6	36.7	28.4	16.6

[1] Ages as of October each year; averages for several years are averages of the individual years included.
[2] Average of 1959 and 1960; 1958 figure not available.

SOURCE: Based on Bureau of the Census surveys of school enrollment (Series P-20).

The method of deriving full-time enrollment from the projections of total enrollment involves essentially application of the current percentages of college students enrolled full time to the projected total enrollment by age group and sex. The results are summed and translated into the figure for undergraduate and first professional full-time enrollment by a conversion factor. For the *constant-rate* projection (projection III) the conversion factor is a constant based on the current relationship; for projections I and II the conversion factor decreases over the period of the projections in accordance with the change in the relation of full-time to total enrollments in the base period 1953 to 1959.

PROJECTION BASED ON FATHERS' EDUCATIONAL ATTAINMENT

The educational attainment of the fathers of college-age persons represents an exogenous variable relative to college attendance rates; that is, it represents an outside causal factor. It is only one of a number of causal factors affecting college attendance that might be considered, such as family income distribution, color, geographic location, scholarships and loans, intelligence, and availability of college opportunity. The factor, educational attainment of fathers, has three characteristics, not matched by these other factors, that recommend it for use in projecting college enrollment rates:

(1) It can probably be predicted with greater accuracy than college enrollment rates themselves.

(2) It is correlated with such rates, and it may be assumed that the relation is causal rather than adventitious.

(3) It has changed over past years and is projected to change further during the period ahead.

Since the method is new, the procedure is explained here in detail. It is as follows:

In essence, future college enrollment rates for persons in the age groups 18–19 and 20–24 are assumed to remain the same as they are now *in relation to fathers' educational attainment.* The higher educational attainment of the fathers of the future age groups thus results in an increased enrollment rate for these age groups as a whole. College enrollment rates used for persons under 18 years of age and for those 25 years of age and over were kept at the 1958–60 rates (the same as in projection III).

The more specific steps by which this is accomplished are as follows (the critical assumption is stated in step 2 and is discussed later):

(1) The educational attainment of the fathers of persons aged 20–24 in 1960 is known.

(2) The educational attainment of the fathers of future groups aged 20–24 is assumed to rise in accordance with the rise in educational attainment of the male population aged 45–54.

(3) College attendance rates for 1960 (according to fathers' educational attainment) for the population aged 20–24 are applied to future populations aged 20–24 (according to fathers' educational attainment) to estimate the future college attendance of persons 20–24 years old in future years.

(4) We also know the percentage of the 20–24 population in 1960 who had ever attended college, regardless of whether they were still enrolled as of 1960. These 1960 percentages according to fathers' attainment are applied to future populations aged 20–24 according

to fathers' attainment to estimate the future percentage of this age group that may be expected to have attended college.

(5) It is assumed that the future changes in the percentage of persons 18–19 years old enrolled in college will be proportional to the future changes in the percentage of persons 20–24 years old ever attending college, as estimated in step 4.

(6) For other age groups (16–17, 25–29, 30–34) the future attendance percentages are those reported in 1958–60, the same as in the *constant-rate* projection. Thus, projection II makes no allowance for increased attendance rates in the age group 25–34, even though the rates have risen somewhat during the 1950's. Not only are the data lacking concerning the educational attainment of the fathers of these persons, but also it may be doubted whether in that age group the fathers' attainment is directly influentional as much as in the lower age groups.

Table 6 shows the college attendance experience of the population aged 20–24 in 1960 according to the educational attainment of their fathers. The table shows the percentage of persons 20–24 enrolled in college as of October 1960 and also gives the percentages of those who ever had been so enrolled. The relation between college attendance and father's educational attainment is obviously a strong one. Other studies have abundantly confirmed this fact.

TABLE 6.—Percent of civilian noninstitutional population aged 20–24 enrolled in college currently or previously, by fathers' educational attainment, and by sex, 48 contiguous States and District of Columbia, October 1960

Fathers' educational attainment	Current college status			Current and previous college status		
	Total	Enrolled	Not enrolled	Total	Enrolled at some time	Never enrolled
	MALES AGED 20–24					
Total	100	20	80	100	36	64
Not a high school graduate [1]	100	13	88	100	23	77
High school graduate, no college	100	28	72	100	54	46
Some college, not a college graduate	100	41	59	100	70	30
College graduate	100	62	38	100	88	12
	FEMALES AGED 20–24					
Total	100	7	93	100	25	75
Not a high school graduate [1]	100	4	96	100	15	85
High school graduate, no college	100	9	91	100	36	64
Some college, not a college graduate	100	24	76	100	67	33
College graduate	100	21	79	100	77	23

[1] Includes cases where fathers' attainment was not reported.

SOURCE: Bureau of the Census survey of school enrollment, October 1960 (Series P–20).

Table 7 shows the educational attainment of all males in the Nation aged 45–54 in 1960, together with projections of the attainment of this age group in 1970 and 1980 as made by the Bureau of the Census. This projection can be made with considerable accuracy because most of the persons involved have already completed their formal education. The primary problem is one of getting data for the base period. Examination of the figures shows a very substantial increase in the educational attainment of males aged 45–54; particularly noteworthy is the decline in the proportion of men of this age with less than 4 years of high school—from 63.7 percent in 1960 to 41.7 percent in 1980. At the same time the proportion of those who have had some college education rises from 16.0 percent to 25.5 percent.

Table 7 also shows the educational attainment of the fathers of persons aged 20–24 in 1960, and the estimated attainment of the fathers in 1970 and 1980, assuming that the educational attainment of fathers changes in proportion to that of all males 45–54. This is the assumption mentioned previously in step 2.

TABLE 7.—Estimated percentage distribution by educational attainment of (a) males 45–54 years of age, and (b) fathers of persons 20–24 years of age, 48 contiguous States and District of Columbia: 1960, 1970, 1980

Year	All males 45–54 years of age	Educational attainment of males 45–54 years of age			
		Less than 4 years of high school[1]	4 years of high school	1–3 years of college	4 or more years of college
1960	100	63.7	20.3	7.6	8.4
1970	100	50.0	30.2	9.3	10.5
1980	100	41.7	32.8	11.6	13.9

Year, by sex and age	All fathers of persons 20–24 years of age	Education attainment of fathers of persons 20–24 years of age			
		Not a high-school graduate[1]	High-school graduate, no college	Some college, not a college graduate	College graduate
Sons 20–24 years of age:					
1960	100	70.0	17.4	5.6	7.0
1970	100	56.9	26.8	7.1	9.1
1980	100	48.7	29.9	9.1	12.4
Daughters 20–24 years of age:					
1960	100	71.8	16.4	5.1	6.7
1970	100	59.0	25.5	6.6	8.8
1980	100	50.8	28.7	8.5	12.0

[1] Includes cases where educational attainment was not reported.
Details may not add to totals because of rounding.

SOURCE: Attainment of males as of July from Bureau of the Census projection of educational attainment (Series P–20, No. 91, Jan. 12, 1959). Educational attainment of fathers as of October 1960 from Bureau of the Census survey of school enrollment.

CALCULATION: Fathers' attainment in 1960 projected to 1970 and 1980 at same rate of change as for males 45–54 years of age, and then adjusting to 100 percent.

In support of the assumption it may be noted that the educational attainment of fathers and that of all males 45–54 years of age were very similar in 1960. Moreover, the use of age group 45–54 does not seriously impair the estimate. The age group was selected for convenience because it had already been projected; other age groups such as 40–55 would be expected to have similar increases in attainment. The basic point is that a specific age group, whatever the exact age composition may be, is taken to represent the fathers of the population aged 20–24 in 1960, 1970, and 1980, insofar as changes in educational attainment are concerned. This assumption would not be correct if, for example, (*a*) fathers of the population aged 20–24 in future years are a younger group than now, or (*b*) fertility of persons with higher educational attainment has increased more than that of persons with lower attainment. Either of these changes would be such as to increase the attainment of the fathers more than has been estimated and would thus tend to raise the figures shown in projection II.

Once the attainment of the fathers of persons aged 20–24 has been projected, the application to future populations of 1960 enrollment rates in relation to fathers' attainment, as described previously, is a simple matter.

Of course, fathers' attainment is only one of many factors related to attendance at college, albeit a major one. In the period from 1950 to 1960 only a part of the increase in college enrollment can be explained by increases in the educational attainment of the fathers of the students. For example, college enrollment rates for males aged 20–24 increased 6.3 percentage points, of which only 1.8 are attributable to changes in their fathers' educational attainment. For women aged 20–24, college enrollment rates increased 2.6 percentage points, of which only 0.6 point is attributable to changes in their fathers' educational attainment. Obviously, other factors also were effective during this period in raising attendance rates.

PROJECTIONS FOR 50 STATES AND FOR AGGREGATE UNITED STATES

The projections and tables up to this point have referred to the 48 contiguous States and the District of Columbia because the available basic population projections from the Bureau of the Census have been for this area. For the convenience of those desiring such coverage, projections for 48 States and the District of Columbia have been adjusted in table 8 to cover the 50 States and the District of Columbia, and in table 9 to cover the aggregate United States, includ-

ing outlying parts (Canal Zone and Puerto Rico have college enrollments). The adjustment made is based on the current relation between the enrollment in the latter areas and the enrollment in 48 States and the District of Columbia. Separate conversion factors are applied for each sex, for both total enrollment and full-time enrollment.

TABLE 8.—Fall enrollment 1950–60 and projections 1965, 1970, 1975, total opening enrollment and full-time undergraduate and first professional, by sex, 50 States and District of Columbia

[In thousands]

Year	Opening enrollment			Full-time undergraduate and first professional enrollment		
	Total	Men	Women	Total	Men	Women
1950	2,296	1,573	723			
1951	2,107	1,394	713			
1952	2,139	1,353	786			
1953	2,236	1,426	811	1,557	1,004	553
1954	2,494	1,603	890	1,665	1,103	562
1955	2,703	1,774	929	1,856	1,237	619
1956	2,927	1,917	1,011			
1957	3,047	1,991	1,056	2,016	1,335	680
1958	3,236	2,098	1,138			
1959	3,377	2,161	1,216	2,199	1,417	784
1960	3,583	2,287	1,296			
	PROJECTION I—TREND PROJECTION					
1965	5,220	3,424	1,796	3,509	2,266	1,153
1970	6,959	4,622	2,337	4,807	2,916	1,891
1975	8,616	5,772	2,844	5,755	3,657	1,898
	PROJECTION II—FATHERS' ATTAINMENT PROJECTION					
1965	4,664	3,046	1,618	3,101	2,038	1,063
1970	5,980	3,941	2,019	3,856	2,562	1,294
1975	7,090	4,714	2,376	4,610	2,932	1,678
	PROJECTION III—CONSTANT-RATE PROJECTION					
1965	4,337	2,846	1,491	2,947	1,944	1,003
1970	5,205	3,471	1,734	3,534	2,374	1,160
1975	5,941	4,001	1,940	3,979	2,693	1,286

SOURCE: Figures for 1950–60 from Office of Education surveys; those for 1965–75 converted from projections for the 48 contiguous States and the District of Columbia.

The total enrollment for the 50 States and the District of Columbia is shown, in projection I, to rise from 3.6 million in 1960 to 7.0 million by 1970, and in projection III to 5.2 million. Further increases may be expected to occur after 1970; projection I shows that by 1975 enrollment will be 2.4 times that of 1960 if attendance rates increase as they have in the past. Even if attendance rates remain at present levels (projection III), there will be 5.9 million persons enrolled in colleges and universities by 1975.

TABLE 9.—Fall enrollment 1950–60 and projections 1965, 1970, 1975, total opening enrollment and full-time undergraduate and first professional, by sex; aggregate United States (including outlying parts)

[In thousands]

Year	Opening enrollment			Full-time undergraduate and first professional enrollment		
	Total	Men	Women	Total	Men	Women
1950	2,297	1,569	727			
1951	2,116	1,399	718			
1952	2,148	1,387	761			
1953	2,251	1,432	818			
1954	2,500	1,602	898	1,566	1,009	557
1955	2,721	1,784	937	1,696	1,109	587
1956	2,947	1,928	1,019	1,868	1,244	624
1957	3,068	2,003	1,065			
1958	3,259	2,110	1,148	2,030	1,344	685
1959	3,402	2,174	1,228			
1960	3,610	2,271	1,339	2,212	1,421	790
	PROJECTION I—TREND PROJECTION					
1965	5,257	3,445	1,812	3,423	2,260	1,163
1970	7,007	4,649	2,358	4,398	2,934	1,464
1975	8,677	5,807	2,870	5,191	3,478	1,713
	PROJECTION II—FATHERS' ATTAINMENT PROJECTION					
1965	4,697	3,064	1,633	3,123	2,050	1,073
1970	6,001	3,964	2,037	3,883	2,577	1,306
1975	7,140	4,742	2,398	4,442	2,950	1,492
	PROJECTION III—CONSTANT-RATE PROJECTION					
1965	4,367	2,863	1,504	2,967	1,955	1,012
1970	5,241	3,492	1,749	3,589	2,389	1,170
1975	5,992	4,025	1,967	4,006	2,709	1,297

SOURCE: 1950–60 from Office of Education surveys; those for 1965–75 converted from projections for the 48 contiguous States and the District of Columbia.

RELATED ENROLLMENT SERIES

The estimates presented in this chapter can perhaps best be evaluated in terms of other series developed by the Bureau of the Census and by the Office of Education. It is worth while also to note briefly sources of information now available on full-time college enrollments and to comment on the relation of fall enrollment as of a single date in the year to the cumulative enrollment for the full academic year.

Census Bureau projections.—The U.S. Bureau of the Census has prepared illustrative projections of school and college enrollments to 1980 (Series P–25, No. 232). Table 10 presents the projections of total fall college enrollment for all of the series that were computed; the publication gives breakdowns of some of these series by age group and by sex.

The two principal series, A and C, present figures similar to the figures given here for projection I (*trend* projection) and projection III (*constant-rate* projection), respectively, as may be seen by comparing table 8 and table 10.

The Census Bureau projections were obtained in a manner analogous to that employed here. Projected trends in the percentage of an age group enrolled in school or college (based on different assumptions) were applied to projections of the population by age. The projected enrollment for each age group was then divided into elementary, secondary, and college enrollment in accordance with the present proportions for each age group.

The enrollment rate series differ with respect to the trend in the proportion of population at each age enrolled in colleges and universities. Series A implies a continued increase in enrollment rates by age with some leveling off by future dates; the base period for the trend is 1950–59. In series C it is assumed that enrollment rates will remain constant at the 1957–59 average annual level. Series B assumes rates roughly halfway between series A and series C. In series D, it is assumed that rates remain constant at 1957–59 levels through 1964, decline to the 1953–55 levels by 1974, and then remain constant at these levels to 1980.

TABLE 10.—Bureau of the Census projections of fall college enrollment for the civilian noninstitutional population under 35 years of age, 50 States and District of Columbia; 1965, 1970, 1975, 1980

[In thousands]

Population projection series [1]	Attendance-rate projection [2]	1965	1970	1975	1980
II	A	5,379	7,020	8,325	9,018
III	A				8,815
IV	A				8,599
II	B	4,664	5,825	6,928	7,757
III	B				7,577
IV	B				7,389
II	C	4,375	5,261	6,028	6,807
III	C				6,642
IV	C				6,487
II	D	4,289	4,774	5,075	5,492
III	D				5,350

[1] Assumptions as follows: Series II—fertility constant at 1955–57 level; Series III—fertility declines to 1949–51 level by 1965–70, then constant; Series IV—fertility declines to 1942–44 level by 1965–70, then constant.
[2] Assumptions about enrollment rates as follows: Series A—increasing to 1975, then constant; Series B—average of A and C; Series C—constant at 1957–59 levels; Series D—constant through 1964, declining to 1953–55 level by 1974, then constant.

NOTE: Corresponding figures for earlier years are estimated as 2,214,000 in 1960; 2,379,000 in 1955; and 3,570,000 in 1990.

SOURCE: Bureau of the Census, Illustrative Projections to 1980 of School and College Enrollment in the United States (P-25, No. 232).

The population series projections underlying these enrollment figures differ only with regard to the projected level of fertility; these differences in fertility are inoperative for college enrollments until after 1975 because the future college students up to that date have already been born.

The 5 additional years beyond 1975 are shown in these Census Bureau projections to be a period of continued enrollment growth; thus, the enrollment trend is upward for at least 20 years into the future.

Other enrollment data.—The estimates presented earlier develop projections of full-time undergraduate enrollments, including as undergraduate enrollment first professional degree students. Historical information on full-time enrollments is available from two sources in addition to the data collected by the Office of Education as shown in tables 4, 8, and 9. The Bureau of the Census, in its sample surveys of school and college enrollments, collected data on the full-time status of college students, including both graduate and undergraduate students, for the fall of 1959 and the fall of 1960. Comparable data are not available from the sample surveys in earlier years. These figures define as full time those students taking 12 or more hours of class attendance during an average school week.

The periodical *School and Society* has published annually for many years statistics on full-time college enrollments, also including both graduate and undergraduate students. Although the coverage is not always consistent from year to year, the full-time data for 4-year colleges as reported in this survey move more or less parallel to the full-time enrollment statistics of the Office of Education and the Census Bureau.

It should be pointed out that fall college enrollments are decidedly smaller than enrollments for the entire academic year. Academic year figures include students enrolling after the fall report has been submitted. No estimate of projected academic year enrollments has been made because they cannot be related directly to population data by age groups. Moreover, the relation of academic year enrollments to fall enrollments has been erratic in the past so that the conversion from one to another is unreliable. Although much historical data for academic year enrollments are available, current surveys are emphasizing fall enrollment statistics.

The projection of college enrollment previously in use by the Office of Education for planning purposes anticipated 4,677,000 students in the fall of 1965 and 6,066,000 students in the fall of 1970 (48 States and the District of Columbia). The earlier estimates were almost exactly halfway between the *trend* projection and the *constant-rate* projection given in this chapter. This earlier projection was based on a procedure different from the projections developed here.

The new projections show a range of numbers based on differing assumptions with regard to rates of attendance. The method of projection has been improved by analysis of at least one causal factor, besides the usual analyses based on population trends for males and females. Furthermore, future full-time enrollments have been estimated for the first time. It is hoped that the estimates presented will provide a better basis for planning purposes than has been available heretofore.

CHAPTER 2

Social and Economic Determinants of the Demand for Education [1]

*Harvey E. Brazer and Martin David**

THE FORMAL EDUCATION of the majority of Americans who were born before 1905 ended before they reached high school. Only one-sixth of the people now 55 or more years of age attended college, and less than half of these hold a college degree. In striking contrast, only a small fraction (14 percent) of those born between 1926 and 1942 have failed to go on to high school or beyond. Indeed, of that generation which, for the most part, has concluded its schooling, almost one-third have gone to college. Thus in the course of two to three generations the proportion going to college has doubled. Moreover, on the basis of parents' expectations for their children's education, as reported in this study, it would appear that about two-thirds of the children born in the United States between 1943 and 1959 will seek education beyond high school. The trends indicated in table 1 suggest that within the past 50 years the educational attainment of the modal members of succeeding generations has moved up from less than a high-school education to 1 or more years of college.

This sharp raise in the level of educational attainment may be ascribed to a number of causal factors. One of them, certainly, has been the increase in real income of families in the United States. Within each succeeding generation a larger fraction of American families have been able to afford the costs involved in extending the

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*Harvey Brazer prepared the research on which this article is based while professor of economics and research associate of the Survey Research Center at the University of Michigan. Martin David was study director for the research project and is now assistant professor of economics at the University of Wisconsin. The project was made possible through grants from the Ford Foundation and the U.S. Office of Education under its cooperative research program. The views expressed are those of the authors and do not in any way reflect the views of the sponsoring agencies.

[1] The findings of this study apply to persons who are heads of spending units. A spending unit is a group of persons related by blood, marriage, or adoption, living in the same dwelling unit, who pool their incomes for their major items of expense. If the spending unit contains a married couple, the head of the unit is the husband. Otherwise the head is the person who earns the most money.

As a consequence of the definition, four-fifths of all spending unit heads are men. The women who are heads of spending units are one-fifth of the adult female population of the United States.

education of their children through high school and college. Income has increased and families have become more aware of the social and economic importance of education. At the same time the age at which young people may legally leave school has been raised and educational facilities have been expanded.

TABLE 1.—Trends in educational attainment of spending unit heads in the United States: percentage distribution, by age

Educational level	Percent, by age and year of birth			
	55 and over (before 1905 [1])	35–54 (1905–25 [1])	18–34 (1926–42 [1])	1–17 (1943–59 [2])
Total	100	100	100	100
No education	4	1	0	0
Elementary school	40	26	14	3
Some high school	17	23	23	
High-school diploma	8	18	21	
High-school diploma, plus noncollege training	6	11	12	29
College, no degree	9	10	18	10
Bachelor's degree	5	8	10	
Advanced degree	2	3	3	58

[1] Education attained by spending unit heads, estimated from a national probability sample of the United States taken in 1960. Differential mortality of highly educated and uneducated persons may produce some upward bias in the distributions.

[2] Education expected for children now in school. The percentages are based on a sample of the adult population of the United States, reported in *How People Pay for College*, by John B. Lansing, Thomas Lorimer, and Chikashi Moriguchi, Ann Arbor, Mich., Survey Research Center, University of Michigan, 1960. p. 100.

Another major factor has been the substantial movement of population from rural, agricultural environments to urban, industrial areas. This movement has brought a larger proportion of the population into communities in which educational facilities are more readily accessible and in which more education is demanded of those seeking employment and status.

Our rapidly advancing technology has provided a phenomenal increase in the demand for persons with high levels of education. Apparently the demand for persons with education beyond high school has kept pace with the supply, and there are no visible signs of a weakening in the market for college graduates.[3]

Increases in income, facilities, and demand for persons with education provide fertile conditions for increasing educational attainment in this country. But they do not explain the motivation that has produced the astounding increase in education. In this chapter some of these motivational factors will be explored.

This chapter is based on information collected in a survey of a nationwide probability sample of spending units in the United States,

[3] See Herman P. Miller, ch. 9 of this publication. There are contrary views, such as that of Robert J. Havighurst, *American Higher Education in the 1960's*. Columbus, Ohio State University Press, 1960.

taken in March and April of 1960. Sampling procedures used in the "Patterns of Family Change" study from which these data are drawn are outlined in appendix A. Our approach is to present data from the survey that relate educational attainments in this country and offer a set of tentative hypotheses that might be used to explain the highly significant relationships observed in the data. As in all research, particularly research that depends on the personal interview for its basic data, many relevant factors relating to educational attainment have been excluded from the analysis both because of inherent limitations of the survey method and because of limitations of time and resources available for this particular investigation. We recognize that in several cases more detailed analysis would have been desirable and that many of the interpretations offered could equally well be replaced by alternative formulations.

The chapter is divided into three parts. The first sets forth hypotheses about the manner in which motivation for education is generated within the family. The second tests these hypotheses against cross-sectional data that describe the educational accomplishments of children in relation to the characteristics and background of their parents. Also in the second part, educational attainments of families whose children are still in school or are preschoolers are contrasted with the families' educational aspirations. The third part offers some brief remarks on the realism of parents' aspirations for sending children to college.

I. Motivation for Educational Attainment—A Model

The transmission of levels of education from parents to children is impressive. If educational attainments are classified into three broad groups—grade school or less, some high school or high-school diploma, and at least some college—then almost three-fifths of spending unit heads report that they are in the same group as their fathers. This implies that the distribution of educational attainments is strongly influenced by the experience of the last generation; it also implies a strong mechanism for transferring the values and accomplishments of each generation to the succeeding generation.

We believe that this transfer is accomplished via three routes: (1) The motivation and values of the family create the atmosphere in which the children are reared. (2) The material and career accomplishments of the parents serve to demonstrate to the children the utility and importance of the parental values; the career failures of the parents may motivate children to reject parental values. However, such rejection is a less powerful motivating force than the positive accomplishments of parents. (3) The achievements of the

parents influence the family income and assets, which become the resources for financing the higher education of children.

We cast these general notions into specific hypotheses about the relationships between the education of children and their parents' background. For the most part values held by the parents are measured indirectly by a set of indicators. Chart 1 illustrates the manner in which specific measures of the family's background relate to the model we have developed. The left-hand column of the chart lists some of the more obvious influences on educational attainments; the reader can easily suggest others. The right-hand column indicates variables that were measured in the 1960 survey and that might relate to the underlying influences on educational attainments listed in the left-hand column. In most cases the underlying influence is reflected in more than one measured variable—cultural norms stressing education would certainly be reflected in reference groups other than the religious group shown in the chart. Conversely, some of the measured variables, such as race, are associated with several underlying influences on education—availability of facilities, cultural norms, and lifetime income levels. In short, the chart provides a crude outline which we shall elaborate on in the discussion of our findings.

II. Factors Influencing the Education Actually Attained by Children of a Cross Section of the U.S. Population

Educational attainments of the children of the family were measured by the average number of grades completed by living children of the head who were finished with school at the time that the family was interviewed. This measure contains some downward bias: teenagers who have already dropped out of school are included in our average, while those who are continuing their education and will raise the average at some time in the future are not taken into consideration.[8]

Strictly speaking, the analysis of educational attainments reflects not only demand for education but also the supply of educational facilities available to children of the respondents in our sample at various times in the past. Only if we assume that the supply of educational facilities will continue to increase in much the same way as it has in the past can we extrapolate from the experience of this generation of children in relation to the background of their parents.

[8] Other measures of educational attainments might have been more useful for a more elaborate analysis of the structure of demand for college places. For example, an analysis differentiating between the attainments of girls and boys would appear to be extremely useful, as there appear to be substantial differences in the aspirations for educating male and female children. Another useful distinction would be to differentiate characteristics of families whose children complete college from families whose children only attended college for 1 or 2 years.

A MODEL OF MOTIVATION AND EXPERIENCE INFLUENCING THE TRANSMISSION OF EDUCATION FROM GENERATION TO GENERATION

Theoretical determinants of educational attainments	*Indicators or proxy variables*
Motivation of parents and their values:	
Need-achievement of the parents.	A measure of need-achievement of the head[1] based on perception of the relative desirability of various occupations.
Attitudes toward hard work and self-help as the means for attaining desired goals.	Expressed evaluation of hard work as the means for getting ahead.
Cultural norms stressing education, expressed in religious, community, and social groups with which parents are affiliated.	Religious affiliation and participation in religious activities by the head.
Achievements of parents that demonstrate the effectiveness of values held by the parents:	
Actual educational accomplishment of both parents.	Education of the head, and education of his wife, if he is married.
Educational achievement of the parents relative to the achievement of the grandparents.	Difference in the education of the head and his or her father.
Career paths demonstrating impact of education on earning power and advancement.	Occupation of the head.
Past mobility of the head which indicates attempts on the part of the parents to improve their situation.	Whether head moved off a farm.
	Whether head moved to the North.
Successful planning of finances and other activities of the family.	Age of the head at the birth of his first child.
Availability of education:	
Existence of local facilities.	Region.
	Urbanisation.
	Color.
Economic ability to send children to college:	Peak income of the head in past years, his education, his occupation.
a. Earning potential.	
b. Demands on income and their timing.	Age of the head at the birth of his first child.
	Number of living children of the head.

Education achieved by children

[1] The head of the spending unit is the husband in units containing a married couple; otherwise the head is the major earner in the spending unit.

Average education attained by the children of respondents was related to the indicators shown in chart 1 by a multivariate statistical analysis. Education of the spending unit head proved to be the most important factor influencing the education of the children. In table 2 the relative importance of each of the indicators used to explain educational achievements of children is shown by the rank of its importance based on the beta coefficient of the indicator.[4] The beta coefficient is a standardized measure of the size of the effect of the indicator on the dependent variable. It takes into account both the differences between classes of the indicator and the distribution of the population among those classes.

Taken together, the explanatory variables account for two-fifths of the variance in children's completed education, as indicated by a coefficient of multiple determination, R^2, of 0.414. On the average, children who are finished with school received slightly less than 12 grades of schooling. The standard error of estimate of the result is 1.96 grades.

Parallel findings emerge from multivariate analysis of parents' aspirations for educating their children of school age. Aspirations are measured by answers to two questions: "How much education do you expect your boys to have before they stop going to school?" and "How much education do you expect your girls to have before they stop going to school?" The questions were asked of all heads of spending units with children aged 20 or under. The answers were coded according to the highest level of education mentioned.

Table 3 shows that two-thirds of the parents of boys and more than half of the parents of girls expect their children to attain some educa-

[4] The multivariate procedure is developed in *The Design and Analysis of Experiments*, by Oscar Kempthorne (New York, John Wiley & Sons, 1952, p. 91–110). The procedure is completely analogous to a regression procedure in which each classifying variable shown in our results is replaced by a set of dummy variables. (See "Use of Dummy Variables in Regression Equations," by Daniel B. Suits, *Journal of the American Statistical Association*, 52: 548–566, December 1957, and "An Analysis of Wages and Salaries in Great Britain," by T. P. Hill, *Econometrica*, 27: 355–381, July 1959.) The beta coefficients presented in this article are the standardized regression coefficients which obtain if each classifying variable is scaled according to the adjusted deviations shown in succeeding tables.

The *F*-tests are calculated by treating the adjusted deviations associated with each classifying variable as a one-way analysis of variance with unequal cell sizes. The ratio of the variance explained by the adjusted coefficients to the variance unexplained by the entire multivariate procedure forms our estimate of *F*.

As the sample is clustered, sampling errors in the data exceed what would be expected from estimates assuming simple random sampling. Clustering is not as likely to affect the significance of multivariate relationships as it is likely to increase the sample errors of simple proportions and means. The consequence of clustering on the multivariate analysis is that the significance levels shown for *F* in the text somewhat exaggerate the true level of significance. Nevertheless it is highly likely that all relationships shown to be significant at the 0.01 level are truly significant. The number of cases on which each coefficient is based are included in the tabulations as a guide to the sampling error of the coefficient.

tion beyond high school. These findings are roughly consistent with other studies of parents' aspirations for their children.[5]

TABLE 2.—Characteristics of spending unit heads used to explain average number of grades completed by children[1]

Characteristics of the heads of spending units	Relative importance		Significance (*F*-ratio)
	Rank	Beta coefficient	
Education	1	0.374	[3] 28.02
Difference in education of heads and wives	2	.187	[3] 8.00
Occupation	3	.153	[3] 3.75
Number of children	4	.122	[3] 5.96
North-South migration	5	.114	[3] 2.47
Need-achievement index and attitude toward hard work	6	.104	[3] 2.48
Peak earnings	7	.098	1.54
Religious preference and church attendance	8	.096	[3] 2.11
Age at birth of eldest child	9	.091	1.90
Difference in education of heads and fathers	10	.087	[3] 3.03
Color	11	.069	[3] 3.81
Urban-rural migration	12	.045	.54
Age	13	.037	.55

[1] Calculated for spending unit heads who have children finished with school. Cases in which the education of children was not ascertained are excluded. Grades completed refer only to academic schooling with "some college" considered 13 years; "college degree," 16 years; master's degree, 17.
[2] Significant at a probability level of 0.01.
[3] Significant at a probability level of 0.05.

TABLE 3.—Percentage distribution of spending units with girls or boys aged 20 or under, according to the education level expected for them by their parents

Education level expected by heads of spending units	Index values	Percentage distribution for—	
		Girls	Boys
Total		100	100
Elementary school	1	0	1
Some high school	2	1	1
High-school diploma	3	31	28
High-school diploma, plus noncollege training	4	4	1
College, no degree	5	6	4
Bachelor's degree	6	49	58
Advanced degree	7	1	4
"Don't know" or general response		5	5
Not ascertained		3	3
Average grades of schooling expected (interpolated from mean value of the index)		13.5	14.3
Mean value of index		4.8	5.1
Percent of spending units with children 20 years of age or younger		36	40

EDUCATION OF PARENTS AND GRANDPARENTS

The average education attained by the children, grouped according to the education of the spending unit head, is shown in table 4, column 2. Children of a head with no high-school training are likely to

[5] Roper estimates that 69 percent of children below 18 years of age are expected by their parents to go to college. See Elmo Roper & Associates, *Parents' College Plans Study; The Education Program of the Ford Foundation*, 1959(?), p. I. Data from Lansing, Lorimer, and Moriguchi, cited in table 1 of this chapter, show a similar figure.

attain some high-school training and children of a college graduate some college training. The third column of table 4 displays the difference between the average attainments given in column 2 and the grand mean. These "unadjusted deviations" exaggerate the impact of the head's education on the educational attainments of the children. The effects of income, color, and other factors that are correlated with education are included in the averages shown. Persons with high incomes are likely to be highly educated, so that the deviations may register the greater financial ability of educated persons to send their children to college as much as they reflect the transmission of ideas and parents' motivation for educating the children. Column 4 indicates the extent to which the children's education deviates from the average when effects that can be attributed to other factors are removed by multivariate adjustment. Thus column 4 is labeled "adjusted deviations." Column 5 shows the extent to which the multivariate estimates differ from simple tabulations of means. The differences display the extent to which simple tabulations include effects that can be traced to other variables. Columns 2 and 5 will be dropped from the remaining tables as the information in them can easily be derived from the remaining data.

TABLE 4.—Average grades of completed education of children, by education of the spending unit head, and deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

Education of spending unit heads	Number of cases	Average education of children in this group (years)	Unadjusted deviations [1]	Adjusted deviations [2]	Difference, cols. 3 and 4
No education	26	9.14	−2.68	−1.60	−1.08
Elementary school	478	10.86	−.96	−.68	−.28
Some high school	177	12.01	.19	−.12	.31
High-school diploma	92	12.81	.99	.98	.01
High-school diploma, plus non-college training	80	12.76	.94	.66	.29
College, no degree	68	13.90	2.08	1.65	.43
Bachelor's degree	35	14.70	2.88	1.89	.99
Advanced degree	16	15.72	3.90	3.06	.84

[1] Deviations (in grades) from the grand mean of 11.82 grades.
[2] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.

Unadjusted deviations are shown in subsequent tables because they may represent the cumulative effect of a variable that is logically prior. For example, color is determined before birth. It affects education, occupation, and income; the unadjusted effects reflect the total impact of color on the educational attainments of children—an impact which is significant even though a good portion of the effect can be attributed to other variables.

The educational achievement of children does not increase systematically with every increase in the amount of schooling obtained

by the head of the spending unit. High-school graduates with nonacademic or vocational training have children with relatively less attainment than do those who are high-school graduates with no vocational training. However, the vocationally trained have higher *aspirations* for their children. This inconsistency suggests that the attainments of children of the vocationally trained may rise in future years.

The pattern of adjusted deviations in table 4 offers two interesting results. First, it lends support to our hypothesis that motivation for the children to continue in school is directly related to the educational attainment of the parents. Children of more educated parents attain more education than the average, even after the results are discounted for the better economic situation of the family. Secondly, the results indicate some regression of children toward the average. Children of parents who did not finish grade school average some high-school training, while children of college graduates average less than 3 years of college training. For parents with college training this result was to be expected. Not all children have the ability to complete a college course successfully, and only a small proportion of all children will continue after college with graduate work. The net result of less education attained by a few less able children is to lower the average of the entire group below an average attainment equal to the parent's college degree. The superior accomplishment of the children whose education exceeds their parents' grade-school training suggests that community influences motivate children to complete a minimum education no matter what their parents' background.

TABLE 5.—Average grades of completed education of children by the difference in educational attainment of parents; deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

Head's education compared with wife's [1]	Number of cases	Unadjusted deviations [2]	Adjusted deviations [3]
2+ levels less than wife	61	1.94	1.87
1 level less than wife	103	−.01	.46
Same level as wife	310	−.48	−.10
1 level more than wife	79	1.07	−.08
2+ levels more than wife	67	1.80	−.94
Education of wife not ascertained	9	.16	.09
Heads are single, widowed, or divorced [4]	310	−.62	−.11

[1] Levels of education are defined as:

No education	High-school diploma, plus noncollege training
Grade school	College, no degree
Some high school	Bachelor's degree
High-school diploma	Advanced degree

[2] Deviations (in grades) from the grand mean of 11.82 grades.

[3] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.

[4] Heads of spending units include women whose husbands are not present and for whom the educational attainments were not ascertained.

The average education achieved by the children is also influenced by the educational achievements of the mother. The more education the wife has relative to her husband, the more education the children attain. Thus the education of both parents appears to stimulate education of the children. The adjusted deviations in table 5 suggest an asymmetry in the effect of differences in the parents' education. Where the wife has less education than her husband, achievements of the children are impeded, but not so much as they are advanced when the wife has more education than the husband.[6]

Children learn from, and are motivated by, the experiences of their parents. We assume they also recognize the educational achievements of their grandparents and use the experience of that generation to judge the value of an education. In cases where the grandfather has more education than either parent, we expect children to achieve more schooling than the parents' education would indicate. If the grandfather has less education than the parents, we should not expect the educational achievements of the children to be affected, although some regression to the accomplishments of the grandfather would not be surprising.

TABLE 6.—Average grades of completed education of children according to the difference in educational attainment of heads and their fathers; deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

Education of spending unit head compared with that of his father [1]	Number of cases	Unadjusted deviations [2]	Adjusted deviations [3]
Lower level than father	86	0.43	0.39
Same level as father	674	−.80	−.02
1 level more than father	129	1.09	−.37
2+ levels more than father	80	2.81	.39

[1] Levels of education used here were: grade school or less; education of father not ascertained; some high-school or high-school diploma; some college or college degree.
[2] Deviations (in grades) from the grand mean of 11.82 grades.
[3] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.

The multivariate analysis confirms part of our hypothesis. Heads who have less education than their fathers have children who are likely to attain half a grade more schooling than the average (adjusted deviation). Where heads have achieved more education than the grandfather, however, both a positive and a negative deviation from the mean are shown. The negative effect could be interpreted as a regression of all children to an average level of education; the positive effect could be interpreted as the transfer of the parents' extremely

[6] By definition, certain combinations of head's education and difference in education of the head and wife cannot exist. For example, with the levels used in this survey, it is impossible for the head to have an advanced degree and his wife to report more education than he. Also by the nature of the definition, the two extreme groups on the scale typically include wives or husbands with a high-school education or more.

high mobility to their children. The cause of a combination of these two effects is obscure.

Virtually identical results emerge from multivariate analyses of aspirations for the education of younger children. The education of both head and wife is positively related to aspirations, much as in tables 4 and 5. The relationship between the grandfather's education and aspirations for children, unlike the result above, clearly indicates a pattern of regression to the attainments of the grandparents. Where heads have less education than their fathers, they aspire to relatively high attainments for both boys and girls; where the heads have more education than their fathers, their aspirations are relatively low.

OCCUPATION OF THE HEAD

Several interpretations of the relationship between occupation and educational attainment of children can be developed. One possibility is that the link between education and particular career lines is demonstrated to the children through the occupation and success of the breadwinning parent. Children may relate the ability of the parent to attain high-status professional work, as in medicine, to his educational achievements. This would provide incentive for the children of professional and managerial workers to obtain more education than children of unskilled laborers.

An alternative interpretation of the results is that occupation serves as an indirect measure of the lifetime earnings of the family. Professional and managerial workers are better able to afford college education for their children than operatives or laborers. Some support for the latter interpretation comes from the fact that the occupation of the head bears little relationship to his aspirations for educating boys.

The differences between the adjusted and unadjusted deviations shown in table 7 exhibit clearly the advantages of the multivariate technique used to obtain the adjusted results. A simple set of averages attributes differences to occupation that the multivariate adjustment attributes to education and other dimensions. As a result, the adjusted effect of occupation is substantially smaller than the unadjusted effect.

SIZE OF FAMILY

The larger the family, the more demands upon its income for current needs and the less it can afford the double cost of sending children to college and forgoing the income that they can earn. Therefore we believe that the number of children born to the head should be

associated closely and inversely with the average amount of schooling achieved by the children. Table 8 shows this effect clearly. The same effect is seen in the relationship between number of children and parents' aspirations for educating children.

TABLE 7.—Average grades of completed education of children by occupation; deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

Occupation of spending unit heads [1]	Number of cases	Unadjusted deviations [2]	Adjusted deviations [3]
Professional	59	2.60	0.32
Non-self-employed manager or official	39	2.17	.75
Self-employed businessman or artisan	62	1.04	.54
Clerical and sales worker	100	1.11	.49
Craftsman or foreman	124	.06	−.05
Operative	164	−.48	−.14
Laborer	219	−1.26	−.56
Farmer	103	−.75	−.13
Government protective worker	10	1.32	.06
Head has never worked or occupation was not ascertained	59	−.96	.13

[1] For the unemployed and retired, occupation refers to the type of work usually or formerly engaged in.
[2] Deviations (in grades) from the grand mean of 11.82 grades.
[3] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.

NORTH-SOUTH MIGRATION

We would expect children of mobile families to have somewhat more education than children of immobile ones because mobile families have broader horizons and are probably more motivated to take advantage of economic opportunities. The variable that indicates whether the head of the spending unit moved between North and South was included in the analysis to test this notion.

TABLE 8.—Average grades of completed education of children, by number of living children of the spending unit head; deviations from the grand mean or 11.82 grades

[For spending unit heads whose children have finished school]

Number of living children of the spending unit head	Number of cases	Unadjusted deviations [1]	Adjusted deviations [2]
1 child	208	0.76	0.32
2 children	231	.45	.23
3 or 4 children	292	.03	−.07
5 or more children	208	−1.47	−.54

[1] Deviations (in grades) from the grand mean of 11.82 grades.
[2] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.

The education of children in families that move from one area of the country to another appears to be more advanced than would otherwise be expected. Children of foreign-born parents and of parents who move out of the South achieve more education than would

be expected on the basis of other characteristics of their parents.[7] In spite of the additional achievement, a gap of almost 1½ years of education remains between the education of children of migrants from the South and the education of children of persons who have lived outside of the South throughout their lives (see the unadjusted deviations, table 9). Children of persons who migrate from North to South do not attain more education than is characteristic of the North, but their attainments do not drop to the average level that is characteristic of the South.

TABLE 9.—Average grades of completed education of children by North-South migration of the spending unit head; deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

North-South migration of spending unit head	Number of cases	Unadjusted deviations[1]	Adjusted deviations[2]
Head grew up in non-Southern States:			
Living in South	121	0.24	0.07
Living out of the South	484	.42	.07
Head grew up in the Southern States:			
Living in South	201	−1.34	−.54
Living out of the South	88	−1.02	.06
Head grew up in foreign country	78	.35	.54
All others[3]	17	−.08	.16

[1] Deviations (in grades) from the grand mean of 11.82 grades.
[2] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.
[3] Includes persons who grew up in more than 1 region of the country and persons whose region was not ascertained.

NEED FOR ACHIEVEMENT

Parents influence educational accomplishment by the value which they place upon overcoming obstacles and succeeding in the face of difficulties. This value is termed the need-achievement of the parents. An extensive body of literature relates need-achievement to success in school, perception of relative remuneration available in jobs of varying difficulty, and the objective opportunities for getting ahead in the world.[8] According to psychological theory, this value is transmitted to children at an early age, largely through early training of the children in independence. High levels of need-achievement will be reflected in the child's determination to compete successfully in the academic tests that permit entry to higher levels of education. Low

[7] Nearly half of the migrants to the North are Negroes.

[8] See *The Achievement Motive* by David C. McClelland, John W. Atkinson, Russell S. Clark and Edgar L. Lowell, New York, Appleton-Century-Crofts, 1953; also "Some Social Consequences of Achievement Motivation," by David C. McClelland, in *Nebraska Symposium on Motivation, 1955*, Lincoln, University of Nebraska Press, 1955, p. 41–65; also *Achievement Motivation and Occupational Mobility in the United States*, by H. J. Crockett, Jr., Ann Arbor, Mich., University Microfilms, 1961; also "Race, Ethnicity, and the Achievement Syndrome," by Bernard C. Rosen, *American Sociological Review*, 24: 47–60, February 1959.

levels of achievement motivation will be associated with a child's willingness to get by with an average or the minimum required performance.

Parents also motivate their children to educational attainment by their emphasis on working hard and their perception of success as the just reward for effort. This value will determine the extent to which the child feels effort pays off. Parents who feel that hard work brings little payoff are in a number of cases members of minority groups. For this reason they may not encourage their children to make the same effort as do parents who see the gates of opportunity open to persons with ability and talent who work hard.

TABLE 10.—Average grades of completed education of children, by the need-achievement index and head's attitude toward hard work; deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

Need-achievement index and heads' attitude toward hard work	Number of cases	Unadjusted deviations [1]	Adjusted deviations [2]
Hard work is equal to or more important than luck; need-achievement index is—			
High	190	0.96	0.32
Medium	334	.08	.03
Low	160	−.51	−.25
Hard work is less important than luck; need-achievement index is—			
High	84	1.29	.75
Medium	100	−.96	−.32
Low	72	−1.20	−.26
Need-achievement index was not ascertained	40	−.28	−.26

[1] Deviations (in grades) from the grand mean of 11.82 grades.
[2] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.

In this analysis we have used an index of need-achievement based on the head's perception of the relative desirability of various occupations.[9] The index appears to make an independent contribution to the explanation of the level of education achieved by the children in the family. Children of parents who score high on the index

[9] The index of need-achievement was derived from the following question: "We are interested in how people compare occupations. How do you think most people would feel if a boy of theirs chose each of these types of work?"

The occupations listed were carpenter, mail carrier, high-school teacher, doctor, bookkeeper, auto mechanic, night watchman, bus driver, and drugstore owner.

Respondents rated the occupations in five classes ranging from "not happy" to "delighted." In theory, persons with high need for achievement will differentiate sharply in favor of high-reward, difficult occupations as opposed to low-reward, easy occupations; persons with low need-achievement will not differentiate as sharply in favor of the high-reward occupations and might even prefer low-reward, easier occupations. Therefore the slope of the relationship between the status-income ranking of the occupations and the ratings which were given for each occupation should indicate not only the extent to which the respondent differentiates high-status, high-income occupations from low-status, low-income occupations, it should also reflect the achievement motivation of the head. The slope was calculated for every spending unit head and used as the basis for the three need-achievement index groups shown in table 10.

achieve more schooling than do children of parents who score low. However, the head's attitude toward hard work as a means of getting ahead in the world does not have as strong an effect as we had expected. In spite of the belief that hard work is less important than luck in getting ahead in the world, a small group of persons who score high on the need-achievement index have children who perform well above the expectation based on their parents' characteristics. The children of this group attain more education than do the children of the group who feel that hard work is more important than luck. In the group who think hard work is less important than luck and who fall in the middle range on the need-achievement index, the children have less education than the average, and less than children of the group who feel that hard work is more important. This finding is what we would have expected on the basis of our hypotheses relating attitude toward work and educational achievement. For the remaining group it cannot be said that attitude toward work makes any difference in the educational achievement of children.

The adjusted deviations related to the need-achievement index may reflect, as we suggest, differences in the early training and motivation that parents give to their children; other interpretations may be equally valid. The need-achievement index may measure the extent to which parents place high value on jobs that require substantial education and low value on those jobs which do not. It may also measure the intelligence of the respondent. In either case the same relationship to educational attainments would be expected.

The need-achievement index of the head appears to influence not only the *attainments* but also the *aspirations* of the head for educating his children. This finding suggests that differential expectations provide one force by which high levels of need-achievement are translated into high attainments. However, the evidence does not support the hypothesis as consistently in this instance as it does in the analysis of completed education. Expectations for boys of parents who feel luck is more important do not vary in relation to the need-achievement index.

PEAK EARNING LEVELS

The maximum annual earnings received by the head of the spending unit were included in the analysis to measure the family's financial ability to send children through college. Though the relationship between level of peak earnings and children's education is somewhat irregular, the deviations are in the expected direction; high peak incomes are associated with more than average educational attainment.

TABLE 11.—Average grades of completed education of children by the peak earnings of the spending unit head; deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

Peak annual earnings of spending unit head	Number of cases	Unadjusted deviations [1]	Adjusted deviations [2]
$1–449	21	−1.10	0.01
$450–$949	30	−1.74	−.38
$950–$1,949	66	−1.61	−.28
$1,950–$2,949	87	−1.08	−.32
$2,950–$4,949	178	−.24	.12
$4,950–$7,449	224	.34	−.01
$7,450–$9,949	82	1.03	.08
$9,950 and over	97	1.87	.37
Head never worked	65	−1.26	−.60
Earnings not ascertained	119	−.06	.19

[1] Deviations (in grades) from the grand mean of 11.82 grades.
[2] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.

The failure of peak earnings to be more closely related to educational achievements can be ascribed to a number of conceptual and empirical factors. Peak earnings were thought to present the most favorable measure of earnings for retired persons and others whose incomes have declined since the period when their children were in school. However, the level indicated by peak earnings reported may be distorted by reporting errors; it may reflect atypical earnings during a very brief period; and it corresponds with disparate relative income positions for different cohorts in the sample. As a consequence, peak earnings do not necessarily reflect lifetime earning patterns and the ability of the family to support children in college. Education and occupation may be more closely associated with lifetime earning patterns. (See tables 4 and 7.)

In contrast to the relationship between peak earnings and educational attainments, the gross disposable income received by the spending unit in 1959 is the second most important determinant of the level of education expected for boys.[10] Its importance, however, is considerably smaller with respect to girls. Once the other variables have been taken into account, the level of education expected for boys in spending units with incomes between $1,000 and $1,999 is almost 1½ index levels (cf. table 3) below that expected by heads of spending units with incomes of $15,000 and over. The spread for girls, however, is only half as wide.

RELIGIOUS PREFERENCE AND ATTENDANCE

When religious groups are categorized according to the difference in the average income level of their members and the proportion of the members that are college graduates, a significant relationship

[10] Gross disposable income includes estimates of income which the family earns from home production and the imputed rental value of its home as well as the usual elements of money income. An estimate of the unit's Federal income tax liability is deducted.

appears between the affiliation of the parent and the educational attainment of the children. Children in families that attend church regularly attain a higher educational level than do children in families that attend church sporadically.

The relationship between the religious affiliation and the educational attainment of the children may be interpreted in a number of ways. The scale of religious affiliation may provide an indication of the ability of the parents to afford an education for their children; the scale may also measure the degree to which a particular reference group provides a standard of educational attainment which guides the parent in educating his children. Alternatively the scale may discriminate between different emphases on education among the three major categories. Without further evidence, which is not available in this body of survey data, we cannot say more about the validity of these interpretations.

TABLE 12.—Average grades of completed education of children by religious preference and church attendance of the spending unit head; deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

Religious preference and church attendance of spending unit head	Number of cases	Unadjusted deviations [1]	Adjusted deviations [2]
Family unit heads of Catholic preference, who attend church:			
2–3 times a month or more	122	0.22	0.08
Once a month or less	80	−.38	−.13
Family unit heads of Protestant preference:			
Fundamentalist Protestants [3] who attend church:			
2–3 times a month or more	211	−.55	.07
Once a month or less	180	−1.31	−.55
Non-Fundamentalist Protestants who attend church: [3]			
2–3 times a month or more	165	.95	.24
Once a month or less	213	.33	.09
Other religious preferences reported	48	.65	−.05

[1] Deviations (in grades) from the grand mean of 11.82 grades.
[2] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.
[3] The division of religious sects of the Protestant faith was suggested by tables appearing in a study by Bernard Lazerwitz ("Some Factors Associated With Variations in Church Attendance," *Social Forces*, 39: 301–309, May 1961). Protestants were divided into two groups based on the average income and education of members of particular sects. This sociological distinction appears to correspond closely to doctrinal differences among Protestant groups as suggested by Lazerwitz.

AGE AT BIRTH OF FIRST CHILD

Age of the head of the family at the birth of his eldest living child was assumed as an indicator of the planning horizons of the family and also of its ability to finance the education of the children. Families who had children late would have opportunities to save and to earn income by having both the husband and the wife in the labor force, while the presence of a child born shortly after an early marriage tends at least temporarily to remove the wife as a source of family income, at the same time that it places a burden on the husband's income. Thus the variable employed in table 13 provides an index of both the planning horizons of the family and its ability to

accumulate assets for sending children to college. While the deviations shown in the table are not highly significant, they are sufficiently systematic to support the hypothesis that the earlier a couple starts a family the less likely it is that their children will have a college education.

TABLE 13.—Average grades of completed education of children by age of spending unit head at birth of first child; deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

Age of spending unit head at birth of 1st child	Number of cases	Unadjusted deviations [1]	Adjusted deviations [2]
No "own" children [3]	19	−0.39	−0.51
Under 18	42	−2.35	−.92
18–19	62	−1.12	−.41
20–24 [4]	344	−.26	−.01
25–29	259	.45	.13
30–39	188	.76	.15
40 and over	25	.14	.00

[1] Deviations (in grades) from the grand mean of 11.82 grades.
[2] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.
[3] Includes heads with adopted children and those whose responses were inconsistent.
[4] Includes spending unit heads whose age at birth of 1st child was not ascertained.

COLOR

Nonwhite children attained significantly less education than did white children.

The difference between the unadjusted deviation (–1.82) and the adjusted deviation (–0.52) for nonwhites implies that parents of nonwhite children are more likely to exhibit other characteristics associated with low educational attainment—for example, the parents are poorly educated and have low-paying occupations requiring little education. The adjusted deviations suggest racial differences in cultural values and in the availability of facilities, which account for more than half a grade of difference in educational attainments. The unadjusted deviations point out that the color differences produce a 2-year average difference in the completed education of children between white and nonwhite groups.

TABLE 14.—Average grades of completed education of children by color of spending unit head; deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

Color of spending unit head	Number of cases	Unadjusted deviations [1]	Adjusted deviations [2]
White	805	0.21	0.06
Nonwhite	134	−1.82	−.52

[1] Deviations (in grades) from the grand mean of 11.82 grades.
[2] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.

Though whites and nonwhites have substantially different aspirations for educating their boys, the difference is associated with differences in the education, income, and other characteristics of the two groups, as the adjusted deviations contribute nothing to an explanation of parents' aspirations. The two groups agree more closely in their expectations for educating girls. But when expectations are adjusted for education, income, and other differences, nonwhites have significantly higher aspirations for girls. This finding may reflect the more strongly matriarchal nature of Negro society.

It is worth noting that nonwhites *attained* significantly less education than whites, although aspirations for educating boys are identical and aspirations for educating girls are somewhat higher among nonwhite parents. The discrepancy between attainment and aspirations may stem from the fact that heads of spending units whose children have not yet finished school are younger than those whose children have completed their education. Thus our finding is probably a consequence of the improvement in the status and opportunities open to the nonwhite that has occurred in this last generation.

RURAL-URBAN MIGRATION

On the average, persons who live in an urban area obtain somewhat more education for their children than those who live in a small town or a rural area. The children of persons who migrated from farms to the city attained somewhat more education than children of those who never moved. Though these effects parallel the effects shown for moving between North and South, they are so small as to be relatively unimportant.

TABLE 15.—Average grades of completed education of children, by rural-urban migration of the spending unit head; deviations from the grand mean of 11.52 grades

[For spending unit heads whose children have finished school]

Rural-urban migration of spending unit head	Number of cases	Unadjusted deviations [1]	Adjusted deviations [2]
Head grew up on farm; now lives—			
In rural area	235	−0.97	−0.06
In town 2,500–49,999	111	−.77	−.13
In city 50,000 or more	65	.33	.27
Head grew up in town or city; now lives—			
In rural area	131	.26	−.04
In town or city	369	.55	.02
All others [3]	28	.04	.03

[1] Deviations (in grades) from the grand mean of 11.52 grades.
[2] Deviations (in grades) from the grand mean of 11.52 grades, with other factors controlled by multivariate adjustment.
[3] Includes persons who grew up in several places and persons for whom locality was not ascertained.

AGE OF SPENDING UNIT HEAD

Age of the spending unit head was included in the analysis on the assumption that older persons, who were educated in a period when educational standards were lower than at present, might have less motivation for educating their children than younger parents. This notion is refuted by table 16. Apparently motivation does not vary systematically with the age of the parent.[11]

SUMMARY OF FACTORS INFLUENCING EDUCATIONAL ATTAINMENT

Tables 4 through 16 confirm many of the hypotheses which were sketched in chart 1. The positive associations between children's education and education of the parents and the need-achievement index of parental values suggest strong underlying values stimulating educational achievements. Occupation, peak earnings, age at birth of first child, and number of children probably derive a portion of their impact on attained education from their relationships to lifetime earning patterns and the ability to pay for higher education.

TABLE 16.—Average grades of completed education of children, by age of the spending unit head; deviations from the grand mean of 11.82 grades

[For spending unit heads whose children have finished school]

Age of spending unit head	Number of cases	Unadjusted deviations [1]	Adjusted deviations [2]
30–39	30	−1.57	−0.11
40–49	186	−.61	−.19
50–64	457	.22	.05
65 or over	206	−.08	.05

[1] Deviations (in grades) from the grand mean of 11.82 grades.
[2] Deviations (in grades) from the grand mean of 11.82 grades, with other factors controlled by multivariate adjustment.

III. The Realism of Educational Aspirations

We know that almost every American expects his children to finish high school. This expectation appears to have become firmly established as a minimum standard, one which contrasts sharply with the fact that at the turn of the century only 7 percent of the children aged 14 to 17 were attending high school. As we have seen (table 3), however, more than half of the parents of girls and two-thirds of the parents of boys expect their children to go beyond high school. Our

[11] The small positive deviations shown for the older age groups follow from the fact that these are the groups which include most of the persons who had their children at a comparatively older age and whose children went to college. The younger groups, by definition, had their children early and did not send them to college. Thus, most of the effect shown for the unadjusted deviations is attributed to the age of the head at the birth of his first child.

study permits us to say a good deal about the characteristics of spending unit heads that will produce a high potential demand for higher education in the future. Increasing educational attainments of parents; increasing incomes; increasing proportions of the labor force in professional, managerial, and other white-collar occupations will lead to greater demand for higher education. This conclusion emerges quantitatively from several pieces of evidence.

We have already commented on the remarkable increase in educational attainments and the close relationship between parents' education and their children's academic training. Assuming that the step-up relationship will continue to hold for children born to the present generation, we can estimate than one-half of the next generation will have some college experience.[13]

TABLE 17.—Actual and projected education of children of spending unit heads under 35, according to education of the head and of head's father

Education of spending unit head	Education of head's father (percent)					Estimated education received by the children of spending unit heads under 35 [2]
	No high school [1]	Some high school	High-school graduate	Some college	Total [2]	
Total	100	100	100	100	100	100
No high school	21	5	2	1	14	8
Some high school	20	14	16	8	23	15
High-school graduate	31	46	32	22	32	32
Some college	19	34	50	69	30	45
Percent of all spending unit heads represented in the tabulation	18	3	4	3	28	

[1] Includes heads whose education was not ascertained.
[2] See 1960 census data on education of children in relation to fathers' attainment and projections based on these data in Louis H. Conger, Jr., ch. 1 of this volume.

This finding is quite consistent with the Office of Education's projection that roughly 44 percent of all persons between the ages of 18 and 21 will be in college by 1970.[13]

A quantitative estimate of completed education of children in the coming generation can be obtained from the multivariate analysis presented in tables 4 to 16.[14] For any one family we can estimate the

[13] The estimated distribution of education is obtained by multiplying the proportions in the "Some college" row of table 17 by the proportions in the total column of table 17 and adding the products; i.e., 19% × 14% + 34% × 23% + 50% × 32% + 69% × 30% = 45%. Estimates of the proportion who will be high-school graduates or high-school dropouts are obtained in the same fashion.

[13] As reported by Philip H. Coombs, "An Economist's Overview of Higher Education," in *Financing Higher Education: 1960–70*, Dexter M. Keezer, ed., New York, McGraw-Hill Book Co., 1960. p. 15.

[14] The estimates are based on the assumption that relationships developed from differences between individuals in a cross section reflect the true impact of individuation, rather than the peculiar impact of history on different persons in our sample. We know that in the population of persons who have children finished with school, there are some whose education was terminated by unusual events such as the depression of the 30's and

average completed education of their children by selecting the adjusted deviations appropriate to the particular characteristics of that family and adding them to the grand mean. To estimate the average completed education of children of a group of families, we must weight the average education obtained for each family by the number of children in the family. We have calculated such a sum of weighted averages for spending units with boys aged 20 and under. The average educational attainment projected is 12.1 grades. When this average is taken together with our projection of the distribution of education in the next generation, the result suggests that a large proportion of the students enrolling in colleges in coming years will not complete a full 4-year course.

Comparing projections of past experience with parents' expectations for their children, we see that rises in parents' aspirations are roughly consistent with the rate at which educational attainments have been increasing in this country in the past half century. Clearly parents' aspirations to send their children to college are a natural consequence of their own experience and the desire to provide just a little bit more education for their children.

World War II. If conditions and events differ markedly in the next 10 to 15 years from those in the immediate past, or if colleges and universities change their practices markedly, the amount of education completed by the children who are now in school may differ from that estimated here on the basis of a cross sectional analysis of educational attainment.

The estimates may be slightly high, as the families with boys under 20 years of age are somewhat more likely to have additional children than the group with children who have finished school. As estimates of average births per married woman obtained from the "number of children" variable used in the projection agree closely with Bureau of the Census estimates of the same statistic, the bias cannot be important.

CHAPTER 3

The Need for Professional Personnel

*Seymour L. Wolfbein**

THERE ARE three overriding forces operating in this country which work toward a continued, and even an accelerated, demand and need for professional personnel. They join, in the decade of the 1960's, to accelerate this demand and need.

GROWTH OF THE SERVICE-PRODUCING, WHITE-COLLAR SECTORS

The *first* is the continued, evolutionary, structural change, industrially and occupationally, that contributes to the growth of the service-producing, white-collar sectors of the economy.

As background, the long-range trend is summarized in table 1.

TABLE 1.—Occupational distribution of employed population, United States, 1910, 1960, and 1970

Type of occupation	Percent of employed population, by year		
	1910	1960	1970
TOTAL	100	100	100
WHITE COLLAR	23	42	45
Professional and technical	5	11	13
Proprietary and managerial	7	11	11
Clerical and sales	10	20	21
BLUE COLLAR	37	37	36
Skilled	12	13	13
Semiskilled	14	18	18
Unskilled	11	6	5
SERVICE	10	12	13
FARM	31	9	6

SOURCE: Bureau of Labor Statistics, U.S. Department of Labor.

The persistence of these job trends has been emphasized in recent years even with alternations in overall economic activity. Events during the most recent recession are an example of these trends. In March 1961 there were a million fewer factory workers on industrial

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payrolls than in March 1960. Yet *total* nonfarm employment actually rose by 800,000 between those dates. During that period, the number in each of the major groups of manual or blue-collar workers fell, but there was actually a million and a half employment increase among white-collar workers, about one-fourth of which was accounted for by the continued growth among professional and technical personnel over the year. In summary form table 2 shows what happened during this period.

TABLE 2.—Persons employed in nonfarm occupation groups, March 1960 and March 1961

[In millions]

Occupation group	March 1960	March 1961
TOTAL	60.0	60.8
WHITE COLLAR	26.2	26.7
Professional and technical	7.6	8.0
Managers, officials	7.0	7.3
Clerical, sales	12.7	14.4
MANUAL OR BLUE COLLAR	22.8	23.1
Craftsmen, foremen	8.3	8.7
Operatives	12.0	11.3
Laborers, except farm and mine	2.2	2.0
SERVICE	8.2	8.6
Domestic	2.1	2.4
Other	6.1	6.2

SOURCE: *Monthly Report on the Labor Force*, March 1961, U.S. Department of Labor, Washington, D.C. p. 8.

INCREASE IN DEMAND FOR PROFESSIONAL AND TECHNICAL PERSONNEL

Current projections suggest about a 40-percent increase in employment among professional and technical personnel during the 1960's—on top of a similar expansion in the 1950's. This expansion is by no means an unrelated factor in the subject we are exploring. The *second* factor, then, is the very substantial rise in professional and technical employment that occurred during the past decade and that will be followed by another significant upturn in the immediate years ahead. This emphasizes not only the continued strong demand for professional and technical workers but also some of the pressure points involved in meeting that demand.

In the face of these anticipated demands, the current decade will see an actual diminution in the number of persons in the working population who are in the prime working age group 35–44 years. Many of these persons were born in the low-birth-rate depression years of the 1930's, and we are about to experience the impact of the events of those years. We face an almost unprecedented kind of manpower

situation—enormous numbers of young workers, but an actual downturn in the number of workers in the age group 35 to 44. Thus the net labor force increase of 13.5 million during the 1960's will be distributed as follows:

Age group	*Percent*
14–24	47
25–34	13
35–44	−1
45–64	37
65 and over	4
Total	100

Since the smallest increases, and also, in fact, the decreases, are going to occur among workers in age groups that already have had some career development and experience—age groups from which we normally draw higher level professional personnel—the problem of meeting the overall demands in these fields is a difficult one.

ACCELERATION OF TECHNOLOGICAL CHANGE

The conjunction of an expected substantial increase in demand, with a rather unusual manpower situation on the supply side, is further marked by the anticipated accelerated developments in technological change during the 1960's.

Thus, our *third* factor ties the package together. The whole movement toward the white-collar, service-producing, professionally oriented structure in our economy is founded on the tremendous increases in productivity that have occurred in this country. Perhaps the best way of putting this is to say that the great productivity advances of the past have placed us in the position of *affording* to have the majority group in our working population engaged in service-producing activities rather than in goods-producing sectors. As we are the only country in the world in this position, there is nothing in the offing that points to anything but a continuation of demands for services which carry with them corresponding demands for professional personnel, accentuated by the many thresholds we apparently are scheduled to cross in the years immediately ahead.

We have entitled this brief summary statement "The Need for Professional Personnel." But we began, in our very first sentence, by talking about the "accelerating demand and need for professional personnel." Anyone using, in juxtaposition such as this, the terms "demand" and "need," makes overt his ambivalence, his hesitancy, his real doubts about the course of events in the immediate years ahead.

By "need" we really mean our aspirations—what we think ought to take place—in research and development, health services, teaching, architecture, and so forth.

By "demand" we really try to convey, as best we can, our realistic appraisal of what will actually occur, of how the needs will be tempered by forces such as availability of funds, our actual manpower situation, and our ability to utilize personnel effectively.

Obviously there are innumerable (and different) assessments of "needs" for professional personnel. Just as each individual has a standard of living to which he aspires and which he views in relation to his actual level of living, so, too, are there individual and group differences in the matter of needs and demands for professional and technical personnel.

It is a striking hallmark of our times that while there are differences of the sort we have just described, as well as differences in how, and in what mechanisms should be used, to bring demands and needs together—there is a significant amount of accord on the proposition that we have a long way to go to fulfill the *needs* of our current and projected population for the services of professional and technical personnel. Perhaps this is another way of saying that the aspirations, the expectations, of our society today are high indeed.

In the two following chapters an attempt is made, in a quantitative and qualitative way, to underscore the needs and demands for selected "professional personnel," "higher level personnel," "brainpower," and so forth.

It seems to us that the twin keys to discovering what we are after can be described briefly as follows:

The first is the overriding factor of change, whether it be in factory-systems management, weaponry and space research, medical diagnostics, economic and statistical computations, or teaching techniques. In these fields theory and practice have been subject to radical and frequent changes and will surely continue to be.

Under these circumstances, whether one talks of demands or needs, the critical factor is the great necessity for more and more professional personnel who are endowed with the maneuverability, the flexibility, the adaptability to respond with creativity to the changes to which we have just referred. This is the second key.

These two keys will open the door to an educational policy directed to flexibility in training professional and technical personnel, and to a labor-management policy directed to efficient utilization of such manpower. These policies, in combination, will enable us to match "demands" and "needs" for such personnel.

CHAPTER 4

Health Manpower: An Illustration

*William H. Stewart, M.D.**

AMONG THE MOST IMPORTANT educational needs is the need for preparing workers in the field of health.

Early in World War II it became apparent that military demands for physicians, dentists, and nurses posed a serious threat to the health of the civilian population. So serious, indeed, that several remarkable educational innovations came about. Medical and dental schools accelerated their programs, so that the school year was shortened to 9 months, and five classes were graduated in the 4 years 1942–45. At the same time substantial Federal funds were invested in the cadet nurse program, which with scholarships increased enrollments so that the number of nurses graduated rose from 27,000 in 1943 to 41,000 in 1947.

By the war's end, most people apparently assumed that demobilization would provide the civilian population with enough health workers and the emergency programs were abandoned.

To the more critical, however, it was apparent that the problem was not to be so easily solved. Increasing population and increasing use of health services pointed even then to the need for expansion of training opportunities. A series of studies, including those of the National Security Resources Board in 1951,[1] and the President's Commission on Health Needs of the Nation in 1952 [2] pointed to a coming emergency.

The Nation's increasing need for health manpower is related to three major phenomena: growth of the population and change in its age distribution, increasing use of medical and hospital services, and changing patterns of medical practice and specialization.

It is expected that the population of the United States will exceed

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[1] Rusk, Howard A., Medicine, Mobilization and Manpower, in *Medical Education in the United States and Canada*, 1950–51, pt. II, Proceedings of the 47th Annual Congress on Medical Education and Licensure. Reprinted from *Journal of the American Medical Association*, 147 : 131–169, Sept. 8, 1951.

[2] U.S., The President's Commission on the Health Needs of the Nation, *Building America's Health:* vol. 1, *Findings and Recommendations*, 1952 ; vol. 2, *America's Health Status, Needs and Resources*, 1953. Washington, D.C.

235 million by 1975—an increase of 55 million over the 1960 population. The number of persons under 15 is expected to increase by almost 20 million; the number over 65 by 6 million.

The National Health Survey has found that people aged 65 and over have more than twice as much illness and disability as those under 65. The also have more physician visits and more hospital care. Young children, too, receive more medical care than do adults in general.

Thirty years ago the average person saw a doctor two or three times a year; now the annual average is five visits. Since 1940 the rate of admissions to general hospitals has increased from 74 per 1,000 persons per year to 134 per 1,000. There is every indication that the factors that are bringing about the wider use of medical services, including improved economic and educational status, increasing urbanization, and extension of hospital and medical care insurance, will continue to increase the demand for medical services.

Changing patterns of medical practice will be discussed later in this chapter.

PHYSICIANS

In the United States today there are approximately 260,000 physicians. The ratio of physicians to population has risen only slightly since 1930 (table 1). We now have 7,500 graduates a year, a number that is not adequate to maintain the present physician-population ratio during the next 15 years.

TABLE 1.—Supply of physicians (doctors of medicine and doctors of osteopathy) in relation to population of the United States: selected years, 1930–61 [1, 2]

Year	Number of—	
	Physicians, M.D.	Physicians, D.O.
1930	154,600	10,300
1940	175,168	12,400
1949	201,277	12,700
1960	236,089	14,100
1961 (estimated)	246,000	14,200
	Rate per 100,000 population—	
1930	125	8
1940	133	9
1949	135	9
1960	133	8
1961 (estimated)	134	8

[1] U.S. Department of Health, Education, and Welfare, Public Health Service, *Health Manpower Source Book* [published in a number of sections]. Sec. 9, Physicians, Dentists, and Professional Nurses, 1960; Sec. 10, Physicians' Age, Type of Practice, and Location, 1960; PHS Pub. No. 268, Washington, D.C.; also unpublished estimates by the Public Health Service.

[2] U.S. Department of Health, Education, and Welfare, Public Health Service, Report of the Surgeon General's Consultant Group on Medical Education, *Physicians for a Growing America*, PHS Pub. No. 709, Washington, D.C., 1959.

There has been considerable discussion of the question of the present and future adequacy of supply. It has been maintained, for example, that better organization of services will make for more efficient use of the physician's time, that more hospitalization and less home visiting enable the doctor to see more patients in a day or a week.

These statements are indeed true. But in general appraisal of the picture, two major problems are often overlooked. First, the physician's workweek now averages 60 hours, with a general complaint from patients: "Doctors are too busy . . . we'd like to talk more, to tell them more; we'd like them to explain more; to listen more." [2] And, secondly, with more and more specialists, relatively fewer physicians are in private practice, especially in general practice.

A major change in medical service has been the increased employment of physicians in hospital service, teaching, research, industry, administration, and other types of institutional practice. Since 1931, while the population has increased by about two-fifths, the number of physicians in these types of service has more than tripled (table 2).

TABLE 2.—Change in type of practice of physicians (M.D.) and in total population of the United States: 1931 and 1959 [1]

	Number		Percentage increase
	1931	1959	
Total population	124,149,000	176,912,000	42
Physicians:			
Total	156,406	236,089	51
In private practice	134,274	160,592	20
In hospital service, teaching or administration	12,600	47,661	278
In Federal Government service	3,551	17,519	393
Not in practice	5,981	10,317	72

[1] U.S. Department of Health, Education, and Welfare, Public Health Service. *Health Manpower Source Book* [published in a number of sections]. Sec. 10, Physicians' Age, Type of Practice, and Location, PHS Pub. No. 263, Washington, D.C., 1960.

Changes in patterns of service.—For personal health services, the civilian population of the United States now has a physician-population ratio of about 100 per 100,000 population. Is this enough, too little, or too much? The best yardstick we have is the experience of medical groups that offer comprehensive care on a prepaid basis. These groups, which attempt to meet the health needs of the members and which have the advantages of organization and auxiliary help to make the best use of the physician's time, now utilize the services of from 1 to 1.25 physicians per 1,000 persons.

These groups do not provide care to patients with long-term mental illness, and they have a lower-than-average proportion of persons

[2] Mayes, Herbert R. "What does the doctor do? Much. What does the patient want? More." *Journal of the American Medical Association*, 167: 1864–1867, July 12, 1958.

past 65 years of age among their members. The experience of these groups strongly suggests that we do not have enough physicians in private practice to provide adequate services to the entire population.

Other needs are apparent. In the past year particularly there has been much concern over hospitals' unmet needs for interns and residents, who combine obtaining educational experience with providing substantial amounts of medical service. Even the present use of some 9,500 graduates of foreign medical schools in our hospitals has failed to meet this considerable need.

Mental hospitals are notoriously understaffed—their present need is for more than 3,000 physicians.

It is estimated that over 25,000 physicians are spending all or part of their time in teaching or research. There are increasing demands for physicians to serve on medical school faculties, and the need for physicians for medical research is a critical factor in the growth of such research.

Health departments and other health agencies are seriously handicapped by their inability to secure needed physicians for their staffs.

All of these findings taken together suggest that the present ratio of physicians to population is less than adequate. And yet the present outlook is not for an improvement but for a worsening of this picture.

To maintain merely the present ratio of physicians to population would require 335,000 physicians in 1975—11,000 more than we expect to have. To reach the level of 335,000 we must by 1975 increase the number of our medical school graduates to 11,000—3,500 a year more than the present number.

Medical school facilities.—There are 86 medical schools in the United States. Of this number, 83 offer the full 4-year program; 3 are schools of the basic medical sciences, offering only the first 2 years of medical education. Most medical schools are fairly small; the average number of graduates is 100 a year, with a range of from 50 to 175.

The 6 schools of osteopathy graduate an average of 75 students a year.

To secure the capacity to allow an additional 3,500 graduations a year will require both expansion of existing schools and creation of new ones. The best judgment today seems to be that present schools might handle another 1,000 students per class, but that another 20 to 24 schools must be established.

This is a task of great magnitude. Medical schools require both a substantial physical plant and a substantial operating budget. A school with 100 students per class, with a typical program and an average-sized research program, requires a basic science building which will cost not less than $5 million, and probably considerably more.

It must have a teaching hospital of 400 to 500 beds. If it builds its own hospital (and most schools find this necessary), there will be a capital outlay of $10 to $15 million.

Operating budgets average about $2 million, with tuition providing only 17 percent of the income of private medical schools and 9 percent of the income of public ones.

Expanding the Nation's capacity for providing medical education is a slow process. After the initial steps in establishing a medical school have been taken, the graduation of the first class of students requires a minimum of 8–10 years. For this reason, long-range planning is an overriding necessity.

Length of medical school training.—The medical school curriculum requires continual reevaluation. Not only must it encompass the growing body of knowledge concerning diagnosis and treatment, but it must also give more emphasis to the preventive and rehabilitative sectors of modern medicine and to the preparation of the student for practice as a member of a health team in the community. Such demands on a curriculum that already requires a length of time greater than that of any other profession will necessitate inspired approaches to medical teaching.

Almost every student enters medical school with a bachelor's degree. After 4 years of medical school he enters a hospital for a 1-year internship and usually remains another 2 or 3 years for residency training in a specialty field.

Serious attention is now being given to the possibility of shortening this period of training and of bringing the study of the humanities and of science into some better relationship. Several schools are experimenting with some combination of the last year or two of the undergraduate program with the first 2 years of medical school.

Others are looking at the relation between the last 2 years of medical school and the hospital internship and residency in an attempt to make the clinical experience both shorter and more meaningful.

And perhaps more important is the growing realization that most medical education is not directed at the basic and growing need for more family physicians—for the practitioner who does not only consider a disease entity, but is able to serve the patient as a person. Programs training physicians to attain such broad competence are rare today, and nothing is more sorely needed.

DENTISTS

Though the supply of physicians has just kept up with the population growth, the supply of dentists has shown a relative decrease. Between 1930 and 1960 the number of dentists per 100,000 population (including the Armed Forces) dropped from 59 to 56 (table 3).

TABLE 3.—Number of dentists in the United States in relation to population, selected years, 1930–60 [1]

Year	Number of dentists in the United States	Number of dentists per 100,000 population
1930	73,108	59
1940	81,686	62
1950	85,676	57
1960 (estimated)	100,000	56

[1] U.S. Department of Health, Education, and Welfare, Public Health Service. *Health Manpower Source Book* [published in a number of sections]. Sec. 9, Physicians, Dentists, and Professional Nurses, 1959; Sec. 10, Physicians' Age, Type of Practice, and Location, 1960; PHS Pub. No. 263, Washington, D.C.; also unpublished estimates by the Public Health Service.

At current training rates, the number of dentists as projected will rise from 100,000 in 1960, to 118,000 in 1975—only 50 per 100,000 persons.

Many of the same factors pressing the demands for medical care are evident with respect to dental service. These include rising standards of living, greater sophistication as to the value of health services, experimentation with prepaid dental service. There is urgent demand for dental school faculty and for research workers.

Again using the maintenance of present population ratios as a minimum goal for 1975, we find a need for increasing the graduation rate of dentists from 3,200 to 6,200 a year.

Dental school facilities.—There are 47 dental schools in the United States. All of these offer a full 4-year program. Even if present schools substantially increase enrollment, another 20 dental schools are needed if we are to secure the needed 3,000 additional graduates a year.

NURSES

While the number of graduate nurses has steadily increased both absolutely and relative to population, there seems to be no diminution in the demand for more nurses. With 500,000 nurses working today, hospitals now have an estimated 20,000 vacant positions. In many nursing schools, teachers are needed. Public health nurses cannot be found to fill many existing community positions. In recent years the number of nurses graduated each year has stood at about 30,000—a number equal to about 4 percent of the 17-year-old girls in the population (table 4).

In recent years two significant changes have taken place in nursing education. First is the substantial increase in graduates receiving the bachelor's degree, more and more considered to be a requisite for supervisory and teaching positions. The other is the great increase in the training of practical or vocational nurses, much of it as part

of the State vocational education programs, which receive substantial Federal support through the U.S. Office of Education. These 1-year programs are making a major contribution to meeting nursing needs. Their rapid and continuing growth stands in marked contrast to the training picture for most types of health workers.

TABLE 4.—Number of nursing-school graduates, 1952 and 1958

Type of course	1952	1958
Graduate nurses	29,016	30,410
Baccalaureate or master's degree	1,998	3,671
Diploma—3-year course	26,720	26,314
Associate degree—2-year course	298	425
Practical or vocational nurses—usually 1-year course	6,000	12,407

SOURCE: U.S. Department of Health, Education, and Welfare, Public Health Service, Division of Nursing, Facts About Nursing, unpublished data.

But even these expanded training programs have not met existing needs. With the expectation of considerable increase in the number and use of hospital beds, with the sharp rise in the number of nursing homes, and with new emphasis on home nursing care for the chronically ill, there is every indication that we must continue to expand our capacity for the education and training of nursing personnel.

STEPS TO MEET NEEDS

To provide even for maintaining present levels of supply of health manpower in relation to population over the next 10 or 15 years will require vigorous action by the educational institutions concerned, by State and regional authorities, by voluntary groups, by the Federal Government, and by others.

At the institutional level, steps are being taken to expand existing medical schools and to establish new ones. Since 1950 seven new 4-year medical schools have been established. If the goal of the Surgeon General's Consultant Group on Medical Education—20 new medical schools by 1970—is to be reached, however, the rate of establishment over the next decade must be three times as great as it was during the previous one.

There has recently been extensive experimentation with the medical curriculum at such universities as Western Reserve, Johns Hopkins, Cornell, Stanford, Boston, Northwestern, and Wayne. Comprehensive family-care clinics, interdisciplinary approaches to teaching, integration of basic medical science courses with college premedical courses—these are some of the new developments in the medical education curriculum.

An important trend in the organization of medical education is the increasing development of the medical center. A medical center

is an integrated administrative complex within a university, optimally including a medical school, affiliated hospitals, and associated health education and health service programs of the community. The medical center can train physicians, dentists, nurses, public health specialists, and ancillary medical personnel with more efficiency than can its components working separately.

State action.—On the local, State, and regional levels, steps taken to expand medical education include provision of financial help by the various levels of government. The report of the Surgeon General's Consultant Group cited the variation in State outlays for medical education and showed that these outlays are not uniformly related to the fiscal capacity of the States.[4] The distribution of States by support in relation to personal income in 1957–58 was as follows:

Estimated amount of State and local governmental support of medical education per $1,000 personal income	*Number of States*
Total reporting	48
40 cents or more	8
25–39 cents	11
1–25 cents	20
None	9

Another contribution that is being made on the State and regional level is planning. Regional groups such as the Southern Regional Education Board, the Western Interstate Commission on Higher Education, and the New England Board of Higher Education have undertaken broad evaluations of training capacity in terms of the total health manpower needs of a region. These agencies have recommended establishment of needed schools and suggested general geographic locations for them. They have also served as channels for the interstate flow of funds for the support of medical education.

Voluntary support.—Support from voluntary sources has been substantial. In 1957–58 the American Medical Education Foundation for the National Fund Medical Education, the Commonwealth Fund, the Ford Foundation, and various other organizations, as well as individuals, contributed an estimated $33 million to medical schools in gifts, grants, and endowments. But contributions from nongovernmental sources, even if greatly increased, will not sufficiently finance the needed expansion of medical education.

Increasing the supply of medical and dental students.—If the capacity of medical and dental schools is to be expanded, will there be enough qualified applicants to fill the places? Many schools are reporting that they are hard pressed to find enough acceptable students

[4] U.S. Department of Health, Education, and Welfare, Public Health Service, Report of the Surgeon General's Consultant Group on Medical Education, *Physicians for a Growing America*, PHS Pub. No. 709, Washington, D.C., 1959.

today. That the average quality of medical school students has declined is suggested by the fact that the percentage of first-year students failing or withdrawing in academic difficulty is almost half again as high now as it was in the early 1950's.[5]

Medicine and dentistry are professions that offer substantial prestige and a high-income level. But they have become professions which few persons can afford to enter unless they come from families with relatively high incomes, or have wives who can work to provide substantial financial assistance. Forty percent of medical students come from families with annual incomes that exceed $10,000. Even with their parents' support and their wives' incomes, 40 percent of married medical students owe over $5,000 at graduation and 17 percent, over $10,000.[6]

After he finishes his undergraduate education, the medical or dental student looks forward to another 4 years, which will cost on the average more than $10,000. And for the medical student there will be an additional 3 or 4 years of hospital training in which his income will be less than his expenditures.

Although substantial fellowships amounting to $2,000 a year or more are available to many graduate students in other fields of biological and physical science, little such aid is available to medical and dental students. In the last 10 years the number of Ph. D.'s in the physical and biological sciences, in which scholarship aid has been more plentiful, has increased at a much faster rater than has the number of medical graduates. (See chart.) It is apparent that such aid is essential if medicine and dentistry are to secure the needed recruits.

Federal aid.—On the Federal level several agencies now provide educational and training opportunities for health manpower. The Public Health Service, the Office of Education, the Office of Vocational Rehabilitation, and the Armed Forces have programs through which many students are educated at some stage of their health service careers. The National Defense Education Act student loan program provides much-needed financial assistance to many students.

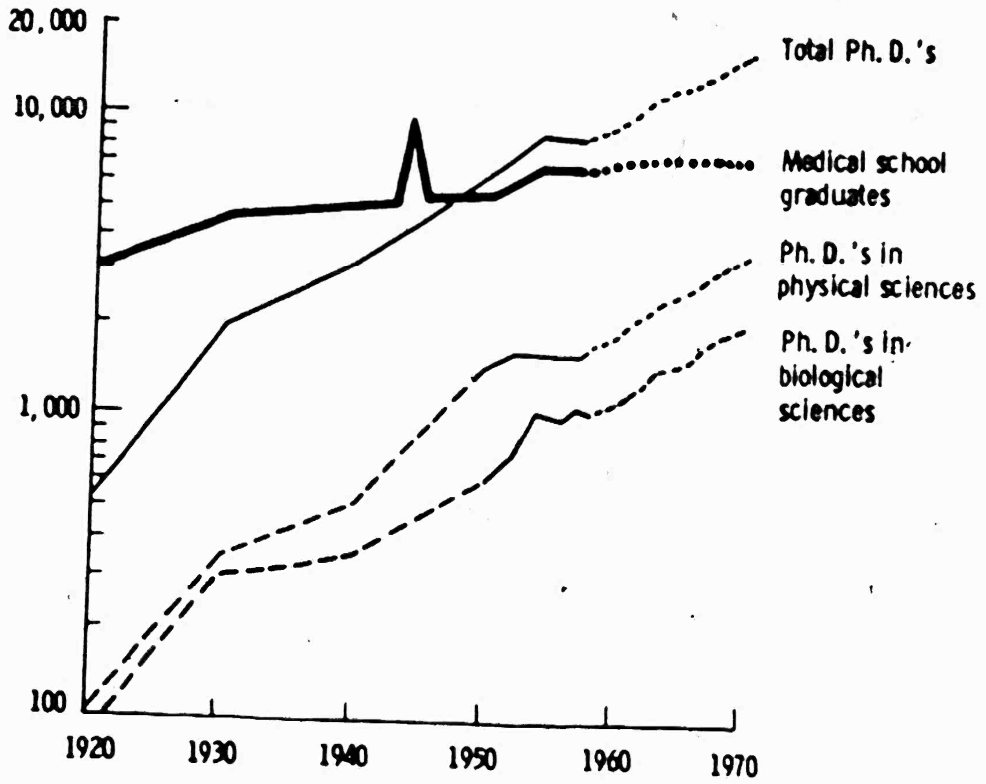
To increase the output of physicians and dentists, additional Federal aid has been recommended for the construction of medical and dental education facilities, and for scholarships to medical and dental students. Federal aid may be necessary also for expansion of educational opportunities in other health occupations.

Legislative proposals now before the Congress would provide matching funds for (1) the construction and expansion of facilities

[5] Ibid.

[6] Association of American Medical Colleges, study of financial problems of medical students, May 1959. Unpublished.

MEDICAL GRADUATES AND PH D.'s: 1920–58 AND ESTIMATES TO 1970[1]



Note: Plotted on logarithmic scale to show rate of growth.

for schools of medicine, osteopathy, public health, and dentistry; (2) scholarship aid for students in schools of medicine, osteopathy, and dentistry; and (3) limited educational grants to the schools.

No comprehensive study has been made of needs for Federal assistance for the training of graduate nurses. In May 1961 the Surgeon General appointed a consultant group, similar to that on medical education, to advise him of needs in this area.

For practical nursing, a very effective program of Federal aid is now in operation. Federal funds for this program amount to $5 million a year.

SUMMARY

The national need for an increased production of health personnel, particularly in the key professions of medicine, dentistry, and nursing, is being increasingly recognized.

Today a great deal of attention is being given to exploring ways to meet the need, including planning for new and expanded schools

[1] From *Physicians for a Growing America*. U.S. Department of Health, Education, and Welfare, Public Health Service Report of the Surgeon General's Consultant Group on Medical Education, PHS Pub. No. 709, Washington, D.C., October 1959. p. 17.

in the health fields, for curriculum experimentation, for student recruitment, and for both private and public financial assistance to the schools.

Two of the major problems faced by the universities that are considering expanding or establishing schools of medicine and dentistry are: (1) meeting the great cost of providing the requisite facilities, and (2) attracting enough well-qualified students. Legislative proposals before the current Congress aim to solve these problems. Such legislation would do much to stimulate and assist educational institutions in their efforts to respond to the Nation's need.

CHAPTER 5

National Requirements for Scientists and Engineers: A Second Illustration

*Thomas J. Mills**

OUR DEFINITIONS of the professions of scientist and engineer are not precise. Frequently we find the scientist engaged in the applied work one traditionally associates with the engineer. Conversely, growing numbers of engineers are found in scientific research laboratories where their skills are in demand both for science applications and for basic research in many scientific fields. More complexity and further definitional problems are added when one attempts to trace growth over time.

Rather than attempt to refine our definitions so that they might become more precise instruments (comparable data would not be available in any event), it is convenient to consider these professions as consisting of rather broad spectra. The profession of scientist is broadly concerned with the further development and extension of the subject matter of science. The engineer is more likely to be engaged in the application of known scientific principles to practical economic problems. In each profession will be found some persons who in terms of training, interests, and kind of work performed are closer to persons in the other profession than to those in their own. All of this is to say that the professions are closely akin, and satisfactory criteria for classification are few. At the fringes of these groups are technicians in science and engineering, whose knowledge of scientific principles is generally more limited.

GROWTH OF THE SCIENTIFIC AND ENGINEERING PROFESSIONS

Bearing in mind that precise definitions of "scientist" and "engineer" are not available, I am presenting here estimates of the general magnitude of growth in the United States of the professions of scientist and engineer.

*Program Director for Scientific Manpower, National Science Foundation.

TABLE 1.—Number of scientists and engineers, United States, 1900–59

(In thousands)

Year	Total	Scientists [1]	Engineers [1]
1900	45	4	41
1910	68	8	60
1920	149	19	130
1930	281	66	215
1940	378	92	286
1950	734	200	534
1959	1,110	310	800

[1] These estimates are developed from several sources, including the "Steelman Report," *Manpower for Research*, vol 4 of *Science and Public Policy*, by John R. Steelman, Washington, Government Printing Office, 1947, and the American Council on Education report, *The Production of Doctorates in the Sciences: 1936–1948*, Washington, 1951.

[2] Data for 1900–60 from the Bureau of the Census, *Decennial Census of Population*, data for 1959 from the National Science Foundation.

From these data it will be seen that from 1900 to 1959 the number of scientists is estimated to have increased 75 times, and the number of engineers 20 times. For scientists, this is equivalent to an increase of more than 7 percent compounded annually since 1900; for engineers, an increase of more than 6 percent. During that period the number of all professional, technical, and kindred workers increased about six times, while the total population of the United States was increasing less than 2.5 times. As tenuous as our statistical data are, especially for the earlier years, the conclusion seems clear. The rates of growth of these professions are so large that even a very considerable margin of error would have little effect on the relative picture.

WORK ACTIVITIES OF SCIENTISTS AND ENGINEERS

It is well known that scientists are principally engaged in research and development, production operations, or college and university teaching. Relatively smaller numbers are employed as managers, writers, and consultants. Engineers are most likely to be employed in production operations, although large numbers are engaged in research and development and in management. Table 2 shows estimated percentage distributions of scientists and engineers by type of work.

TABLE 2.—Work activities of scientists and engineers in the United States, 1960, percentage distribution, by type of work

Type of occupation	Percentage distribution of—	
	Scientists	Engineers
Total	100	100
Production	23	40
Research and development	43	30
Teaching	20	2
Management and administration	5	8
All other	9	20

SOURCE: National Science Foundation estimates, developed from numerous Foundation-sponsored surveys of industry, colleges and universities, and Government, and from the Foundation's National Register of Scientific and Technical Personnel.

EMPLOYMENT PATTERNS OF SCIENTISTS AND ENGINEERS

The types of employers of scientists and engineers reflect the locations in which their work is done. With the growing emphasis on research and development in industry, business establishments now employ more scientists than do either governmental or educational institutions. The greatest number of engineers have traditionally worked in private industry. In 1960, 83 percent worked in industry. Educational institutions, principally colleges and universities, are the second largest employers of scientists, and Government is next. This relationship is reversed for engineers, who are employed in larger numbers by the several levels of Government than by educational institutions. Only 2 percent of engineers are employed in educational institutions.

Estimated percentage distribution of scientists and engineers, by type of employer, appear in table 3. *Percentages given are approximate only and should not be considered precise values.*

TABLE 3.—Employment of scientists and engineers in the United States, 1960, percentage distribution by type of employer

Type of employer	Percentage distribution of—	
	Scientists	Engineers
Total	100	100
Industry	50	83
Educational institutions	25	2
Government	20	14
All other	5	1

SOURCE: National Science Foundation estimates, developed from numerous Foundation-sponsored surveys of industry, colleges and universities, and Government, and from the Foundation's National Register of Scientific and Technical Personnel.

FORMAL EDUCATION OF SCIENTISTS AND ENGINEERS

As is true of other professions, formal higher education constitutes the main part of the preparation of scientists and engineers. There are still considerable numbers in these professions without the conventional baccalaureate—particularly in engineering—but these are becoming the exception. To a large extent these numbers may reflect the fuzziness of the definitions of scientist and engineer rather than constituting a subgroup of these professions. It is agreed in any event that professional workers without any formal higher education in these fields are relatively few and the number will grow progressively smaller as higher levels of training are sought and demanded for professional recognition.

Graduate study is increasingly required in these professions. Per-

sons with graduate degrees in science, which are traditionally associated with college and university teaching, are found in increasing numbers in industry and Government. In some fields of science a doctorate is becoming a requirement for full professional recognition. Data reported to the National Register of Scientific and Technical Personnel show that about 40 percent of the scientists registered in it hold a doctorate, and another 25 percent a master's degree. Scientists included in the Register are, however, more likely to be engaged in research or college teaching, fields traditionally associated with graduate degrees.

The baccalaureate is more likely to represent the highest degree held by engineers than it is by scientists. But in engineering too, more emphasis is being placed on graduate study. More graduate students are now enrolled in engineering than in any of the basic science fields, and the number of doctorates conferred each year in engineering is now exceeded among the science fields only by the number conferred in chemistry. At the present time probably no more than 1 to 2 percent of the engineers hold doctorates; another 7 percent or more have a master's degree. For about 67 percent of the engineers the baccalaureate is the highest degree held.

Table 4 gives estimated percentage distribution of the highest degrees held by scientists and by engineers. Each level is a broad spectrum that includes not only scientists and engineers who have completed the minimum qualifications for that level but also those who have progressed almost to the next level. It is noteworthy that more than two-thirds of the engineers without degrees are estimated to have completed 1 to 3 years of college.

TABLE 4.—Education of scientists and engineers in the United States, 1960, percentage distribution by highest degree held

Highest degree held	*Percentage distribution of—*	
	Scientists	*Engineers*
Total	100	100
Doctorate	25	1
Master's degree	35	7
Baccalaureate	35	67
No degree	5	25

Source: National Science Foundation estimates, developed from numerous Foundation-sponsored surveys of industry, colleges and universities, and Government, and from the Foundation's National Register of Scientific and Technical Personnel.

FUTURE DEMAND FOR SCIENTISTS AND ENGINEERS

Estimating future demand for any occupation with an acceptable amount of precision is far from an exact science. Various methods have been developed to project future demand (or need) for pro-

fessionally trained manpower in order to arrive at the kinds of data required to establish sound personnel policies and reach necessary decisions on educational facilities. Among these methods are the following:

Projection of occupation—population ratios.—For some occupations demand estimates are prepared by assuming a desirable ratio between the number of persons in a profession and in the total population. The ratio may be such as to maintain the current relationship. Or the ratio may be arbitrarily placed above or below these current ratios, after account is taken of developments in the utilization of and the need for these professional services. Given the population projection and the ratio, the occupational estimate is readily derived.

Summation of job opportunities.—Sometimes estimates are made of the demand for workers by summing up information solicited from large employing groups reporting present job opportunities—those filled as well as those unfilled—and employer expectations regarding opportunities for employment in a period ahead. The effect of this method is to diffuse the responsibility for an estimate among employers, who are believed to have information on which to base a valid judgment. To provide a reasonable guide to estimation, the definitions of job opportunities need to be carefully standardized and consistent assumptions followed.

Projection of occupational trends.—The historical growth rates associated with an occupational category are sometimes projected on the assumption that the underlying economic and social factors responsible for the observed historical trend will operate more or less in the same way in future years.

Projection of occupational developments and economic growth.—A number of estimates of future requirements have been made that establish with few or many variables the complex relationships that existed in the past between the occupation and other economic or social phenomena. One fairly simple relationship often applied is that between growth trends in an occupational category and changes in the gross national product. An industry-by-industry examination of the numbers required in an occupational category for a given change in value of production is illustrative of a more complex method of projection.

Projection of needs based on criteria of desirable levels of professional services.—Estimates of needs for professional services and of manpower to provide these services have at times been formulated. These estimates do not attempt to define the magnitude of the market demand for an occupational group, or of employment prospects directly; rather they set out to define what the number of persons in an occupation "ought" to be in order to meet certain desired objec-

tives, as, for example, in scientific research, faculty staffing, or direct provision of professional services to individuals and to industry.

Analysis of the demand.—Although we are a long way from the development of adequate tools for accurate projection of market demand for persons with specific types of professional education at current or even projected salary levels, historical relationships between output and occupational demand can be used to yield an approximation of such demands. Moreover, detailed analysis of labor market requirements helps to demonstrate the nature of problems emerging even if it does not yield a precise set of numbers of persons required in each occupational category. For one thing, such analysis serves to emphasize, at least in the case of scientists and engineers, the importance of the Federal Government in the demand-supply equation. Currently the Federal Government provides about 60 percent of the more than $13 billion expended each year on scientific research and development, one of the principal activities in which scientists and engineers are engaged. Additional scientists and engineers in large numbers are employed in the production of military hardware items or in the administration of Federal science programs. Federal activities thus account either directly or indirectly for a large, although unknown, proportion of the employment of all scientists and engineers.

The Federal Government plays a far less important role in the training of scientists and engineers. Although there is little Federal financial support of elementary and secondary school education, the Federal Government indirectly is a strong influence for science education. At the college and university level, increasing amounts of Federal funds are providing support for students, faculty, and facilities. Federal funds are especially important in the graduate schools, where large amounts are devoted to providing fellowships, research and instructional equipment, and research assistantships, principally in the science and engineering disciplines.

Whatever methods are used, projection of demand for scientists and engineers displays unique problems. These rapidly expanding professions are outgrowing many past relationships. Data permitting the measurement of these relationships are scanty and time series information is even more limited. Lack of precision in the occupational definitions again poses a problem. These limitations upon the estimating process are stated here not to discourage projection, but to suggest that any estimate derived should be regarded as a point within a range, rather than an exact statistic.

It has been shown earlier in this chapter that the number of scientists has been increasing by over 7 percent compounded annually since 1900, and the number of engineers by more than 6 percent. If these

rates continue through 1970, there will be an indicated requirement for about twice as many scientists and engineers as were employed in 1959. (This estimate assumes that the number employed in the past has been equivalent to the number required.)

Growth of demand at about this magnitude is indicated by a Bureau of Labor Statistics study prepared for the National Science Foundation, and published in 1961. This study, entitled "The Long-Range Demand for Scientific and Technical Personnel, a Methodological Study," extrapolated employment to 1970 on the basis of the past ratios of scientists and engineers to total employment, industry by industry. The findings were then reviewed and adjusted in the light of recent developments suggesting some modifications of patterns of employment. The final estimates show about a 90-percent increase in the number of scientists and engineers needed over 1959 levels, for a total of a little more than 2 million by 1970.

As crude as these projections may be, they appear reasonable. They are in line with trends over the past 60 years, when relatively little public attention was paid to science and engineering. Within the past decade science has generally been identified as important to economic growth and military security, and we may expect that this emphasis will continue for the next decade, in view of the state of the cold war. It may be persuasively argued that the projections are more likely to be low than high in the light of our national undertakings. For the purposes of this discussion we will use the Bureau of Labor Statistics estimates—550,000 scientists and 1,485,000 engineers—as an approximation of requirements by 1970.

IMPLICATIONS FOR HIGHER EDUCATION

Our national labor force contains no unutilized reservoir of trained manpower adequate to meet national requirements of the magnitude noted above. The requirements will have to be met through training large additional numbers. In view of the educational qualifications required for acceptance in these professional groups at present—college and often graduate education—the burden of training adequate numbers falls largely upon the Nation's colleges and universities. Thus, the need for scientists and engineers becomes translated into a requirement for the higher education necessary to produce them.

The colleges and universities at first glance would appear to be in a position to provide this training. Total enrollments in colleges and universities are expected to rise from 3.6 million in 1960 to perhaps 7.0 million by 1970.[1] For a somewhat smaller enrollment, the number of earned degrees in 1969–70 has been estimated to include a little

[1] See Louis H. Conger, Jr., ch. 1 of this publication.

over 700,000 bachelor and first professional degrees and about 18,000 doctorates.

A second look raises some doubts as to whether higher education will achieve this task. The overall estimate of expanded college enrollments represents actually the number of qualified students wishing to enroll, provided colleges can admit them. ("Qualified" is meant in the sense that this group represents students of approximately the same levels of ability as the students colleges have admitted in recent years.) In question is the ability of the colleges to absorb an average of 300,000 more undergraduates each year for 10 years—an annual increase of almost 10 percent of present enrollments. Will additional faculty and facilities be available to provide higher education to so many without sacrificing quality?

Even assuming that an enrollment of this magnitude can be accommodated, it is not certain that scientists and engineers will be produced in the volume required. A requirement of 1,485,000 engineers by 1970 implies an increase in engineering baccalaureates from the 38,000 engineering degrees granted in 1960 to an average of about 80,000 a year over the next 10 years, when both additional requirements and replacements for death and retirement are taken into account. The decline in freshman engineering enrollments since 1957 has already fixed the number of engineer baccalaureates at fewer than 40,000 per year through at least 1964. At this rate engineering baccalaureates will have to average more than 100,000 per year for the 6-year period 1965–70 to meet the estimated requirement. This seems impossible.

Even the assumption that a quarter of the new engineers will enter the profession without a degree does not make it a simple matter to meet the estimated requirements. Under this assumption more than 70,000 new baccalaureate engineers would be required on the average during the years 1965–70, in view of the smaller 1961–64 classes.

Requirements for scientists present a similar problem. The 550,000 scientists required by 1970 implies an annual average of more than 30,000 new scientists trained per year over the next 10 years when allowance is made for replacement of normal attrition. If no more than 25 percent of them are doctorate holders (the present percentage), doctorates in science should average about 7,500 granted per year over the next 10 years. Currently fewer than 6,000 doctorates a year are granted in all sciences and engineering combined. According to present trends, science doctorates conferred should reach about 10,000 per year by the end of the decade. It would appear that the present proportion of scientists with the doctorate can be maintained and might be increased slightly. A substantial enlargement of the proportion of scientists with doctorates does not appear likely, however.

MEETING THE REQUIREMENTS

Although analysis of the projected requirements, in engineering particularly, suggests that these requirements cannot be met by the output of higher education, the jobs will not remain vacant. The vacancies of one year cannot be realistically added to those of the next year to arrive at a cumulative number of vacancies. Personnel will be found to fill most of the positions; unfortunately, the workers will be less broadly trained than is desirable. (Some of them, of course, will be baccalaureates in fields other than that usually associated with their positions. For example, science baccalaureates will be found in engineering jobs.) Generally, the effect may well be to substitute more narrow, on-the-job oriented training for the broader education associated with institutions of higher education. The scope of this chapter does not extend to comparing the relative merits of the broad and the narrow systems, but for the training of professionals it is usually believed the systems should be complementary rather than competitive or exclusive.

Educators have set forth the dimensions of the problems facing higher education in future years. The tasks and the challenge are herculean. Additional resources are needed to expand college and university facilities and to recruit and retain the teaching staffs required under present standards. Even greater resources are required to elevate the quality of education so that the responsibilities of the colleges and universities for training scientists and engineers may be met.

To use most effectively and efficiently the resources that are allocated for higher education, there must be more widespread application of some of the methods that are now applied in only a limited or experimental way.

More nearly complete utilization of educational plant through lengthening both the school day and the school year gives promise of training larger numbers in a shorter time. Continued attention to techniques for selecting students and more attention to retaining them would be especially valuable if together they reduced the 40–50-percent rate of loss in undergraduate study. Utilization of faculty is a topic always approached with trepidation. Yet it is the single most important one from the standpoint of quality of training. The tools that extend faculty teaching skills, such as the various forms of visual aids; the recognition of instruction as the primary mission of higher education; and attention to teaching loads are among the areas where progress frequently can be made with limited resources. Finally a mechanism by which the student body can be apprised of the opportunities and challenges of the different professions would do much to bring the supply more nearly in line with prospective requirements.

Part II

HIGHER EDUCATION AS AN INVESTMENT IN PEOPLE

CHAPTER 6

Human Capital: Concepts and Measures

*Mary Jean Bowman**

I. Prefatory Remarks

THE PAST FEW YEARS have seen a rising interest in viewing education as an investment and in attempts to assess the role of education in economic productivity and economic growth. There are of course many approaches to this set of problems. One can look in detail at the particular kinds of education possessed by certain groups of people in order to ascertain how this education affects their subsequent productive roles, at the same time comparing these results with the associated costs. At the other extreme, one may take a global approach that attempts to assess the aggregative costs of education and the aggregative impacts of education on the economy. Aggregative analysis may be viewed as providing a picture of the wide setting within which the more detailed studies take their place. Between these extremes there are of course many possible variations, just as there are also variations within the detailed and the global approaches.

This chapter was written for professional economists, but it is nonetheless relevant for those who make educational policy. It is concerned with the theory and measurement of "human capital," which are basic to any attempt at assessment of aggregative aspects of investment in education. There are a number of different concepts of capital, and throughout this paper the importance of choosing concepts and measures appropriate to the particular problem is stressed. In most of the discussion "human capital" is defined as one or another variant of education "embodied" in the labor force.

Analysis of human-capital concepts and measures is necessary as a basis for proceeding to consideration of four important questions:

1. What have been the total human-capital inputs into the productive system, and how have these affected national outputs, that is, gross national product, over a period of time?

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2. How large a part of society's productive resources has been put into formation of human capital over the past, and how has this compared with what has gone into investment in physical capital?

3. What rates of return have been realized from investments in human capital (in college education, high-school education, and so forth)? For example, $12,000 invested in a college education will add some (empirically observed) amount to average earnings during a man's lifetime over and above what he would earn if he terminated his education with completion of high school. Taking into account the time pattern of these additions to his annual earnings, what rate of interest on the $12,000 investment is implied? The $12,000, merely assumed here, is the human-capital measure needed as the base to which the additions to the earnings stream are then related.

4. Looking ahead, how may past, present, and prospective aggregate investments in formation of human capital be expected to affect the stream of national product in the future? Putting this in another way, one asks first what is the productive potential embodied in the human-capital stock, how is this distributed among the various age cohorts, and how is it changing through time? How will these facts be reflected in the size of the contribution human capital will make to gross national product and in changes in the magnitude of that contribution over coming decades? Questions of this kind are especially important in situations that are rapidly changing. For example, the fact that a large percentage of the educated populations of newly developing countries are young makes a big difference. By contrast, a very different situation has arisen in Israel, where the new immigrants have educational backgrounds far inferior to those of earlier settlers and where the most highly educated people are disproportionately in the older age categories.

The concepts and measures of human capital that are appropriate in analyzing these various problems differ considerably. Two primary distinctions are important (variations of detail aside).

First and most important is the distinction between capital viewed as a *store* and capital as a current *input* into production. As a store, capital is something from which a stream of future yields can flow, and its value depends on both the size of this flow per year and the period over which the flow will persist. For example, a new college graduate with a prospective 45-year earning life ahead of him is more capital, as a store, than the 50-year-old college graduate whose future lifetime income will be less. On the other hand, looking at the education embodied in these men in terms of its contribution to production in 1961, that is, as a capital input, there is no such difference in their capital values. (For the moment, both the differences in the quality

of education received by the younger and the older man and the effects of longer experience on the earning power of the older man are ignored; such problems will be considered later.) The "effective current stock" concept introduced in this paper is a measure of capital as an input. Some such measure is the appropriate concept, and indeed the only appropriate concept, for analysis of the first of the four basic questions posed above. This is true whether physical or human capital is involved, even though empirical measures of physical as well as of human capital as inputs have heretofore been lacking. On the other hand, questions 2 and 3 call for a concept and measure of human capital as a *store*. Question 4 requires use of both a store and a projected input measure.

Second, there are the distinctions in methods of weighting. A year of elementary schooling is not economically the same as a year in college; adding these together to get an estimate of aggregate human capital requires some weighting system that will give greater importance to the college year than to the elementary-school year. But there are two quite different points of view from which the relative importance of the elementary-school year and the college year may be assessed. One of these is a comparison of their respective costs. The other is a comparison of their respective values in what they may contribute to the productive potential of the individual. In either case some unchanging system of weights is needed for most purposes. For example, costs as of a particular year or earning increments associated with education at a particular time (say 1950) may provide the weights. These are "base-year" weights. The distinction between base-year cost and base-year yield weightings is often an important one. Cost weighting focuses on the resources used in forming human capital and is clearly the appropriate type of human-capital concept for use in dealing with questions 2 and 3. On the other hand, weighting in terms of base-year yields attributes to each component in education an importance commensurate with its productivity potential as of the base year. (An educational administrator in my course in economics of education suggested that this might be called measurements in "ED's.") Both base-year cost and base-year yield weightings of capital as an input have a legitimate place in attacking question 1, but the use of the one or the other implies a difference in the nature of the question itself. A base-year yield weighting is appropriate to question 4, provided an assumption that this weighting will have continuing validity is legitimate. However, empirical estimations appropriate to question 4 involve problems of quite a different order from those that arise in connection with the first three questions, and adequate treatment would require another long paper.

II. The Treatment of Quantity and Quality in Measuring a "Unit" of Human Capital

An implicit elementary concept of human capital has long been at hand in economic writings, primarily in the context of analysis of economic growth. Subsistence-fund theories that regarded mass consumption as the fueling and maintenance of the human machine are clear examples.[1] However, until recently human capital has been measured only as an undifferentiated number of men. In fact, anything verging on explicit treatment of human beings as capital was for a long time in disrepute.[2]

Meanwhile, the basis has been laid for an explicit concept of human capital that attributes different quantities of this capital to individuals with different productive capacities. Attacking Marshall's narrower concept of capital, which excluded human capital by definition, Fisher presented an all-inclusive theoretical analysis in which capital was *any* stock, physical or human. Then came a host of studies of national income or product and physical capital formation, of productivity per worker or per man-hour, and of physical capital-output ratios. The inadequacy of physical capital and employment or man-hour series in explaining growth in the national income has directed attention increasingly to an undefined "third factor" that explains the rise in outputs relative to inputs. Recently there have been some attempts to give this third factor a more respectable status, whatever it may be called. The popular label seems to be *t*, interpreted as "technological change" in so broad a sense as to include the growth and spread of knowledge and know-how in the population by whatever processes.[3] In fact, *t* includes changes of all kinds in the capital stock embodied in men, physical and "mental," and also changes in the efficiency of physical capital and economic organization and structure.[4] Picking

[1] In this connection, see Mary Jean Bowman, The Consumer in the History of Economic Doctrine, *American Economic Review*, 41 : 1–18, May 1951.

[2] During the interwar decades there were sporadic treatments of the concept of human capital, but these were not integrated into any major stream of economic thought and were therefore relatively abortive. Examples are: J. R. Walsh, Capital Concept Applied to Man, *Quarterly Journal of Economics*, 49 : 255–285; February 1935; and Louis I. Dublin and Alfred J. Lotka, *The Money Value of a Man*, New York, Ronald Press, 1930.

[3] Examples are work by Aukrust and Bjerke in Norway and by Solow in the United States. See O. Aukrust and Juul Bjerke "Real Capital in Norway" in *Income and Wealth, Series VIII*, International Association for Research in Income and Wealth, London, Bowes & Bowes Publishers, 1959, p. 80; and Robert M. Solow, Technical Change and the Aggregate Production Function, *Review of Economics and Statistics*, 39 : 312–320, August 1957. *See also* Chapter 7 in Edward F. Denison, *The Sources of Economic Growth in the United States*, Committee for Economic Development, Supplementary Paper No. 13, January 1962.

[4] Over the past decade authors of the income and wealth studies sponsored by the National Bureau of Economic Research have made recurrent references to the need for examination of investments in the human factor, though none of them has yet published anything on measurement of human-capital formation. Most if not all of the recent efforts to measure effects of education on economic growth in the United States have been either made by Prof. Theodore W. Schultz of the University of Chicago or stimulated by him.

up this theme, Schultz has attempted to isolate and measure in cost terms one major component of this change in human capital—the education embodied in persons in the labor force.[5]

Writers on physical capital have pointed out that in a dynamic world, cost and yield perspectives are quite different both conceptually and in measurement results. Also, appropriate concepts and measures will differ according to whether concern is with (1) assessing capital formation as part of national product—a *result*—or (2) productivity studies that use capital measures as indicators of resource inputs—a *cause*. In the latter context the usual concepts of capital stock and new capital formation (cost or yield weighting aside) are not the most suitable ones; instead, a measure of a type I am terming "effective current stock" is wanted. Thus, measurement of changes in stock involves three general concepts within each of which there may be a further variety of concepts and measures: gross capital formation, net capital formation, and changes in effective current stock.

One of the major problems, which has been widely discussed in connection with gross physical capital formation, is the treatment of quality versus quantity. However, a quantity focus does not mean that education or physical capacities embodied in human capital must be relegated to the "quality" sphere, leaving measures of human capital in their old undifferentiated form of population or labor-force counts. Let us consider for the moment education only, treating education embodied in human beings as synonymous with human capital merely to avoid awkward terminology. A measure of education embodied in persons in the labor force can be used to convert this particular quality into a quantity, still leaving changes in the productivity of a unit of education in the quality category. The educational component of human capital then becomes a specific independent variable, comparable with physical capital and labor-force measures in analysis of economic growth.

Conceptually, units of human capital defined in the limited sense of "education embodied in the labor force" may be measured in a number of ways, all but one of which have at least approximate counterparts in the identification and measurement of units of physical capital. These units are:

A. Number of school years (with or without adjustments to school-year equivalents in terms of numbers of days of schooling per year).[6]
B. Efficiency-equivalence units.

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[5] For details, see Theodore W. Schultz, "Education and Economic Growth" in National Society for the Study of Education, Nelson B. Henry, *Ed.*, Part 2, *Social Forces Influencing American Education, 1961*, University of Chicago Press, 1961, pp. 46–88.

[6] The first aggregation of school years to my knowledge was discussed in C. Arnold Anderson and Mary Jean Bowman, "Educational Distributions and Attainment Norms," in *International Population Congress*, Rome, 1954, sec. 27. However, the focus of that paper was on distribution of schooling and identification of the location and importance of intermediate completion norms. The aggregates were not used to measure human capital as such.

C. Base-year lifetime earned incomes.
D. Approximations to base-year real costs.
   1. Real costs as consumption forgone.
   2. Real costs as inputs of labor effort (or time) and savings.
E. Approximations to current real costs.

A. NUMBER OF SCHOOL YEARS

A simple aggregate of school years or school days embodied in the labor force provides a proximate measure of total human capital that has no counterpart with respect to total physical capital, the components of which can be added only through some kind of money valuation. However, this would give the same weight to a year (or a day) in college as to one in elementary school. Hence, some system of weighting may be desirable. In any case, only when cost or yield-value weights are used does the measure of human capital become comparable to measures of physical capital.

B. EFFICIENCY-EQUIVALENCE UNITS

Measures in "efficiency-equivalence" units (not to be confused with base-year yield weightings) incorporate productivity changes in the measurement unit. In the case of education this would involve weighting years of schooling obtained at different times (or in different schools) in terms of their productive contributions. For example, if the high-school education of 1960 turns out students whose lifetime productive capacities exceed those of the 1940 graduates by, say, 20 percent (after adjustments for effects of postschool experience), the education embodied in a 1960 graduate would have a weight 1.20 times that embodied in a 1940 graduate; in efficiency the 1960 graduate is the "equivalent" of 1.20 graduates of 1940. Such a weighting would be analogous to measures of physical capital in which new capital goods are valued in terms of their base-year productivity equivalents; this is the same as weighting by base-year costs of turning out capital of equivalent productivity, provided base-year ratios of cost to productivity for various kinds of capital are equal (that is, capital markets are in equilibrium). If the purpose of measurement is assessment of changes in productive capacity, such an approach is appropriate; changes in the quality of schooling have been incorporated in the measure. However, if it is productivity relative to ultimate inputs that is of interest, efficiency-equivalence units are clearly inappropriate.

C. BASE-YEAR LIFETIME EARNED INCOMES

Measurement in terms of base-year lifetime earned incomes does not build changes in productivity or quality into the definition of a unit of capital. Such a measure is very different from the productivity weighting involved in efficiency-equivalence units. In the case

of physical capital, base-year market price approximates capitalized lifetime yield, which tends to be equated also with production costs. Thus, to the extent to which competitive equilibria are approximated, the distinction between base-year capitalized income and base-year cost measures of physical capital (see D below) tends to disappear. This is not the situation in the case of human capital, which is not sold as capital and has no market price. Taking a market view of the value of new human capital requires explicit (not merely implicit) estimation of the value of lifetime earnings. If the concept is confined to the educational component, this becomes the value of the increments to lifetime earnings attributable to education. But market forces do not equate costs of new human capital and its capitalized expected income to the degree to which this occurs in the case of physical capital. Regardless of the interest rate used, if any, in discounting, empirical evidence shows that these yields vary by levels of schooling.[7]

If a broader concept of human capital is wanted, one that includes noneducational components, measurement in base-year lifetime earned income units is the most convenient and probably the only feasible approach. A classification of human capital by education categories would in this case include people with no education, a group excluded when human capital is narrowly defined as educational capital only. When human capital is defined broadly, classification by education is of course only one of many possible ways of disaggregating the total into components with distinctive income characteristics, but it is one of the most useful.[8]

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[7] For a discussion of stabilities and instabilities in lifetime-income differentials by education level in the United States since 1939, *see* Herman P. Miller, Annual and Lifetime Income in Relation to Education: 1937–1959, *American Economic Review*, 50: 962–986, December 1960. Analyses of lifetime incomes according to education, as evidenced in 1950 census data, are presented in Paul C. Glick *and* Herman P. Miller, Educational Level and Potential Income, *American Sociological Review*, 21: 307–312, June 1956; and in H. S. Houthakker, Education and Income, *Review of Economics and Statistics*, 41: 24–28, February 1959. Houthakker estimates capitalized values of both pretax and posttax incomes at age 14, without discounting, and using several discount rates. Under the auspices of the National Bureau of Economic Research, Gary S. Becker is currently completing an intensive study of rates of return from education. A brief report of some preliminary findings appeared in his article, Underinvestment in College Education? *American Economic Review*, 50: 346–354, May 1960. An earlier study by Milton Friedman *and* Simon Kuznets sets forth the basic methodology (*Income From Independent Professional Practice*, New York, National Bureau of Economic Research, Publication No. 45, 1945).

[8] Though he did not identify his series as a measure of "human capital," Kendrick's weighting of man-hours in each industry by average base-year hourly wages in that industry involves an adjustment of the human-factor input measures that would be similar to a base-year income measurement of human capital if higher wage industries employed higher quality labor. However, high hourly wages are often associated with irregular and seasonal employment (as in the building trades), or dangerous and disagreeable working condition (as in mining). A breakdown by industry has no very direct relation to human-capital formation as such. Using education instead of industry categories focuses on the significance of changes in the human factor itself rather than the locus of its employment. *See* John W. Kendrick, *Productivity Trends: Capital and Labor*, New York, National Bureau of Economic Research, Occasional Paper 53, 1956, and his *Productivity Trends in the United States*, Princeton University Press, 1961.

Choice of discount rate in measurement by base-year lifetime earned income is an arbitrary matter, and there is much to be said for simply aggregating lifetime earnings without discounting.[9] However, this does not imply merely adding up average incomes at each age as they appear in census tabulations of incomes by age and education. The desired lifetime figure is expected total lifetime earnings, and these are affected by mortality and other withdrawals from the labor force. The same procedures that provide capital-consumption estimates in the measurement of net capital formation provide the basis for base-year lifetime-income estimates of gross capital formation.

D. APPROXIMATIONS TO BASE-YEAR REAL COSTS

Regardless of whether future earned incomes are discounted or not, any valuation of human capital in base-year lifetime income units may be regarded as an expression of quality differences in quantitative terms; however, prior and subsequent changes in quality within an education (or other) category are excluded. Cost valuation of the educational stock embodied in the labor force goes further than this in the quantitative direction. Basically it goes back of the educational components to measure the resources that produce them. Even base-year differences in quality or productivity from one education category to another are excluded to the extent that they deviate from cost differences. This is a step toward measurement in base-year "real cost" terms. But the concept of real costs has more than one meaning. Subjective real costs may be defined either as consumer satisfactions forgone or as disutilities of labor and of waiting. The objective counterpart of the former is consumer goods and services forgone. The objective counterpart of the latter is labor time involved in production plus interest viewed as a payment for waiting.

At this point it is useful to compare Denison's approach to the measurement of gross physical-capital formation with approximations of human-capital formation through investment in education.

[9] Houthakker (cited in footnote 7) demonstrates the importance of the rate of discount selected in its effects on capitalized values of total lifetime incomes even after allowing for mortality. Because of differences caused by education in the time distribution of lifetime income, the higher the discount rate used the lower the resulting educational differentials in capitalized values. His figures are for total—not merely earned—incomes; this exaggerates the effects. However, the discount rate chosen will have a significant effect on the weightings of the various education categories even when earned incomes only are considered.

Choice of a discount rate when the analysis is in the context of individual decision-making (Houthakker's frame of reference) involves considerations somewhat different from those that are most pertinent for purposes of measuring aggregate human capital. For the latter purpose, risks (and risk aversions versus gambling propensities) can be ignored. This narrows the range of discount rates that might "reasonably" be used: presumably a "gilt edge" rate would be a maximum.

Denison argues for a cost-based physical-capital formation measure such that—

> . . . if the costs of two types of capital goods were the same (or would have been the same were both newly produced) in the year in whose prices the measures are expressed, they are considered to embody the same amount of capital regardless of their ability to contribute to production.[20]

Applying a similar approach to measurement of the educational component of human capital leads to a valuation of each year of schooling at its base-year cost—the method used by Schultz in comparing the educational "stock carried" in the populations of 1929 and 1957. The only important difference is that in the case of physical capital, virtually all costs involve market exchanges, whereas a large element in the costs of formation of educational capital is the earning forgone by students—"opportunity costs." From a social point of view, these opportunity costs measure the sacrifice of consumer goods and services involved in allocating the labor time of students to schoolwork. But direct outlays on educational plant and equipment and services of teachers and other school staff—like all outlays in the production of a physical-capital good—are also rough measures of opportunity costs. Thus the base-year weights are in both cases approximate measures of real costs in the meaning of base-year consumer goods and services forgone. Subsequent shifts in the composition of physical capital toward, for example, relatively more of the kinds of capital the production of which required (in the base year) large proportions of skilled workers will be reflected in a rise in the measured "quantity of capital," other things aside. This is consistent with the interpretation that the quantity of capital has risen in terms of the consumption that would have been forgone to produce it in the base year.

Base-year money-cost valuation of physical capital deviates systematically from a base-year real-cost measure in terms of labor time and waiting. I shall avoid interminable complexities by considering only labor time for physical capital. To start with, the base-year cost valuations count a man-hour of expensive labor as more than a man-hour of cheap labor. If the composition of capital remained unchanged, estimated rates of capital formation would be the same (so far as the labor element is concerned) as the rates of increase in labor time that would have been required to produce it in

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[20] Edward F. Denison. "Theoretical Aspects of Quality Change, Capital Consumption, and Net Capital Formation," in Conference on Research in Income and Wealth, *Problems of Capital Formation, Concepts, Measurement, and Controlling Factors*, Studies in Income and Wealth, vol. 19, National Bureau of Economic Research, Princeton, N.J., Princeton University Press, 1957, p. 222. *See also* Denison's discussion of employment versus man-hour series as real-cost measures and as "effective labor input" measures in his "Measurement of Labor Input," pages 347–372 in *Output, Input and Productivity Measurement*, *Studies in Income and Wealth*, vol. 25, Princeton University Press, 1961.

the base year. However, a shift to kinds of capital requiring more expensive labor and away from those requiring cheaper labor (at base-year rates) would lead to a measured increase in capital without any change in the total undifferentiated man-hours that would have been needed to produce it in the base year.

Similar considerations apply to the cost measures of educational capital. However, they may come fairly close to base-year labor-time real-cost measures because the estimates of actual consumption forgone for the various schooling levels are correlated wth real costs in terms of labor time. It is the opportunity-cost component that accounts for this. A change in the composition of aggregate school years that increases the proportion of college years in the total will raise aggregate opportunity costs (and hence measured capital) for a given total of school years because these costs are higher for college than for lower levels of schooling. But if student time is regarded as work, it is clear that a college year (at least in the United States) entails more direct "labor" than an elementary-school year.

Unlesss interest rates are built into the cost estimates, real costs of waiting are of course underestimated for the higher levels of education relative to the lower. This means that a shift to a larger proportion of college years in the aggregate of schooling will underestimate the increase in human capital in base-period real costs of waiting.[11]

E. APPROXIMATIONS TO CURRENT REAL COSTS

As Denison has pointed out, his measure of capital is not equivalent to a current real-cost measure either in consumption forgone or in terms of labor and savings. This applies to base-year cost measurement of human-capital formation as well. To attempt measurement of either physical or human-capital formation in terms of current consumption forgone would make nonsense of productivity analysis by building increases in national levels of living into the capital measures. This is strikingly obvious if one looks at American college students' consumption forgone in the 1930's versus that taking place today. It is appropriate to look at current consumption forgone in the context of current decisions concerning allocation of resources to education, but such a concept has no place in measurements of changes over time in the quantity of capital.

If we view real costs in terms of labor time and waiting, it is equally clear that the costs of capital formation being considered are not equivalent to current real-cost measures. The deviation from current real costs in the case of physical capital will be of consider-

[11] This problem is discussed in the section on labor force participation and withdrawals, later in this chapter.

able magnitude if advancing technology (broadly defined) permits output of the same capital good today at a real cost in labor and saving significantly less than in some base year. Again, similar deviations from current real-cost measures are involved in the case of human capital, but they are of lesser magnitude.

Base-year money-cost valuations of human and physical capital are alike in excluding from "changes in quantity" two types of quality changes: changes in the efficiency of the resources (or of their organization) involved in producing the capital and changes in productivity per measured unit of capital formed. The fact that real labor and waiting costs of forming physical capital have declined more rapidly than real costs of forming human capital has some interesting implications for interpretation of empirical observations concerning growth rates in physical versus human capital. The ratio of human-capital growth rates to physical-capital growth rates measured in current real-cost units would evidently be greater than that indicated by measurement in base-year money costs.

III. Some Special Considerations in Cost-Based Measurement of Human-Capital Formation

Most estimates of gross (and net) physical-capital formation are convenient compromises with bookkeeping practices. As such they start with values in current dollars. Various devices for deflating these figures to a constant dollar base have been used. However, the diversity of physical capital (even when only plant and equipment are considered) and the rapid changes in its composition pose problems of far greater magnitude than are involved in cost measures of the educational component of human capital. There is no underlying basis for identifying units of physical capital comparable to school-year equivalents,[12] nor can a few major components analogous to levels of schooling be as readily identified.

On the other hand, cost measures of gross human-capital formation run into special difficulties. The most important set of problems is in the sorting out of investment in human producer capital versus immediate consumption and, more important, investment in human consumer capital. This is awkward enough even when attention is concentrated on the educational component only, but it is much more serious when a broader definition of human capital is considered. A second set of problems is the estimation of opportunity costs of

[12] The concept of a "school-year equivalent" as a measure adjusted to a constant number of days in attendance was elaborated by Clarence D. Long in his *The Labor Force Under Changing Income and Employment*. Princeton, N.J., Princeton University Press, 1958. Schultz used the Long method of estimating school-year equivalents.

student time; only one of these problems, the treatment of unemployment, will be discussed here. Finally, some interesting considerations arise in examining the question of whether to count as part of human-capital formation the costs of schooling persons who leave school after only a few years.

THE CONSUMPTION-INVESTMENT COMPLEX

Commenting on the inadequacy of conventional definitions of investment in national income and productivity studies, Abramovitz referred to an underlying "more fundamental concept which is broader: namely, any use of resources which helps increase our output in future periods." [13] In this broad view there is relatively little human consumption that is not in some degree also investment in either human capital formation or its maintenance. The problem of cost allocation between consumption and investment then becomes in part a typical joint product case that poses the question of how overhead costs should be allocated among the products. The chief difference is that economists discussing the distinction between investment and consumption with respect to the human factor often turn to consideration of the motivations of the spender. For theoretical analysis of individual decision-making and preference functions, this is clearly appropriate. However, when the problem is one of measuring the growth and composition of productive resources (in this case specifically of the human resource), the motivations behind resource formation are not the primary consideration.

Counting all base-year costs of education per school-year equivalent as "investment" in human producer capital amounts to treating all consumption products of this measured education, other than investment in human labor, as "zero-cost" byproducts. But these zero-cost consumption returns are omitted from the national-income accounts also. For some purposes simply omitting the cost of educating all men and women not in the labor force is a possible compromise.

Training man's mind aside, the costs of forming human capital are primarily those involved in building his physical condition. But many of the outlays that have this effect are also consumer priorities of the first order, and with minor exceptions any assessment of rates of return on such outlays viewed as investments in producer capital is meaningless unless the men are slaves. The usual solution in studies of productivity has been simply to count men (or, more frequently, man-hours). For time-series analysis this has the same result as if we were to assign any fixed dollar value, however estimated, to a man (or a man-hour), and it carries the implication that a "man" is the

[13] *Resource and Output Trends in the United States Since 1870.* New York, National Bureau of Economic Research, Occasional Paper 52, 1956. p. 12.

same physically from one generation to the next. All intergeneration changes in physical health are ignored and thus thrown into the "qualitative" residuals.

Conceptually it may be helpful to view the physical formation and maintenance of human capital as composed of two parts. The first is some minimum necessary for survival of a given number of potential labor-force members (taking into account mortality rates and allocating total costs among survivors). The simple count of numbers of men may then be interpreted as the equivalent of assessing this survival minimum at a real cost that is constant through time. The second component changes over time with improved nutrition, medical services, and so forth. In regarding outlays that improve health as totally consumption, an important change in human capital is ignored. On the other hand, to handle them all as investment outlays on producer capital with zero-cost consumption byproducts (even if only members of the labor force are included) is to throw a large part of consumer gains into the factor-cost measures, and so to eliminate factor-productivity increases virtually by definition. No cost-based measure of this component seems feasible at present—not merely because of the difficulty of measuring costs but also because of the immediate consumption and the consumer-capital elements involved.

If rates of change in health components of human capital are closely correlated with changes in the cost measures of human-capital formation through education, the relations between the latter and growth in the national income will incorporate effects of better health as well as of education per se, whatever the causal interpretations. If not, proxy variables for changes in health might be plugged into the time-series models. A variable that immediately suggests itself is adult-morbidity rates, justified on the assumption that changes in these rates provide a good index to the physical capacities of survivors in the labor force. But however closely such an index may be associated with changes in men's physical capacity for production, there is no justification for interpreting it as an index of human-capital formation in cost terms. It is more consistent conceptually with an efficiency-equivalence approach to measurement of human-capital formation.

THE TREATMENT OF UNEMPLOYMENT IN ESTIMATES OF OPPORTUNITY COSTS

Taking the approach of traditional marginal analysis combined with probability theory, the opportunity-cost component of educational costs at a given time has been measured by an estimate of the wage income the student would earn if he were to get a job, reduced by the proportion of the population of his age (ideally also of equal

prior training) who are unemployed. As an approximation to a measure of opportunity cost from the point of view of the average individual, that is, of private opportunity cost, this is probably the best way of handling the problem. When unemployment is widespread and chronic, it might be argued that social as distinct from private marginal opportunity costs are zero in the short term so long as the number of jobs available is not altered by the number of young people in the labor market, but this argument would apply equally to all unemployed resources, physical as well as human, and it excludes consideration of alternatives such as public works. Such validity, if any, as may attach to it is in any case limited to short-term marginal valuations, whereas we are interested in long-term averages and aggregates. When long-term aggregate human-capital formation is the focus, social opportunity costs are not zero even with chronic unemployment, and the traditional approach mentioned above is probably the best alternative as a measure of social as well as private costs.

Unfortunately, this pragmatic solution is still ambiguous. The rate of unemployment varies from year to year, but to build these variations into cost estimates according to the years in which each age cohort was trained would distort measures of changes in human capital as a resource available to the economy. Selection of a base year or at least an unemployment rate that may be regarded as in some sense "normal" is the only possible solution—even though definition of what is normal is inevitably somewhat arbitrary. The higher the unemployment rate regarded as normal, the lower the estimated opportunity-cost fraction of total educational costs.

EDUCATIONAL CAPITAL AND THE "UNDEREDUCATED"

Although the educational component in human-capital formation is the one most amenable to measurement, an awkward problem arises in connection with the semiliterates who leave school after a few years only. This becomes most visible when adjustments for capital consumption are attempted as part of the task of measuring the educational component in net human-capital formation. For that purpose it is necessary to identify the lifetime patterns of incomes attributable to education as distinct from the total earnings of the average man in each educational category. But the "undereducated" pose issues that are basic to the logic of treating education as human-capital formation in the first place.

For those who continue in school, contributions of schooling to gross human-capital formation clearly begin with the first years, which lay the foundations for what comes later; obviously costs of these early years should be included in the cost valuations. However, evidence

concerning lapses into illiteracy strongly suggest that 2 or 3 years of schooling is almost total waste when schooling is not continued.

It might be argued that costs of schooling of men who have left school before, say, the third or fourth grade are part of the costs of educating those who continue, and should thus in effect be allocated to the latter. However, as school years per man rise, the aggregate of years embodied in men with less than 3 or 4 years of schooling grows smaller and smaller; thus the educational costs of the undereducated to be allocated to those who continue in school become a smaller and smaller figure both absolutely and relative to the aggregate. Since, in addition, a rising proportion of relatively well-educated men tends to have the indirect effect of raising the absolute productivity level of the shrinking minority of the undereducated (of any given ability level), the perverse performance of this element in costs is all the more awkward.

This suggests that a reasonable alternative in a society in which only a small minority stop before 3 or 4 years of schooling would be to regard outlays on their schooling as analogous to laying the foundations of a building and going no further. The building remains unfinished and expenditures on the foundation add nothing to the available capital stock of the society. However, this is an extreme position. A more reasonable solution might be to weight these years for the undereducated at some fraction of their costs.

IV. Net Human-Capital Formation

One of the knottiest problems in all physical-capital measurement is that of adjusting for capital consumption to arrive at net capital-formation measures--the net effects of appreciation, depreciation, and obsolescence. Fortunately, it is much easier to make reasonable estimates of the time flow of yields and hence of capital consumption and net capital formation in the case of human than of physical capital. Though a durable capital good, human capital is continuously for hire and its "rent" is continually given a value in the market. Physical capital in the form of plant and equipment is not so regularly either rented or sold after its initial purchase by the user.

Conceptually the analogies between human and physical capital are clear enough, but there are some significant differences in the relative importance and the behavior of the various elements determining the distribution of returns through time. An important element in the case of human capital is mortality or withdrawal from the labor force due to illness, accident, or other causes before normal depreciation or even obsolescence has taken its toll. Analogous losses to physical capital through accidental damage, such as fire, are of much less im-

portance. Appreciation with experience appears to be an important element in the time flow of yields from units of human capital, but after a very short breaking-in period, appreciation of physical capital is rare—as the frequent textbook citations of old wine attest. Human capital, like physical, suffers from depreciation, though if human capital is not worked too hard, its rate of depreciation is more likely to be retarded with use than speeded up. Finally, human capital, like physical, suffers from obsolescence, and the more dynamic the economy, the higher the rates of obsolescence. Yet here again there is a significant difference. Human producer capital, and even the educational component of that capital, is less specialized than most physical producer capital. As a result, obsolescence does not sweep away the yield of a unit of human capital or even of the educational component of such a unit to the degree to which this occurs with physical capital. For practical purposes of measurement it is convenient, and in the case of human capital feasible, to ignore consideration of obsolescence as distinct from depreciation, treating them jointly.

Treatment of appreciation of human capital calls for special comment.[14] Over the years between completion of formal schooling and attainment of maximal annual earning capacity, there is, of course, "education" in that continued learning is involved. The increases in productive capacity over these years could be viewed either as further human-capital formation or as entirely analogous to depreciation (that is, simply as an aspect of the time flow of returns inherent in the nature of the original capital when it is put to use). To the extent to which a reduction of earnings in the earlier years is a condition of acquiring the capacity to earn more later, an opportunity cost is involved; the observed sequential increase in earnings is then, in part at least, a reflection of continuing capital formation measured in cost terms. Under these circumstances even informal on-the-job training is thus capital formation. However, much of the observed increase in earnings with age entails no additional costs of any kind. Thus, while treatment of rising annual earnings as appreciation proper rather than as additional capital formation is not an ideal solution, neither is it an entirely unreasonable pragmatic simplification.

Given this simplification, the basic logic involved in using data on the lifetime patterns of yields as a basis for estimating capital consumption is also simple, even though actual measurement becomes

[14] For some valuable sidelights on this problem, see the excellent study of "Investment in Human Capital and Personal Income Distribution," by Jacob Mincer, in the *Journal of Political Economy*, 66:281–302, August 1958. A brief analysis of opportunity costs involved in apprenticeship training is included in Paul G. Keat, Long-Run Changes in Occupational Wage Structure, 1900–1956, *Journal of Political Economy*, 48:584–600, December 1960.

complicated. What is required is an allocation of the original value (however measured) of a unit of capital through time in accordance with the proportion of its lifetime productivity that has been used up. Upon retirement the entire original value, neither more nor less, is accounted for. But this raises two types of questions: What assumptions are involved in using age-income data as measures of lifetime real productivity patterns per surviving member of the labor force, and what is the appropriate way to deal with changing labor-force participation rates and withdrawals from the labor force?

AGE-INCOME DATA AS MEASURES OF LIFE-PRODUCTIVITY CYCLES FOR LABOR-FORCE SURVIVORS

Two basic assumptions are involved in the use of age-income data as measures of real life-productivity cycles among survivors in the labor force. First is the assumption that within each education category (or other categorization of the population) the ratios between incomes at any two ages represents a stable historical life cycle that is repeated with each successive age cohort. The absolute level is irrelevant; it is only the distribution through time with which we are concerned. Second is the assumption that the age distribution of private earned incomes is proportional to that of social returns.

At first sight the assumption that distribution of earned incomes in any single year will apply longitudinally to successive age cohorts in a given educational category seems to be quite untenable. The difficulty is not merely that during a man's lifetime changes in the economic structure may shift the relative market advantages of the various age-education groups; it is also that changes in rates of unemployment through time hit successive age cohorts at different points in their life cycles. This can have effects of considerable magnitude on the time pattern of income per member of the labor force in one age cohort as compared with another. However, it can reasonably be argued that allocations through time for consumption of human (as of physical) capital should not be sensitive to short-term fluctuations in employment—that these have virtually nothing to do with the "amount" of the capital stock or net capital formation in any meaningful sense. If this argument is accepted, then the relevant estimates of lifetime flows will take account of average rates of unemployment for each age-education category, but will ignore fluctuations in these rates. Average or "normal" unemployment rates are important in this context only as they have a different incidence for different age groups within any one educational category. The income averages used to build up the appropriate time flows are then averages for the entire labor force within each age-education group after adjustments for "normal" rates of unemployment.

For the purpose of allocating capital consumption through time, discrepancies between private incomes and real productivity from a social point of view are irrelevant provided these discrepancies are of the same relative magnitude at each age within each education category; differences in the ratios of social to private returns between education categories at any given age will have no effect on the capital-consumption estimates. A priori, age constancy of these ratios is probably a better approximation to the true picture for the average income streams in the pre-secondary-education categories than is any alternative assumption. However, some systematic distortions seem likely in the higher education categories. The observed incomes of men in the middle-age brackets are probably too low relative to younger and older men. Two factors are involved. First, in a dynamic society each new cohort of men with a given number of years of schooling enters the labor force better equipped in knowledge and know-how than its predecessor. An extreme illustration is provided by recent changes in engineering. This means that the younger men earn (and produce) more than their predecessors did at the same age. The result is a flattening of the age-income curve, which rises less than it would with the appreciation of productivity with experience in any single age cohort. Today's young men will in turn gain through experience and receive higher incomes in their middle years than they receive now (or than men now age 40 receive), but they may be followed by a new cohort that is still more productive. This is an inverse way of looking at the obsolescence process. Second, the age-income curve is probably flattened again at the upper age levels relative to a true productivity curve, for status and seniority rules maintain income of older men even when their real productivity is falling.[18] However, this distortion is partially neutralized because the middle-age cohort is more productive age for age than the older one.

A WAY OF HANDLING LABOR-FORCE PARTICIPATION AND WITHDRAWALS

A true life pattern of yields to any given kind of human capital, let us say for the moment male secondary-school graduates, must adjust average productivity per member of the labor force at each age to take account of the proportion of men who have dropped out, whether temporarily or permanently. The measure wanted at each age is earned income per initial member of the age cohort, not average income per active survivor. Initial members would be counted as the

[18] The fact that older men have greater difficulty in finding jobs when they have become unemployed brings about a failure to utilize their productive potentials. This reduces the average income per labor-force member in the upper age brackets. However, it does not affect the relation between actual productive contributions of older men (*real* outputs) and their privately realized earned incomes.

number at the age at which the level of education involved is normally completed.[16] Adjustments for labor-force participation may therefore be greater at the earliest ages than a little later; strictly speaking, it is not just "survivorship" that is involved.

A simple adjustment has been applied to obtain estimates of average incomes per initial member, using U.S. data for males and taking 1950 as the base year in distribution of lifetime yields (including "normal" unemployment rates by age-education categories). The first figure needed was a survival rate based on mortality tables—a standard demographic measure of the number of men at each later age surviving per thousand completing a given amount of schooling. Then for each age-education category the rate of labor-force participation was computed. The product of these two rates yields a "labor-force survival ratio." Multiplying observed average earned incomes per member of the labor force in a given age-education category by the appropriate labor-force survival ratio gives average income per initial member of the age cohort involved, here termed income "per entrant." This provides the basis for proceeding to estimates of net human-capital formation.

LIFETIME YIELDS AND NET CAPITAL FORMATION IN BASE-PERIOD INCOME UNITS

With acceptance of the cross-section age-earnings data as the best available measures of lifetime real productivity patterns, the method of estimating lifetime yields suggested by the preceding discussion may be summarized briefly:

1. Base-year earnings per member of the labor force are computed for each age-education category, allowing for a "normal" rate of unemployment for this category.

2. These earnings are adjusted downward by applying labor-force survival ratios to obtain base-year incomes per entrant.

3. Earnings per entrant for each age are added (each year being given a weight of 1) to get total lifetime yields for each education

[16] This is the point at which the production of the new unit of human capital is completed. Analysis of rates of return to educational investments properly take age 14 (for the United States) as the starting point for all education groups, but our problem is a different one. The logical procedure is to focus either on the point at which the capital is completed or on that at which the first investment occurs. Taking the former view, in a human-capital measure based on lifetime earnings there should be no discounting for years prior to the point at which the new capital is complete, even if subsequent yields are discounted. On the other hand, when cost valuations of the educational component are used, refinement of the estimates to take interest into account would require allowances for interest on each successive investment from first grade on for the period required to complete each level of schooling. Alternatively, a puristic view of real costs of waiting would require carrying interest charges up to the dates of receipt of incomes. Analogously, a puristic treatment of discounting in a yield-based measure would include children who were still below working age as already embodying some capital (positive or negative). This would approach the capital concept in Dublin and Lotka (cited in footnote 2).

category. (A refinement of this would first discount each income per entrant back to the normal completion age for the educational category involved.)[17] These sums are the measure of the capital value per initial member of each education group in base-period lifetime income units without discounting.

It is then a very simple matter to estimate capital consumption, net capital stock, and net capital formation in base-year earned-income units. A year's aggregate capital consumption for each age-education category is simply base-period income per entrant, multiplied by the number of entrants in that category. Summing these figures gives the year's aggregate human-capital consumption. Net capital stock embodied in an average individual in any given age-education category is the base-period lifetime yield for that category minus its cumulated capital consumption. Multiplying this figure by the number of such individuals in the labor force and summing the results for all age-education categories gives a measure of net capital stock. Comparing this total with the total for any other year gives a measure of net human capital formation during the interval.

CAPITAL CONSUMPTION AND NET CAPITAL FORMATION AT BASE-PERIOD COSTS

Some minor modifications of this procedure are needed to arrive at estimates of net human-capital formation at base-period costs. First of all, cost valuations as discussed here apply only to the educational component of human capital. This means that earned incomes per entrant among men with no education must be subtracted from the earned incomes per entrant initially computed. Summing these net or incremental incomes per entrant gives the appropriate lifetime income for each educational category.

However, even if the base year is the same, this measure is not directly comparable with the cost valuation of new capital. An intermediate step is therefore required before capital consumption can be estimated. The percentage of lifetime earnings accruing in each year of age is computed, and these percentages are then applied to the cost valuations of new capital per man in the education category. This gives the figure for capital consumption per member of the labor force

[17] See footnote 16. Another alternative might be considered most appropriate when human capital is measured in base-year lifetime-income units. Remaining future incomes "per entrant" could be discounted to the "present" before summation to get the estimate of net capital stock. Net capital formation over a year is then "present" value as of the end of the year, minus "present" value as of the beginning of the year. The greater task of computation aside, this approach has the disadvantage that the sum of capital consumption estimates over a lifetime will not equal the original value of the new capital. Though summation of the successive capital consumption estimates for a unit of capital would give a lifetime total smaller than the aggregate of undiscounted yields, it would exceed the value of original capital computed by discounting incomes back to the year of completion of schooling.

in each age-education category. From this point on, the procedure is identical with that described for estimating net capital formation in base-period income units.

V. Effective Current Stock

Studies of productivity change as evidenced by relations between aggregate factor inputs and gross or net national product have used estimates of physical-capital stock not because any of these is the conceptually correct measure but because nothing comparable to what has been termed "effective current stock" is available for physical capital; Solow explicitly recognized this problem (see footnote 3). In dealing with human capital we are more fortunate, primarily because there is a better basis on which to assess lifetime distributions of yields. "Effective current stock" measures the relevant potential current inputs of human capital much more directly than other capital concepts.

Estimates of the rates of gross and net capital formation and of changes in effective current stock will differ to an extent depending upon the degree of contrast among educational categories in age-income patterns and the magnitude of changes in educational attainments from one age cohort to the next. Changes in age composition of the population will also affect the results. Choice of "effective current" stock rather than some other measure of human capital is therefore empirically important as well as conceptually sound in attempts to compare year-to-year changes in human-factor inputs and their relation to national product. For this purpose either a cost or a yield base-year measure can be used, but these variants do not measure quite the same thing; the differences between them are analogous to those already discussed in comparing base-year income and cost weightings of gross capital estimates.

Schultz used a "stock carried" estimate of the educational component of human capital that might be regarded as a first approximation to a measure of "effective current stock at base-period cost." "Stock carried" equals capital formation at base-period cost over the past lifespan of the present labor force, minus whatever was invested during this period in people who have died or have left the labor force for other reasons. The time pattern of yields from a unit of human capital is ignored. Using this measure as an approximation to effective current stock assumes that education embodied in human capital has a yield flow that starts out at a level that is maintained unchanged until the capital suddenly and completely disappears.[18]

[18] As an approximation to a measure of net human-capital formation in a growing population, this underestimates rates of capital consumption, since aging of men still in the labor force is ignored. It amounts to making the obviously untenable assumption that total remaining future lifetime earnings (whether or not discounted) are the same for all ages.

It is a comparatively simple matter to convert such a measure into "effective current stock" in base-period cost units by the use of age-income data such as were employed in arriving at net educational capital formation estimates. However, the procedure would be different. No adjustment by "labor-force survival ratios" is required. The incremental income average wanted for each age-education category is just average income per member of the labor force, minus the corresponding average for the uneducated, or undereducated, group that is excluded from the educational component of human capital. The procedure is then as follows: (1) A simple incremental average annual income is computed for each education category, giving each year of age equal weight; (2) ratios of incomes at each age to the average for all ages within each education category are computed; (3) the base-period cost value of a new unit of human capital for the education category involved is multiplied by the income ratio for each age, giving a set of figures for effective current stock per man; (4) effective current stock per man in each age-education category is multiplied by the number of men in that category in the labor force; (5) the estimates obtained in (4) are summed to give aggregate effective current stock at base-year costs.

A similar procedure gives effective current stock of the educational component in base-year earned-income terms. The only difference is that the base-period value of a new unit of human capital is its estimated base-year lifetime income. Estimation of effective current stock of the total of human capital, not merely its educational component, is similar; but the average earned incomes used include the incomes of the uneducated or undereducated, and the investment in the labor force below the education cutoff point is valued and included in the aggregate. It should be noted that this last measure is one way of adjusting a total labor-force count to take into consideration both its age and its educational composition.

Ideally, to convert an "effective current stock available" series into an "effective current stock utilized" series requires adjustment of the labor-force multipliers in step (4) for changes in unemployment rates. This would be done for each year by multiplying the number of persons in each age-education category in the current labor force by the appropriate ratio of current to "normal" rate of unemployment. However, unemployment rates by age and education are rarely available year by year. A cruder adjustment, but one that would give a good approximation, uses the ratio of the current rate of unemployment regardless of age and education to the corresponding normal rate. The aggregate effective current stock estimates for all education and age categories together is then multiplied by this ratio to get current human-capital inputs.

VI. Conclusions

Having argued for the feasibility of human-capital measurement and suggested several types of measures, I must offer a word of warning. No measure, not even an unattainably "perfect" one, can solve the problem of determining the contributions of education to economic growth. The difficulty here is in the very nature of the question posed, and it applies equally to attempts to assess the role of any single factor. An entire *Gestalt* is involved, and hence analysis in terms of a multiple-factor matrix is needed. In such an analysis the role of any single factor emerges for what it is—a conditioned role dependent on the movement of other factors. Moreover, estimates of its importance will depend upon which other factors have been included in the matrix. Each method of dealing with the measurement of education's contribution to economic growth has its own defects. Time-series analysis in terms of aggregates has been the usual approach in assessing the role of physical capital, man-hours of labor, and the catchall third factor, *t*. Introduction of human-capital formation series (or more specifically the educational component of human capital) into such an analysis is one possibility. This has the advantage that social returns not reflected in private-income differentials associated with schooling differentials may be captured; but interpretation runs into serious problems of circular causation because growth in education reflects growth in national income as well as affecting it. Schultz's approach, which applies rates of return on incremental investments in education to cost estimates of the educational stock, avoids this circle. However, it runs into trouble because of the difficulties of distinguishing educational factors from other factors associated with education that affect income differentials, because of divergence of social from private returns, because noneducational changes in structural relationships that are a part of growth are ignored, and because "fallacies of summation" are involved. The best we can do is to use several approaches and compare the results. In dealing with this problem, economists would be well advised to keep continually in mind Åkerman's strictures concerning causation, fallacies of summation, and the importance of structural shifts. These reflections suggest four next steps.

First, we need further experiments with the measurement of human capital in its various aspects, and the sensitivity of these measures to some of the assumptions that have to be made in adapting empirical data. Such exploration may contribute not only to better measurement but also to conceptual clarification.

Second, aggregative analyses of factors in the growth of national income in various countries should be elaborated by introduction of

human-capital formation series. Where the data permit, effective current stock measures should be used. But even in these cases other measures should be tried also, in particular those for which data are most commonly available, so that direct international comparisons are possible. This means a rough cost-based measure of the educational component of human capital, perhaps at first essentially Schultz's "stock carried" measure, in some cases estimating years of schooling embodied in the adult population by projections of earlier data on enrollments, adjusted for mortality and migration.

Third, aggregative analysis using lagged variables is needed—if possible in combination with geographic and international comparisons. For example, changes in outlays on education of youth may be compared with lagged changes in incomes as part of a multiple-factor matrix "explaining" income change. Then, as a check on the problem of two-way causation, changes in educational outlays may be taken as the dependent variable and lagged after changes in incomes. Such an analysis involves comparisons of gross human-capital formation, not capital stock (by any definition), with income. It would go further than anything yet attempted toward the type of "causal" analysis on which Åkerman has laid so much stress.

A *fourth* task is to break human-capital data into several series for types or levels of education, to explore the interrelations among these, and, finally, the nature of the educational "mix" in relation to other factors associated with economic growth. Though data are limited, they are sufficient in a number of countries to make breakdowns of this kind in stock-carried estimates even when estimates of effective current stock are not possible. International comparisons of the paths of the various components of the aggregate stock of education embodied in the population and their relation to economic structure and growth should at the least open up some fresh insights into important but elusive problems.

CHAPTER 7

Rise in the Capital Stock Represented by Education in the United States, 1900–57

*Theodore W. Schultz**

INVESTMENT in human capital is a distinctive and important feature of the economy.[1] People invest in themselves, and these investments have become large, and knowledge about the human capital that is thus formed is fundamental to an understanding of economic growth. A major source of this human capital is education.

To look upon education as an activity that develops human capital is not to disparage its cultural purposes,[2] but among its other contributions are knowledge and skills that are useful in economic endeavor. Economic progress is greatly dependent upon these contributions. Surely the most universal limiting factor in achieving economic growth is ignorance. For attaining an optimum rate of such growth, investment in skills and knowledge is essential.[3]

Education has various measurable dimensions, which differ depending upon the purpose of the measurement. School attendance is one such; others are the years of schooling completed and the number of students finishing elementary school, high school, and college. The real cost entering into education is still another way of measuring education.[4] It is indeed meaningful to treat education as something that is measurable.

Economists make much of the distinction between *flows* and *stocks*. Investment is a flow; plants and equipment are stocks. Land is a

*Department of Economics, University of Chicago. This chapter was based on Professor Schultz's essay, "Education and Economic Growth," in the National Society for the Study of Education 60th Yearbook, Nelson B. Henry, *ed.*, part 2, *Social Forces Influencing American Education, 1961*. University of Chicago Press, 1961.

[1] Theodore W. Schultz, Investment in Human Capital. *American Economic Review*, 51: 1–17, March 1961.

[2] It is necessary to underscore this point because of the widespread apprehensions that arise whenever economic analysis is brought to bear on education. I have gone to much trouble to take account of these apprehensions, as may be seen in my "Investment in Man: an Economist's View," *Social Service Review*, 33: 109–117, June 1959; and also in more recent papers referred to herein.

[3] Branko Horvat. The Optimum Rate of Investment. *Economic Journal*, London, 68: 747–767, December 1958.

[4] Theodore W. Schultz. Capital Formation by Education. *Journal of Political Economy*, 68: 571–583, December 1960.

stock; the productive service that it renders is a flow, and so is rent. The size, composition, and capabilities of the labor force represent a stock; the work that is done in an hour or a week is, on the other hand, a flow, and so are wages and salaries. Inputs, whether they are the results of the efforts of man or the contributions made by material things, are all flow concepts. The natural endowment (land); reproducible physical capital (plant, equipment, and inventories); and the labor force (workers) are all stock concepts.

The connections between additions to the stock of capital as a store of wealth and the corresponding additions to output capacity are very intricate.[8] Things that differ only with respect to durability may represent different stocks of value, although their annual output capacity is the same. Consider two engineers who are equally capable and who do the same amount of engineering work during a particular year. Their respective contributions as engineers during that year are the same, although the two may be very different when viewed as a stock of engineering capabilities because one of them may be a young man just starting his career and with a long productive life ahead of him, and the other an old man doing his last year of work before he retires. In gauging the value of the stock of engineering capabilities, the age of engineers is therefore important.

Education is more durable than most forms of nonhuman reproducible capital. A high-school education, for example, will serve the person during the rest of his life, and of this period 40 years or more are likely to be spent in productive work. Most nonhuman capital has a much shorter productive life than this. Education can be augmented because it is durable, and the fact that it has a relatively long life means that a given gross investment adds more to the stock than the same gross investment typically adds to the stock of nonhuman capital.

In the United States young people entering the labor force have on the average more education than older workers. When the young people who enter the labor force have more education than the old people who are retiring, the value of the stock of education in the labor force rises, even with no change in the number of workers. Such has been the case in the United States for a long time. Though younger workers back in 1900 had only a little more schooling than older ones, this difference has become much larger, much to the advantage of those in the younger age groups. The stock of education accordingly becomes more valuable in two ways: (1) The level of education of the population rises, and (2) a larger share of the total education is embodied in the younger workers than formerly.

[8] Trygve Haavelmo. *A Study in the Theory of Investment.* University of Chicago Press, 1960. p. 12–17.

Why Estimate the Stock of Education?

Estimates of the stock of education may seem remote and academic to persons who are concerned about expenditures for classrooms and for teachers' salaries. There are, however, issues that can be settled only through knowledge about the stock of education: What are our scientific and engineering capacities and at what rates are these increasing? We are constantly devising better methods for measurement of inventories, plants, equipment, natural resources, and other forms of capital because such measurements are necessary in gauging changes in them. Similarly, there is a growing awareness that knowledge is required about changes in the stock of human capabilities.[6]

Comparisons of skills and knowledge in different countries are based as a rule on crude guesses concerning the respective stocks of education. To illustrate, in the United States the number of persons with a high school or a college education has been rising in relation to the number of persons in the labor force. This kind of advance in education has also been taking place in some other countries. Yet the differences among countries in the rates of this advance are impressive. Countries in Western Europe have lagged in this respect compared to the United States, whereas Japan and more recently the Soviet Union, both starting from much lower levels several decades ago, have been moving ahead at a higher rate than has the United States. Moreover, it is altogether possible for the level of education of the labor force to decline, as it appears to have done in recent years in East Germany mainly as a consequence of the large outmigration of doctors, teachers, lawyers, and skilled technicians. Israel's unique pattern of inmigration is also instructive. There came to Israel a large number of highly educated people. But there were not enough secondary schools for preparing young people for college and university instruction to maintain the high level of education which the inmigration of talent had established. Thus, until enough secondary schools and college and university facilities were established, there was a prospect that the level of education of the labor force would decline.

International and other comparisons aside, the economist is turning to human capital to see whether changes in the stock of such capital will account for the otherwise large unexplained increases in output. As things stand, increases in nonhuman capital and in man-hours combined appear to account for only a small fraction of the increases in national income.[7]

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[6] There is already a substantial body of literature treating human resources, talents, and skills, and the demand for and supply of scientific and other personnel.

[7] "Education and Economic Growth," op. cit., pp. 49–50.

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Three Measures of the Stock of Education

The alternative measures that follow are at this stage only clues to what we are seeking. This is necessarily only a progress report. First we examine the concept of a *year of schooling completed* as a unit of measurement. National statistics based on this concept are readily available and they are widely used. Next we present an *equivalent year of schooling completed*, based on 1940, when the average period of school attendance was 152 days. A third measure will then be developed, based on the *real cost of a year of schooling*.

YEARS OF SCHOOLING COMPLETED

Although "years of schooling completed" is a convenient unit of measurement, it is like counting the acres of land in farms without taking any account of the differences in land; an acre of low-productive semidesert land and an acre of highly productive irrigated land are simply added together. Likewise, we can aggregate the education of a population by counting the number of years of schooling completed as one might count acres, houses, or tractors.

Table 1 presents the results of such a count for education. It shows that the years of schooling completed per person rose by about two-fifths between 1900 and 1957. It follows, of course, that the total number of years of schooling completed rose relative both to the population and to the labor force. If each year of schooling completed were the same in amount and value, the inference would be that the stock of education in the labor force, measured in this way, increased somewhat more than 3½ times (from an index of 100 to 359) between 1900 and 1957.

TABLE 1.—Years of schooling completed by the population 14 years and older and by the labor force 18–64 years of age, United States, 1900–57

Year and index 1957	Population			Labor force		
	Number (millions)	Years of schooling completed per person	Total years of schooling completed (millions)	Number (millions)	Years of schooling completed per person	Total years of schooling completed (millions)
1900	51.2	7.64	391	26.1	7.70	216
1910	64.3	7.86	505	35.8	7.91	283
1920	74.5	8.06	600	41.4	8.12	336
1930	89.0	8.32	741	48.7	8.41	410
1940	101.1	8.55	865	52.8	9.02	476
1950	112.4	9.96	1,118	60.1	10.10	607
1957	117.1	10.70	1,253	70.8	10.96	776
Index 1957 (1900=100)	229	140	320	282	142	359

EQUIVALENT YEARS OF SCHOOLING COMPLETED

As a standard, a "year of schooling completed" is much too elastic, for the school year is now 60 percent longer than it was six decades ago. In 1900 the average daily attendance of enrolled pupils aged 5–15 was only 99 days, whereas in 1957 it had reached 159 days. Moreover, the labor force of 1900 consisted mostly of workers who had been in school when the average attendance was even less than 99 days; for example, most workers who then were 35–45 years of age were presumably in school in 1870 when the average attendance was only 78 days (this leaves aside the schooling of immigrants).

I have adopted a procedure developed by Clarence D. Long[*] to adjust the figures on school years completed for these changes in length of school attendance. It gives me comparable figures for years of schooling completed, which I have based on the 1940 experience of an average of 152 days of school attendance.

This simple adjustment for changes in school attendance alters the picture considerably. As is shown in table 2, the rise in equivalent years of schooling completed, adjusted for differences in the length of the school year, is much larger than that shown by the unadjusted figures on which table 1 is based. For the labor force, whereas years of schooling completed rose by about two-fifths betwen 1900 and 1957, the equivalent years of schooling completed became 2½ times as high in that period (rising from an index of 100 to 252). During these same years, 1900–57, the total number of years of schooling completed by persons in the labor force, on a 1940 equivalent basis, rose 6⅓ times (from an index of 100 to 638).

TABLE 2.—Equivalent 1940 years of schooling completed by the population 14 years and older and by the labor force 18–64 years of age, United States, 1900–57

Year and Index 1957	Population			Labor force		
	Number (millions)	Equivalent 1940 years of schooling completed per person	Total equivalent 1940 years of schooling completed (millions)	Number (millions)	Equivalent 1940 years of schooling completed per person	Total equivalent 1940 years of schooling completed (millions)
1900	51.2	4.13	212	28.1	4.14	116
1910	64.3	4.65	299	35.8	4.65	167
1920	74.5	5.21	388	41.4	5.25	217
1930	88.0	6.01	535	48.7	6.01	293
1940	101.1	7.07	715	52.8	7.24	382
1950	112.4	8.46	951	60.1	8.65	520
1957	117.1	10.02	1,173	70.8	10.45	740
Index 1957 (1900=100)	229	243	553	252	252	638

[*] Set forth in his study, *The Labor Force Under Changing Income and Employment*, National Bureau of Economic Research. Princeton, N.J., Princeton University Press, 1958 (see especially app. F). Professor Long has kindly made available to me his basic worksheets, which provide the adjustment factors on which my estimates of "equivalent years of school" are based.

COST AS A MEASURE OF SCHOOLING

The two concepts presented above treat a year of elementary school the same as a year of either high school or college, although they differ greatly in value. A year of high school costs 5 times as much as a year of elementary school, and a year of college almost 12 times as much. I propose to use the following 1956 price tags for a year of schooling:[9] Elementary school, $280; high school, $1,420; and college, $3,300.

Table 3 shows that in 1957 the members of the labor force had completed on the average 7.52 elementary-school years, 2.44 high-school years, and 0.64 college and university year. At 1956 prices, the cost of an average year of this composition was $723.

Two estimates were made for 1900, which are, in substance, a lower and an upper estimate of schooling and costs. In the lower estimate, high-school and college education is allocated within the labor force roughly as it was distributed in the population among the comparable age groups; in the higher estimate, all of this education was allocated to the labor force. Table 4 gives the years of schooling per member of the labor force for both estimates and then the costs for the upper one. At 1956 prices, the costs of an average year of schooling of these two compositions comes to $540 for the upper estimate and to $423 for the lower one.

The results of these preliminary steps in using costs to measure the stock of education are shown in table 5. It should be observed

TABLE 3.—Cost of education per member of the labor force 18–64 years of age, in 1957, according to years of schooling completed[1]

Type of schooling	Years of schooling per member, 1957	Cost of schooling per year in 1956 prices	Total cost per member[2]	
			Amount	Percent
Elementary school	7.52	$280	$2,106	28
High school	2.44	1,420	3,458	45
College and university	0.64	3,300	2,099	27
Total	10.60	[3] 723	7,663	100

[1] Based on table 136 of the *Statistical Abstract of the United States 1959* (U.S. Department of Commerce, Bureau of the Census), which gives the percentage distribution by years of schooling completed for the labor force 18 to 64 years old, 1957. The elementary-school subtotal is (4×5.6)+(7×26.2)+(8×66.3)+100=7.522; the high-school subtotal is (2.5×19.8)+(4×48.5)+100=2.435; and the college subtotal is (2×8.5)+(5×9.2)+100=0.636. Col. 5 is based on these unrounded numbers. It should be noted that the total years of schooling completed per member (10.60) is slightly larger than the total (10.45) 1940 equivalent years of schooling completed, shown in table 2 for the labor force, because of a small difference in the data and procedure used.

[2] Each amount is the product of the corresponding items in cols. 2 and 3.

[3] Average cost per member per year, obtained by dividing $7,663 by 10.60.

[9] For the underlying estimates, see "Capital Formation by Education," op. cit., and "Education and Economic Growth," op. cit., p. 64. The reader should bear in mind that these estimates of costs include *income forgone* by mature students and that this component in the real costs of education is large both for high-school and for college and university education.

that table 5 is based on the upper estimate of costs for 1900. The cost of the educational stock of the labor force, thus defined, in 1957 was 8½ times the 1900 level (from an index of 100 to 849). If the lower estimate figure for 1900 is used, that is, $423 instead of $540, the stock of education in the labor force rose virtually 11 times between 1900 and 1957. The stock of nonhuman reproducible wealth (Raymond W. Goldsmith's estimates)[10] rose only 4½ times, as shown in column 5 of table 5.

TABLE 4.—Cost of education per member of the labor force in 1900, according to years of schooling completed [1]

Type of schooling	Years of schooling per member		Cost of schooling per year	Total cost per member [2]	
	Lower estimate	Upper estimate		Amount (upper estimate)	Percent
Elementary school	3.75	3.437	$280	$962	43
High school	.31	.556	1,420	790	35
College and university	.08	.147	3,300	485	22
Total	4.14	4.140	[3] 540	2,237	100

[1] These estimates are computed from a study of the high-school enrollment and graduates, and also of college enrollment and graduates from 1900 back to 1850. High-school enrollment represented about 0.636 of 1 percent of the population, and high-school graduates, 0.351 of 1 percent. For college and university students, the 2 comparable estimates were 0.270 and 0.135 of 1 percent. Distributing all of these among the labor force of 1900, we have for elementary school (83.5×2.53)+(16.5×8)+100=3.437; high school (2×5.16)+(4×11.33)+100=0.556; college, (2×2.46)+(4×2.46)+100=0.147. The average cost per year of schooling becomes $423 instead of $540 if the lower estimate of years of schooling per labor force member is used (col. 2) both at 1956 prices.

[2] Each amount is the product of the corresponding item in cols. 3 and 4.

[3] Average cost of schooling per member per year, obtained by dividing $2,237 by 4.14.

TABLE 5.—Stock of education measured by costs and stock of reproducible nonhuman wealth, United States, 1900–57 [1]

Year	Cost of an equivalent year of schooling (1956 prices in dollars)	Cost of [2] educational stock, population 14 years and older (in billions)	Cost of [2] educational stock, labor force members 14 years and older (in billions)	Stock of reproducible nonhuman wealth (in billions)	Percentage col. 4 is of col. 5
(1)	(2)	(3)	(4)	(5)	(6)
1900	$540	$114	$63	$282	22
1910	563	168	94	403	23
1920	586	227	127	526	24
1930	614	328	180	735	24
1940	650	465	248	756	33
1950	690	656	359	969	37
1957	723	848	535	1270	42
Index 1957 (1900=100)	134	744	849	450	191

[1] The procedure for deriving the estimates of the cost of an equivalent 1940 year of schooling shown for 1900 appears in table 4, and for 1957 in table 2. A similar procedure was used for 1940. Estimates for the rest of the year were obtained by extrapolation.

In col. 3 each item is obtained by multiplying the corresponding item in col. 4 of table 2 by that in col. 2 of table 5. In col. 4 each item is obtained by multiplying the corresponding item in col. 7 of table 2 by that in col. 2 of table 5.

Cols. 3 and 4 are based on 1956 prices. Col. 5 is derived from the work of Raymond W. Goldsmith, who kindly made available his estimates of U.S. (national) reproducible wealth at 1947–49 prices, which I then adjusted to 1956 prices.

[10] Personal communication.

Concluding Observations

1. A comparison of the several measures presented shows how much they differ. The estimates that follow are restricted to the education of members of the labor force.

Measure of educational stock	Increase between 1900 and 1957 Index 1957 (1900=100)
I. Years of schooling completed (table 1)	359
II. Equivalent 1940 years of schooling completed (table 2)	638
III. Cost of schooling:	
(a) Upper estimate cost in 1900 (table 5)	849
(b) Lower estimate cost in 1900 (table 4), also related text	1,002
Stock of reproducible nonhuman wealth cost (table 5)	450

2. The measure, "year of schooling completed," understates greatly the increase in the stock of education that has been realized over the decades if for no other reason than that the average daily attendance of enrolled pupils rose 60 percent between 1900 and 1957.

3. "Equivalent years of schooling completed" also understates the increase in the stock of education because it does not distinguish among years of elementary, high-school, and college and university schooling; each year regardless of the level is treated the same. From an investment point of view, a year of elementary schooling costs much less than a year of high school or of college, and the latter two have been increasing much more rapidly, as the following estimates show.

TABLE 6.—Years of schooling completed per member of the labor force

Type of schooling	1900 (upper estimate)	1957	Increase between 1900 and 1957 Index 1957 (1900=100)
Elementary school	3.437	7.52	219
High school	.556	2.44	439
College and university	.147	.64	435
Total	4.140	10.60	256

4. Our third measure based on costs of schooling is a preliminary estimate of "stock of output capacity" represented by education. It does not distinguish between the younger and the older workers in the labor force in measuring their education; for example, a year of high school is given the same weight whether the worker is 25 or 60 years of age. There is also the implicit assumption that a year of schooling of a given level (elementary school or high school or college) acquired recently or many years ago are comparable once an adjustment has been made for differences in length of school attendance. Nor is there any allowance for obsolescence of education. Surely some instruction is better now than it was several decades ago, and also, some education is subject to obsolescence.

5. The equivalent years of schooling completed per member of the labor force have risen more for those in the younger than in the older age groups, as the following estimates make clear.

TABLE 7.—Years of schooling completed by members of the labor force, by age group, 1900 and 1957

Age group	Number of years of schooling		Increase between 1900 and 1957, Index 1957 (1900=100)
	1900	1957	
14–19	4.2	11.0	262
20–24	4.6	12.8	278
25–44	4.2	12.2	290
45–64	3.8	7.8	205
65 and over	3.3	5.6	170

6. Despite the greater increase in education of workers in the younger groups relative to those in the older groups, the average productive life of the entire stock of this education may not have changed appreciably. Assuming a productive life up to the 68th year of life and the same rate of deaths and disabilities for each age group, a crude estimate indicates that the average productive life of all of the education in the labor force was slightly more than 30 years in 1900 and about the same in 1957. The reason for this result seems to be the fact that young people now enter the labor force at a somewhat older age than they did in former years, mainly because they continue their schooling for more years.

7. If the above statement about the average productive life of education of the labor force proves to be approximately correct, our estimate that the stock of education in the labor force increased 8½ times between 1900 and 1957, as compared with the increase in the stock of reproducible nonhuman wealth of 4½ times takes on added significance. As I have attempted to show elsewhere, investments in education may explain a large part of the otherwise unexplained economic growth of the United States.[11]

[11] "Education and Economic Growth," op. cit., pp. 78–82.

CHAPTER 8

Education and Economic Growth

*Richard S. Eckaus**

ECONOMIC ANALYSIS of education potentially can contribute a great deal to the understanding required for the formulation of an educational policy that will make the best use of human resources and contribute most to economic growth. Not all education, of course, has an economic motivation, but this does not preclude concentration on the economics of education.

The particular objective of this paper is analysis of the significance of higher education in economic growth. To achieve this objective, it is necessary to consider the role of education in the economy, its contribution to economic growth, and its effect on the distribution of the benefits of that growth. Many of the economic features of education can usefully be analyzed as a process of capital formation. The process and its results can then be compared with other types of capital formation in order to develop a better understanding of the special contribution of higher education to economic growth.

Thus, part I of this paper discusses an educated labor force as a productive capital factor in the economy, and its special characteristics. Part II explores the implications of this analysis for the demand for and use of college-trained manpower. The analytical approach is then extended in part III to a consideration of the conditions of supply of such manpower.

In this area of investigation, as in others, it is easier to ask questions than to find answers. However, it is also true, I believe, that the right questions about an economic policy in education have not been asked often enough and in a sufficiently specific form. When this is done, there is a much better chance of abstracting useful facts from the abundant statistics available. This paper is mainly an attempt to pose the issues of investment in education in a manner susceptible to economic analysis. It presents and discusses some methods of developing a practical basis for resolution of the issues.

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I. Educated Labor as a Capital Input to Productive Processes

It may appear somewhat strained to treat educated labor even in some limited aspects as if it were a capital factor.[1] From the viewpoint of the individual and of society as a whole, however, education is similar to the production of physical capital goods. Both require the use over a period of time of facilities such as buildings, materials and equipment, and labor skills. Both necessitate the sacrifice of goods and services that might otherwise have been produced. Both will yield "services" over some subsequent period. The essential capital-formation features are the same, but, of course, the conditions of "production," the time periods involved, and the resources required vary extensively. These variations, the restrictions they place on human-capital formation, and their implications for growth are discussed here.

EDUCATION AS RESOURCE DEVELOPMENT

To gain an appreciation of the significance of education treated as a process of capital formation in humans, it is helpful to use an analogy with the natural resources of a nation—its farmland, mineral deposits, rivers, and so on. Virtually none of these, by themselves and unimproved, yield useful outputs. Yet after they are worked upon by men and equipment, they produce crops, ores, and power. After developmental work, natural resources become a kind of capital, each type of resource possessing some unique features, but having the same essential quality of yielding goods or services over a period of time after some initial investment of effort. There is no generic term for the developmental efforts that must be applied to natural resources to make them into productive capital, but there is such a term for efforts to develop human resources. It is "education." Over a period of time education will improve the productivity of labor and will result in services that could not otherwise be performed.

In turning to analysis of the special characteristics of educated labor as a capital factor, it will be useful to refer to the analogy with development of resources, natural and human. It is a fruitful one and worth pursuing because it helps to make appropriate the application of well-known economic concepts. For example, the amount and quality both of human and of natural resources in a society depend on their development, and these resources can never be known

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[1] See Seymour E. Harris, *ed., Higher Education in the United States, the Economic Problems.* Cambridge, Mass., Harvard University Press, 1960; Paul C. Glick and Herman P. Miller. Educational Level and Potential Income. *American Sociological Review,* 21: 307–312, June 1956; Theodore W. Schultz, Capital Formation by Education. *Journal of Political Economy,* 68: 571–583, December 1960.

until they are cultivated. Investment in oil exploration and in improvement of extraction techniques will actually change the known available oil reserves. Again, land fertility is not a once-and-for-all unchangeable gift of nature. Fertilization and irrigation will increase fertility, as will development of new crop strains especially suited to the land. These will contribute to the land's economic value and even to what may be considered the total amount of arable land available. Similarly, labor skills not only are developed by education but they are found as well. It just does not seem to be true that human talent will always appear no matter how discouraging the environment and inadequate the cultivation. One of the functions of an educational system is to act as a mechanism for searching out and selecting potential talent. Thus education not only improves the quality of a labor force but also increases the amount of talent beyond what otherwise would be known. And different levels of education probably make different kinds of contributions to the uncovering of individual potentials.[2]

One feature of productive capital that is of great importance in determining its role in economic growth is the specificity of its use in the production of some particular commodity. Many developed natural resources have a wide range of applications in production, or they are applied in a wide range of industries, and accordingly have considerable mobility between industries. Fuel and other power resources are a good example of this; and so, too, are fertile, well-watered land in temperate climates, and many mineral resources. They are the source of a wide range of final products. The products of some resources, however, have only a limited range of alternative uses. Potash, for example, is mainly a fertilizer, and when the processes of synthetic nitrogen fixation were developed in the early years of this century, the value of a fertilizer that had been a great natural resource of Chile was vastly reduced. A similar phenomenon is the obsolescence of physical capital due to a change in technology or to a transfer of demand from the commodity the capital produced. Generally, the greater the range of uses of the capital equipment, the less likely it is to be made completely worthless by such a change. A simple lathe, for example, which can produce rotary metal shapes for a large number of uses, is less likely to become obsolete th a

[2] There is still another reflexive or feedback effect of education on the amount of human skills available—an effect that is of special importance in the economics of emerging nations. This effect makes itself felt via the relation between education and the total size of the population and of the labor force. There is no doubt that in many countries educational levels and birth rates are inversely related. However, it should be kept in mind that education may not be the causal factor in this relation, or at least not the only causal factor. It may to some extent operate only indirectly via its connection with income levels.

complicated machine lathe that is highly specialized in its design for producing some particular part.

Generalization on the relative specificity of educated labor is difficult because of lack of organized information. Still, most human capital is probably uniquely mobile as compared with most physical capital. Certainly the range of usefulness of an elementary education in production processes is very broad. This level of education, however, is not sufficient to meet society's need for skilled and professional workers. Although education permits greater specialization, it does not limit the range of fields in which individuals may be useful in an economic way. "Education is broadening" has a vocational as well as a cultural meaning. Persons with a higher education may become "narrow specialists" but not necessarily. A lawyer's education, for example, seems to equip him for a wide range of occupations that transcend even the broad legal field. Again, the potential openings for a mechanical engineer are many and varied. It is probably true that the transferability of skills, in a very general sense, from one type of productive activity to another, is greater for college- and university-trained persons than for those in manual and technical trades; however, even in the latter there is undoubtedly a considerable transferability of competence and knowledge.[8]

There are instances in which changes in technology, or perhaps demand for the product, have eliminated the need for certain human skills, and in which human capital could not be shifted with ease from one occupation to another. Most of what has been written on the subject of technological unemployment, however, is highly impressionistic, and there have been few attempts to quantify and measure the changes that have occurred. In some of the changes that have eliminated particular types of industry and occupations as, for example, the displacement of handloom weavers by a mechanized textile industry, certain of the skills required in the new industry are the same as those in the old. Of course, fewer persons are required on account of the large increase in productivity, so a substantial obsolescence of human capital is still involved.

It is tempting to generalize that obsolescence of human skills is a greater danger at lower rather than at higher levels of skills and, in particular, that it happens rarely in professions. Certainly it is easier to think of examples of obsolescence in handicraft skills than in professional skills. Yet it does happen in professions also. There

[8] The distinction between general education and occupational training is, in part, a distinction as to whether the studies prepare for further education but the distinction has another sense as well. It also refers to the specificity of the skills created. Though occupational training is most commonly used to describe the development of skills in particular vocations, much of higher education is also training for an occupation.

are physicians whose specialties have become less in demand as a consequence of development of new drug therapies. And certain fields of engineering have lost much of their former vogue, in part owing to changes in technology or in demand for particular products.

HUMAN VERSUS NONHUMAN CAPITAL

Of all the features of human capital that distinguish human capital from physical capital, the most significant are the "noneconomic" factors or motivations.[4] Individuals do not go to school and college merely as the result of a calculation of the rate of return achievable.

Certainly a basic education is commonly regarded as an absolute prerequisite for the achievement of personal, noneconomic goals by the individual and his guardians. Higher education is also heavily overlaid with "noneconomic" motivations, though perhaps not as much as is sometimes assumed in the discussions of the value of a liberal arts education, for example.

Likewise, though employers hire workers mainly on the basis of an economic calculation that takes skills and education into account, the calculation is usually not the only factor in making the contract. As far as the *hirers* of educated labor are concerned, the noneconomic motives, to the extent they operate at all, are probably more significant for the more highly educated workers than for workers with only an elementary-school education.

Many, though not all, of the noneconomic aspects of education can be summed up by the economist as follows: Education is like a consumer good as well as like the investment process. Economists do not inquire deeply into why the tastes of consumers are what they are, but take them as more or less given patterns, which, along with incomes and prices, determine the actual purchases. In a similar way it is possible to concentrate on the implications of noneconomic factors in the education process. A few examples will illustrate the point.

In many societies education has a prestige or a social value that is independent of its economic significance. As obvious examples: in Burmese, Jewish, and early New England societies religion constitutes a primary motive for education to the level of literacy; the individual is expected to be able to participate in religious activity through his own reading. As a less obvious but important example, one might cite the increase in students specializing in the sciences in recent years

[4] This terminology could be interpreted either as an understatement or as the reflection of gross pretentiousness on the part of the economist, as it lumps together in a residual class all manner of influences that rank high on anyone's scale of values. Yet it only reflects the economist's way of organizing the relevant influences to bring them within the scope of his analysis. These noneconomic factors must be taken into account and their economic significance analyzed. The most convenient way to do it at this stage of knowledge is to consider them together.

and the relative decline in applications for admission to medical schools. Yet the medical profession remains at the top of the income heap. The prestige of the scientist is reflected not only in the pursuit of scientific education by students but in the hiring policy of business. Industrial research has been profitable, but it is also true that scientific research manpower has been hired and hoarded by some businesses in a way that cannot be explained by economics alone.

Noneconomic factors are by no means entirely absent from decisions on physical capital investment; to be sure, there are fads and fashions there as well. However, the noneconomic features of physical capital are seldom presented as the main justification of its existence, as is often true in regard to education. The calculations may not be precise and there may be biases in selection, but the major criterion for private investment in physical capital is economic, not esthetic, nor religious, nor any other. Public investment in physical capital is another matter; the motives for this public investment may be quite similar to the motives for sponsorship of public schools.

Two essential features of labor as a factor in production tie the noneconomic aspects of education closely to its economic aspects. First, labor's qualities as a productive input cannot be divided and used separately. A man is a man, and when he works with a spade or a machine he is also a citizen, a member of a family, a little bit of an enterpriser, and so on. The education he acquires in, and for, any one role in which he functions is also applied in some degree in every other role. Put another way—the economic role of education in the preparation of skills for use in production cannot be fully separated from its consumption features. The education and skills obtained as consumer goods may not be distinguishable from those obtained as investment in capital. This also means that the income of labor is not and cannot be fully distinguished between returns due to native ability, unskilled effort, family and cultural indoctrination, or the various types of formal education that have been acquired. In this respect individuals in their acquisition of education are like small proprietors whose business fortunes are not separable in law from their personal fortunes.

The impression is not intended that all the noneconomic aspects of labor can be summed up and analyzed as if they constituted simply another consumer good. Opportunity for social advancement is a private and also a public consumer good, and considered as a public consumer good it is a most unusual one. Since social advancement is related to income, it is associated with investment in education, but it does not depend only on economic achievement.

A second unique feature of labor is its inalienability; more bluntly, people cannot sell themselves. This means that the viewpoints of the

individual and of society are going to be different from the viewpoints of firms hiring labor. Firms pay for and use the flow of labor services resulting from the formation of human capital by education, but they are not primarily concerned with that capital-formation process itself. They may train workers if there is no other way of getting the services they need, but if they do provide training, they need to realize that they cannot be sure of fully recapturing all the benefits of that capital-formation process. It is, of course, no reflection on business firms that their point of view does not correspond with that of the workers nor with an overall vision of society. Permanent vesting of control and "ownership" of his labor in an individual means, among other things, that there can be no guarantee that his motives and incentives will be identical with those of the business firms for which he works or of society as a whole.

Allied to inalienability are the restrictions in a free society, especially, on the means which can be used by society to recapture for general use the benefits of investment in the education of individuals. For example, persons trained by one of the military services may be required to devote a specific minimum time to that service. The more general obligations of citizens for the education received are not well defined, partly because the general social benefits of education also are not well defined.

Education has so far been considered in terms of its ability to reproduce skills and thus form human capital as a consumer good and as an instrument of social policy. It is more than this; it can create the potential for finding new goods, new technologies, and new instruments of social policy. No other kind of capital formation has all these features.

It is useful within the scope of economic analysis to consider education as if it were a process of creating human capital. It is more than that, to be sure, and the economic analysis of this aspect of education is not intended to deny its other aspects or even to reflect on their comparative significance. The purpose of this section has been to describe in a general way the features of human capital that set it apart from physical capital. These require special attention and accommodation of conventional economic theory as the analysis proceeds to a consideration of the specific demand-and-supply factors for human capital.

II. The Educated Labor Required for Economic Growth

Education can be the equivalent both of a consumer good providing personal satisfaction and an investment good that contributes to the production of other goods and services. In considering this latter aspect of education, we now ask questions similar to those conven-

tionally asked about physical capital and economic growth: Is our rate of investment in human capital, that is, in education of persons, adequate if we want to accelerate our rate of economic growth? Is it even adequate to maintain our present growth rate? Is the present composition of this type of investment the optimal one? That is, is the system producing engineers, mathematicians, physical scientists, doctors, and teachers, of various types in the proportions that are most effective in aiding our economic growth? Recent developments in the world abroad that have disturbed the complacency of the United States, as well as domestic pressures such as those due to our population surge, have increased the urgency of such questions. Since the preparation of this volume is in part an expression of this newly increased concern, we need not delve further into its sources.

However, such questions are also being asked in the less-developed nations of the world, perhaps with even greater urgency. These nations start from much lower income levels and are under great pressure to improve their economic performance. There is less leeway in their systems since they have very little of any type of educated labor and other resources and therefore they can less afford mistakes.[8]

These questions differ from the more common ones. Usually they are posed in such terms as: "Shall we spend more on education? Shall we subsidize medical education? Make loans for college education?" Such questions do not specify the objectives of the proposals and thus do not provide or imply a criterion for decision. There are a variety of possible objectives. Economic growth and equalization of opportunity are two such. It is likely that these are not strongly competing objectives, but that is not at all certain, and situations may arise in which they do compete.

Moreover, these latter questions do not recognize another possibility: that there may be more than one set of combinations of investment in physical capital and human capital via education, which would satisfy the requirements of a particular growth rate. Thus, the fundamental economic criterion must be kept in mind; namely, that the optimal combination of the investments required to achieve a certain growth rate in the combination which requires the least sacrifice of consumption (including that education which is a consumer good). It is not because sacrifices are to be avoided at all costs that the criterion is posed thus, but rather because there is no way in which they can possibly be avoided, and they should be minimized. Education, like any other activity, uses productive resources; some types of education require more resources than other types, but in any case the more education, the greater the resource

[8] The questioning of educational objectives has also led to a new concern with educational methods. This is an area that this chapter will not attempt to enter.

requirements. Many of the resources used for education can be devoted to other purposes, and there is a good deal of possible switching between types of education. Resources for education, and for all other types of activity, are not unlimited; in any year there are just so many. If economic growth proceeds, there will be more resources in the future but never an unlimited amount. Therefore, diversion of resources to provide more, better, or different types of education means that some other type of economic activity will have to be sacrificed. The sacrifices may be only of potential output or satisfaction, but that does not make them the less real and important. This is true even when there is some unemployment of resources, as in a recession, because there is always some choice as to how the resources may be reemployed and, if one line of activity is chosen over another, the second is sacrificed. One has only to follow closely the politics of various antirecession measures to realize how well the various economic interest groups realize that this is no abstraction as they maneuver for a preferred position.

This reasoning points up the inadequacy of educational policies based on the maxim, "the more the better." In a full-employment economy, having more of investment in education generally means giving up some amount of something else. Anyone is entitled to the opinion that society *ought* to give up some of its other consumption or investment in order to have more investment in human capital, and the relative wealth of the United States may suggest that such sacrifices are "easier" in the United States than in other countries. Unless such opinions are based on a careful evaluation and balancing of the alternative ways of achieving economic growth, however, they can have no other status than that of personal, normative judgments. Education considered as an investment in human capital is a way of achieving economic production and must be considered as such and balanced against other ways. This approach does not imply a narrow view of the economic contribution of education—a view that leaves out the role of higher education, especially, in creating the basis for finding new knowledge and developing new products via research. Such functions cannot easily be brought within the operating framework of decisions about education, but they should not be ignored, and it is not intended here that they should be.

The inadequacy of the maxim, "the more the better," on which so much discussion of educational policy seems to be based, is perhaps most clearly demonstrated in practical decision making—from local school boards through State boards of education to the Federal Congress. Policy decisions are contrained by limited resources—resources that must be spread among such projects as welfare work

and highway construction. It is important for people to have opinions as to whether all or part of these expenditures should be aimed in a particular direction. But again the question finally must be asked, "How much?" taking into account the alternative investments possible.

THE LOGIC OF EDUCATIONAL POLICY DECISIONS

The logic of the requirements for investment in education for economic growth is the same as the logic for investment in physical capital. It is easier to describe than to implement. A statement of this logic, however, will provide the criterion by which to judge partial policies or rules of thumb to determine if they are at least influencing decisions in the right directions.

Growth by itself is not an adequate specification of an economic goal, for growth can take many forms and encompass different combinations of outputs of consumption goods and investment goods of various types. These different combinations may in turn entail different patterns of inputs of productive resources of various types, including both physical and human capital. Thus, logically, before one can begin to discuss the question of optimum combinations of these inputs and therefore of the requirements for them, the targets of the growth must be specified in terms of the relative increases desired in the outputs of the various sectors. It must also be kept in mind that the targets themselves are not invariant to resource availabilities and possible combinations. These latter two factors will determine the relative cost of reaching various targets, and there is some substitution between them on a cost basis, just as the consumer decides between meat and cheese according to their costs.

There is another type of information that is essential for making decisions on the amount of resources that should be directed toward education to form human capital. This is information about what economists call "production functions": the ways in which materials, physical capital, and human capital can be combined to reach production targets. Essentially it is information about technology in a very general sense. It requires quantitative knowledge about all the inputs for the various outputs. This includes data on the productive resources, human and otherwise, required for the formation of human capital by means of education and of physical capital of various types, as well as of consumer goods. Of course, the questions about the relative mobility of human and physical capital raised in part I of this chapter would also have to be answered.

Given all these kinds of information the economist can visualize a grand synthetic program which results from an optimizing proce-

dure subject to the technological and other constraints described. This program would then specify the optimal amounts of education of various types which should be given, just as it would specify the optimal rate of investment in the different types of physical capital and the best use of natural resources. Educational policy would emerge as just one other aspect of an overall economic policy.

Perhaps it is not even necessary to explain why this grand, dynamic, synthetic program cannot be implemented. Yet it may be useful to underscore the fact that our inadequacies in formulating educational policy for investment in human capital are of the same kind as we would have in formulating an investment policy for physical capital. The technological and consumer information required for that grand program just does not exist and most of it cannot be obtained except at high cost. Moreover, on account of the scope and the complexity of the interrelationships, it would be quite impossible, with all the constraints involved, to solve the huge problem.

The problems may be more obvious if viewed in relation to those of the less-developed countries that do undertake to formulate consciously and explicitly an investment policy not only for the public sector but at least as a guideline also for the private sector. In the United States the primary public investment is investment in education; physical investment planning is left mainly, though not exclusively, to the private sector. (Of course, investment in education in this country is by no means an exclusively governmental activity.) The less-developed countries are trying to improve themselves economically as quickly as possible in the face of pressing resource scarcities. Thus they are vitally concerned with doing as well as they possibly can in the formulation of comprehensive, optimal physical investment programs. They do not completely succeed, owing to the analytical and data problems mentioned earlier. They "make do" with approximative, rule-of-thumb procedures, as we must in formulating a policy for investment in education.

METHODS OF APPROXIMATION

The approximative procedures that economists have developed enable them to know something about the characteristics of that grand synthetic program. Experience has indicated that it is possible to develop rough but useful guidelines for physical-investment programs.

The next step is to compare the use of such approximative procedures when applied to the problems of the requirements for human capital to determine what information and guidance the procedures might yield.

One method in use is to estimate the returns due to investment in education and compare them with the returns elsewhere in the econ-

omy.[6] Since an optimal policy in a perfect market would direct resources where the returns are highest, such a comparison might be expected to indicate whether more or less of the various types of educational investment should be undertaken. Unfortunately, there are many difficulties in applying the method. One of the most serious of these is the inability to estimate *all* the returns attributable *only* to the education that contributes to economic production. Wages and salaries are certainly not entirely adequate for this particular purpose. This suggests that there is a serious problem in drawing conclusions from such studies: what may be true for an individual, as far as the "profitability" of investment in education is concerned, is not necessarily true of society as a whole. Nonetheless the method should be developed further and refined for the light it can throw on the problem so long as the conclusions derived are presented with appropriate care.

One of the most common and most powerful methods used by economists in determining overall physical-capital requirements for growth is the application of ratios of marginal-capital requirements to prospective increases in outputs. Many studies have been devoted to the development of these ratios; and in the hands of an experienced economist, aware of all the inadequacies of the tool, such capital-output ratios can provide order-of-magnitude estimates that might otherwise be impossible to achieve.[7] The ratios have a number of serious faults, which must be taken into account. Aside from many difficult accounting problems that make their use suspect, they are calculated on a historical basis and accordingly reflect a particular past composition of output and of patterns of investment undertaken. Since change in these patterns is usually one of the objectives of growth, the use of historical ratios creates a bias in the results. There are also such problems as adjustment for less than full utilization of capacity, and for the changing importance in different years of additions to existing plant and equipment and of completely new installations.

A rough adaption of this method, comparing trends in enrollment and openings in the professions, is used by Harris in coming to his conclusions about the dangers of "overeducation."[8] This method, however, again fails to distinguish between the various functions of education and assumes that all such education is only for the economic

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[6] See Gary S. Becker. Underinvestment in College Education? *American Economic Review*, 50: 346–354, May 1960 Papers and Proceedings, American Economic Association.

[7] See P. N. Rosenstein-Rodan. *International Aid for Underdeveloped Countries*. Center for International Studies, Massachusetts Institute of Technology, Cambridge, Mass., January 1961.

[8] Seymour E. Harris. *The Market for College Graduates*. Cambridge University Press, New York and London, 1949.

purpose of creating the optimal amount of human capital. Yet it is possible that further work in this direction will eventually also pay off.

ORIGINAL INVESTMENT COST OF EDUCATION

Only recently has an estimate appeared of the capital formation by education, prepared by Schultz, which undertakes to quantify the investment in education.[9] His estimate has a number of conceptual difficulties both in concept and in measurement.

In such estimates the "opportunity costs" to society of educating students must be taken into account. These costs are the opportunities for output and income that are forgone by society when individuals, instead of entering the labor force, remain students. Such costs are naturally greater at the higher levels of education than at the lower. In computing these, some careful "social accounting" must be done. Schultz estimates the opportunity costs essentially by computing the average returns attributable to the lost hours of work of a typical student. He recognizes the potential criticism that the method is a "partial equilibrium" approach, which does not take into account the alternative effects of a wholesale transference of school-age workers into or out of the labor market. However, Schultz claims that his *is* only a problem of a shift on the margin of a typical worker. But an estimate of capital stock in education on this basis cannot be used to estimate the changes in total output due to a radical change in the number of students enrolled in schools and colleges.

Nor should the total forgone earnings necessarily be used to estimate the opportunity cost to society of the years spent in education. The earnings loss is not even a true estimate of the differences in total national income that are due to the withholding of labor from the working force. What also must be taken into account is the possible return on the savings which might have been generated if additional income had been available to the family. The different levels of consumption that might otherwise have been maintained need also to be taken into account. Perhaps no better estimates could have been made concerning the period in which data are available, but it raises doubts about comparability of the estimates for different points of time if the basic behavior patterns have changed and the estimating procedure has not.

Though Schultz recognizes that a part of the education given and received is really a consumer good, he does not separate that part from the total capital formation by education. It might be argued that even though there is some education that is essentially used as a consumer good, it could yield productive services just as the education

[9] Theodore W. Schultz. Capital Formation by Education. *Journal of Political Economy*, 68: 571-583, December 1960.

intended primarily to form productive human capital does. Therefore it, too, should be added to the capital stock created by education. This addition would be hard to justify, however, in the face of the well-known differences in the returns from various kinds of education.

There is a serious omission, however, in the failure to take account of that type of education which usually comes under the "vocational" heading. Only part of this is given in schools, public or private, and, therefore, it is in general not recorded by Schultz's statistics. Yet no one would argue that vocational education is not a significant type of investment in human capital. Much of such education is obtained through more or less formal on-the-job or apprenticeship training programs, and the training acquired in even more casual ways still has an effect. So, on the one hand, Schultz's estimate includes a certain amount of consumption services, and on the other, excludes a certain amount of what undoubtedly is productive of human capital.

Finally, the approach adopted by Schultz, starting from the side of the education which is "given" to students, assumes implicitly that all such education is used. As a matter of fact, not all the members of the student population, even in the working-age groups, are potential members of the labor force or would be in the labor force if they were not in school. This applies particularly to girls. However, it is to some extent true of all students for several reasons. It was pointed out in part I of this paper that education itself is not the only function of an educational system. It also serves as a selection and placement device, and in performing these functions "gives" education that is not used. For example, in the process of becoming a lawyer, a student may first become an engineer in a college career which turns out to have been a means of deciding *not* to become an engineer. Still, it might be argued that this is part of the education necessary to make him a lawyer. There are other and cheaper ways of selecting and placing students, to be sure; but some use of education for this purpose may be inescapable.

It is clear that not all students in the labor force use the maximum amount of education that they receive; some human capital is unemployed. Some educational systems just make mistakes, though when they do it is not only, perhaps not even primarily, the fault of the educational system itself so much as a characteristic of the culture in which it is embedded. Good examples of this point are provided by the educated unemployed in some of the less-developed countries of the world: classics scholars who cannot find jobs or who become petty clerks in the midst of a dearth of human capital with technical skills. In the United States, when teachers leave their profession to take jobs for which they do not need all the skills they have acquired, we have another example of the unemployment of human capital.

REPLACEMENT COST OF EDUCATIONAL CAPITAL

There is another approach to the estimate of human capital and the economy's requirements for growth, which can be described here though results are not yet complete.

Underlying the concept of human capital is the notion that there are specific requirements for educated labor for economic production, and that changes in the composition and availability of this capital affect growth rates. This, in turn, suggests that a careful examination of production processes would reveal the number of workers with different amounts of education required to operate the processes in combination with materials and capital equipment. This is simply an application of the idea mentioned above that there are production functions for the various components of the national product that indicate the outputs which can be achieved by alternative combinations of inputs. Conventionally in economics all workers are treated as homogeneous or equal inputs. When considering the economic requirements for education, it is necessary, however, to distinguish the different types of workers in terms of their different amounts of education, including vocational training. Only disaggregation of jobs into educational categories will reveal whether there are substitution possibilities between such types of labor.

It would be extremely useful for many purposes if complete descriptions of production functions were available, with the alternative disaggregated inputs of labor and the different amounts of education specified, along with other factor requirements.[10] Unfortunately, nothing approaching this detail exists, and in those few lines in which studies of production functions have been made, the specification of labor inputs according to educational level requirements is quite incomplete. In the overall interindustry-economics research program of the Federal Government, sponsored directly by the Air Force, some detailed studies were made of manpower requirements by industry. These studies specified labor requirements by job type and by industry. They did not, however, explore the educational requirements of the different job types, nor take into consideration the substitution possibilities among workers with different amounts of education and other types of resource inputs. The customary assumption in such input-output studies is that there are in fact no such substitution opportunities.

It would be possible to specify the present educational *requirements* of the labor force in detail if all the following information were available: (1) a complete listing of jobs by occupational cate-

[10] See Richard S. Eckaus. The Factor Proportions Problem in Underdeveloped Areas. *American Economic Review*, 50: 642–648, May 1960 Papers and Proceedings, American Economic Association.

gories, and (2) a description of each occupational category in terms of the educational levels required, on the average, for that job. It would then be possible by running through all the jobs and the employment in each to classify all types of employment at the various educational levels. This would then indicate not what education the labor force had actually received, formally or informally, but what was *required* to operate the economy. If the costs of the education of the various types and levels could be ascertained, it would then be possible to formulate an estimate of the human capital employed in the U.S. economy. This would correspond to an estimate of "replacement cost" of the educational investment in people. Such a formulation would omit the education that was obtained essentially as a consumer good—solely for the personal satisfaction received. It would omit also any unused education. If the objective were to provide a basis for estimating the marginal technical *requirements* for education to meet an expansion in the economy, these omissions would be desirable. However, this approach would also omit the amount of education that has to be provided in the performance of the searching and selection functions described above. It also would omit the educational requirements for that component of the population which is not counted as part of the labor force but which, to a great extent, is responsible for the effectiveness of the labor force: housewives. On the other hand, it would include vocational as well as "general educational" requirements.

The basic data requirements specified above can be met only in part for the U.S. economy, but the results mentioned above can be approximated from the available data. The population census provides some information for an occupational distribution by industry.[11] In 1940, for the first time, and again in 1950, some reasonably detailed data on occupations were collected in this census. It is not an ideal source by any means, since responses are recorded from persons who may have no precise idea of their job category and industry classification and may tend to inflate the job description in any case. Unfortunately also, the job classifications used in the census provide only a limited amount of detail for large parts of the employment in many industries, yet no other comprehensive occupational distribution of the labor force is publicly available.

A description of the educational levels required on the average in various jobs is provided in an impressive compilation of information, *Estimates of Worker Trait Requirements for 4,000 Jobs as Defined in the Dictionary of Occupational Titles.*[12] Again, however, this

[11] U.S. Bureau of the Census. *Occupation by Industry, 1950*, Population Census Report P–B No. 1C.

[12] U.S. Department of Labor, Bureau of Employment Security, U.S. Employment Service. 1956.

SCALE OF GENERAL EDUCATIONAL DEVELOPMENT

State of development involving *capability* to function immediately in *one or more* of the following ways:

Level	Reasoning development	Mathematical development	Language development
7	Apply principles of logical or scientific thinking to a wide range of intellectual and practical problems. Deal with nonverbal symbolism (formulas, scientific equations, graphs, musical notes, etc.) in its most difficult phases. Deal with a variety of abstract and concrete variables. Apprehend the most abstruse classes of concepts.	Work with a wide variety of theoretical mathematical concepts and make original applications of mathematical procedures, as in empirical and differential equations.	Comprehension and expression of precise or highly connotative meanings, as in— *Journal of Educational Sociology.* *Scientific Monthly.* Works in logic and philosphy, such as those of Kant, Whitehead, Korzybski. Literary works, such as those of Stein, Eliot, Auden.
6	Apply principles of logical or scientific thinking to define problems, collect data, establish facts, and draw valid conclusions. Intrepret an extensive variety of technical instructions in books, manuals, mathematical or diagrammatic form. Deal with several abstract and concrete variables.	Make standard applications of advanced mathematics, as differential and integral calculus.	Comprehension and expression as of— *Saturday Review, Harper's.* *Scientific American.* "Invitation to Learning" (radio program).
5	Apply principles of rational systems [1] to solve practical problems. Interpret a variety of instructions furnished in written, oral, diagrammatic, or schedule form. Deal with a variety of concrete variables.	Perform ordinary arithmetic, algebraic, and geometric procedures in standard, practical applications.	Comprehension and expression as of— *Popular Science.* "America's Town Meeting of the Air" (radio program).

4	Apply commonsense understanding to carry out instructions furnished in written, oral, or diagrammatic form. Deal with problems involving several concrete variables.	Make arithmetic calculations involving fractions, decimals, and percentages.	Comprehension and expression as of— *Reader's Digest.* *American Magazine.* "Lowell Thomas" (radio program).
3	Apply commonsense understanding to carry out detailed but uninvolved written or oral instructions. Deal with problems involving a few concrete variables.	Use arithmetic to add, subtract, multiply, and divide whole numbers.	Comprehension and expression as of— Pulp detective magazines. Movie magazines. Dorothy Dix. Radio "soap operas."
2	Apply commonsense understanding to carry out spoken or written 1- or 2-step instructions. Deal with standardized situations with only 1 or 2, very occasional, variables entering.	Perform simple adding and subtracting.	Comprehension and expression of a level to— Sign name and understand what is being signed. Read simple materials, such as lists, addresses, and safety warnings. Keep very simple production records.
1	Apply commonsense understanding to carry out very simple instructions given orally or by demonstration. No variables.	None	No speaking, reading, or writing required.

[1] Examples of "principles of rational systems" are: bookkeeping, internal combustion engines, electric wiring systems, house building, nursing, farm management, ship sailing.

SOURCE: Reproduced from "Estimates of Worker Trait Requirements for 4,000 Jobs as Defined in the Dictionary of Occupational Titles," U.S. Dept. of Labor, Bureau of Employment Security, U.S. Employment Service, 1956. p. 110, 111.

publication provides only an approximation of the data desired, since it merely estimates the length of training required on the average for effective performance in a particular job category. For each job it does distinguish the specifically vocational and the general education requirements. Yet the specific vocational training period cannot be easily translated into conventional school years.

Likewise requirements concerning general educational development are described generally in terms of levels of language and reading skills, mathematical competence, and general reasoning ability. These levels cannot be easily translated into units comparable to conventional school years.

In spite of the limitations of the data and the problem of translation, the method provides facts about a description of educational requirements which is not otherwise available. The data, moreover, are closer than any other to the type of data that would enable the economist to stipulate the inputs of human capital in production processes in the U.S. economy. Though the method can be applied now only for the census years, it is the approach that would be used if the technology of all production processes could be described in terms of the alternative amounts of the various required inputs for specified outputs.

In comparing the data for the different census years, it should also be kept in mind that the differences observed are the results of movements among jobs. The method used involves the assumption that a particular job required the same vocational skill and general educational requirements in 1940 and in 1950. No allowance could be made for upgrading of jobs between 1940 and 1950; all that could be measured was the effect of movement between jobs. However, it seems reasonable to assume that this is less significant at the college level than at lower job and educational levels.

Tables 1 and 2 show overall results of the comparison. The requirement for higher education to reach the specified levels for general educational development is limited to a small fraction of the labor force, and this fraction did not change much between 1940 and 1950. In 1940 it was 6.9 percent of the labor force; in 1950 it was 7.5 percent.

Not all of the longer specific vocational training periods can be identified with higher education, though many, and particularly those running over 4 years, usually can. These latter involved only 3.3 percent of the labor force in 1940 and 4.2 percent in 1950 (table 2). Some parts of the vocational training periods of from 2 to 4 years also represent college preparation, but these cannot yet be distinguished from long apprenticeship and similar programs. In any case these percentages should not be added to the percentages requiring a college education for general purposes. There is a great deal of overlapping in the sense that a job requiring a college education as vocational preparation is very likely to require a college education for general background as well.

It is notable that there was a general upward movement of the amount of education required of the labor force in both general background and specific vocational factors. The average schooling required of the labor force for general background was 9.7 years in 1940 and 10.1 years in 1950 (table 1), and the average years of specific vocational education required was 1.26 in 1940 and 1.35 in 1950. These figures provide a basis for comparison of the relative significance of general education and of specifically vocational education in the preparation of the labor force. Altogether then, in 1940 a worker was required to have had, on the average, 11.0 years of both general and specifically vocational education; by 1950 the requirement had risen to 11.5 years—an increase of less than 5 percent.

TABLE 1.—Educational requirements, labor force, United States, 1940 and 1950

Educational level		Labor force			
Scale of general educational development [1]	School grade equivalent [2]	1940		1950	
		Number	Percent	Number	Percent
Total		44,851,060	100.00	55,006,480	100.00
1	0	883,240	1.97	119,220	0.22
2	4	3,475,725	7.75	3,113,040	5.67
3	7	8,775,580	19.57	9,057,170	16.48
4	10	19,264,902	42.96	24,894,200	44.89
5	12	9,567,940	21.40	14,019,480	25.49
6	16	2,313,240	5.16	2,775,180	5.05
7	18	844,420	1.88	1,222,510	2.40
Average years of schooling required		9.7		10.1	

[1] For explanation of this scale, see "Estimates of Worker Trait Requirements for 4,000 Jobs as Defined in the Dictionary of Occupational Titles," U.S. Department of Labor, Bureau of Employment Security, U.S. Employment Service, 1956. p. 110-111.

[2] These figures represent personal judgments about the average amount of conventional schooling required for the corresponding general educational levels. This is obviously a somewhat controversial matter and the advice I have had in translating the scale of general educational development has been conflicting. I do not offer this translation as a definitive one.

Totals may not add because of rounding.

TABLE 2.—Specific vocational training requirements, labor force, United States, 1940 and 1950

Specific vocational preparation range	Labor force			
	1940		1950	
	Number	Percent	Number	Percent
Total	44,851,060	100.00	55,006,480	100.00
1. Short demonstration only	644,975	1.44	255,920	0.47
2. Anything beyond short demonstration up to and including 30 days	7,488,980	16.70	11,544,540	20.95
3. Over 30 days up to and including 3 months	5,931,705	13.23	4,240,220	7.71
4. Over 3 months up to and including 6 months	10,271,980	22.90	12,055,230	21.71
5. Over 6 months up to and including 1 year	1,941,740	4.33	2,755,080	5.03
6. Over 1 year up to and including 2 years	7,883,982	17.54	7,919,880	14.27
7. Over 2 years up to and including 4 years	9,210,985	20.53	12,957,300	23.53
8. Over 4 years	1,458,340	3.23	2,318,370	4.21
Average years of training required	1.26		1.35	

Totals may not add because of rounding.

Another way of assessing the significance of higher education in the training of the members of the labor force is in terms of the number of years of schooling it involves, as compared with the total years required for their general education. In 1940 higher education accounted for only 3.2 percent of all the required years of schooling; in 1950 it was 3.4 percent.

A still more significant economic assessment of the relative significance of higher education in providing the general background required for the labor force is obtained by estimating the total costs of such education relative to that of the other educational levels. This in turn requires an estimate of the costs per student of the different levels of education. Actually only the relative costs per student are important for the present purposes. The problem of estimating opportunity costs was put aside, and direct resource costs as estimated by Schultz were divided by the number of students at each educational level. The costs of schooling at the elementary school, high-school, and college levels computed in that way were in 1940 related in the ratio 1 : 1.9 : 5.8, and in 1950 in the ratio 1 : 1.9 : 4.2, indicating, by the way, a relatively lower rate of increase in the cost of inputs into college education. This helps explain why, in terms of direct resource costs, the costs of higher education required for the labor force would have been 14.2 percent of the total resource costs in 1940, while in 1950 they would have been only 11.0 percent.

Finally, the required amounts of higher education can be at least partially compared with those actually possessed by members of the labor force. From the 1940 and the 1950 census of population, the number of employed persons in those years with 4 or more years of college was computed at 5.9 percent and 7.4 percent of the employed labor force. The requirements for general education (table 1) were 7.1 percent and 7.4 percent of the employed labor force. This indicates that in 1940 some members of the labor force whose jobs required the equivalent of a college education did not have it, and that in 1950 the requirements and actual amounts in the employed labor force matched very closely.

The results are not independent of the data sources, and there may have been systematic overvaluation or undervaluation of the job requirements in the U.S. Employment Service ratings; it is likely that there were systematic upward biases both in descriptions of occupations reported and in educational attainments. Taking all these into account, it is nonetheless useful to find that as yet there is little nonuse of undergraduate or graduate college education among the members of the employed labor force. Two points hardly suffice to define a trend, so the change from 1940 to 1950 cannot be extrapolated.

The point of this presentation is not to give a full picture of the requirements for higher education and the role it plays in the economy, but to demonstrate a method of analysis. The study presented here is a historical one and the results described are highly approximate, but the approach can be developed into a method for estimating current requirements for an expanding economy. Though certainly imperfect, the method can provide a more concrete basis for educational policy than any heretofore available. However, the method tells us little about many pressing contemporary issues concerning requirements for higher education, including: "How much higher education should be directed toward the training of persons for research and development?" This problem has been alluded to above. One of the major difficulties here is in answering the prior question: "How much research and development should there be?" Its outputs are chancy, but possibly very great, and the costs in education high. No entirely conventional approach seems feasible. It will always be a decision shrouded in uncertainty.

III. Conditions Related to Supply of Human Capital

This section will analyze the economic motives for acquiring education, that is, the conditions underlying the formation of human capital to be used in production processes. As was mentioned before, there is a distinction between the educational process, on the one hand, and its outputs, educated labor or human capital, on the other. This section does not deal with the economics of the educational process itself, as, for example, with the allocation of resources between teachers' salaries and equipment.

THE INDIVIDUAL'S CALCULATION

The question for physical capital analogous to that with which we are concerned here would be: "What are the determinants of investment policy, given the technology and market conditions?" The issue as faced by the individual or the family, though seldom considered solely in these economic terms, is: "Should the expenses of additional schooling be undertaken or should the potential student go to work instead and the funds saved or used for additional consumption?" The way questions of this sort are answered must be understood because the actual amount of human capital used depends not only on the requirements or demands arising from technology and the patterns of production but also on the conditions that affect the supply of labor. In the same way the physical capital actually used in an economy depends not only on the investment opportunities but on the amount of savings and of foreign investment that goes on.

The noneconomic influences in these decisions were mentioned in part I above. They should be recalled here since education obtained for noneconomic reasons is often indistinguishable from that obtained from economic motives, and therefore substitutable for it. In the United States and many other countries, expenditures for education rise with income. It is difficult to say how such expenditures behave as the cost of education changes. As between countries the amount spent for education of different levels may vary with no precise relation to income because of essentially different preferences for this kind of consumption good. This paper is concerned with the formation of human capital, however, and therefore the discussion centers on the demand for education for this purpose.

A rational calculation by a family or an individual as to whether to invest in more education would take into account the following items:

(1) The wage income forgone—the amount that could otherwise be earned by the student if he were not engaged in schooling.
(2) The interest income forgone or the consumer satisfaction lost through the amount of money to be paid out as a direct or indirect cost of the education.
(3) The differential in future earnings between income received by a person with additional education and income as it would have been without the additional education.

The first task is to inquire how these calculations look to an individual or a family for different levels of education at different levels of income. The second one is to find whether there are likely to be significant variations between the decisions made by individuals and decisions that are optimal for society as a whole.

Compulsory attendance laws in many places eliminate the need for individual or family decision-making about some levels of education. In this matter the State in one way or another decides what is "right" for its citizens. Of course, not all countries have or can enforce compulsory attendance laws. The lower the level of family income, generally the more significant the loss of any income forgone if a member of the family goes to school, and therefore the greater the difficulty of enforcing the laws. In economies in which the opportunities for advancement through acquiring experience and skill are limited, this forgone income rises with age but levels off at the point where the individual achieves maturity as an earner. One effect of economic growth is to increase the amount of income forgone by study and therefore to discourage individuals from investing in education. The effect of larger opportunity costs probably is more important for upper rather than lower age groups. The same reasoning applies to the interest income or consumer satisfaction that is forgone owing to expenditures on education.

However, one would expect that the significance of differences in income resulting from education would be greater at low income levels than at higher levels. The "discount factor" applied to higher future incomes might vary in a similar way.

As among the different levels of education, it is probably true that the effects of inadequate knowledge and the estimates of the risk involved in undertaking more education have more impact at the higher rather than at the lower levels of education. The relative infrequency of higher education and lack of experience concerning its income effects probably combine to make its payoff seem more uncertain than the return on lower levels of education where the skills learned are more obvious and better known.

DIFFERENCES BETWEEN THE INDIVIDUAL'S AND SOCIETY'S CALCULATIONS

Even such a brief appraisal suggests the following significant aspect of investment in human capital: The calculation of its worthwhileness or profitability is likely to be quite different for individuals and for society as a whole. The difference between individuals' and society's calculations is due in part to what economists call "external economies"—effects on incomes which are not transmitted through the price system and therefore not calculable from it. For example, it is quite possible that even minor improvements in production methods that do not require professional engineering skill to develop are more likely to emerge from a group of workers with a high-school education on the average than from a group with only an elementary-school education. This clearly would be a reason for society to invest in further education. However, no individual worker with a high-school education could claim a higher wage on this account as the effect is due largely to the mutual stimulation of a group of workers with high-school educations.

Another reason for the difference in the calculation of the worthwhileness of education for the individual and for society arises from the differences in the risks involved. This might be explained best by reference to proposals for an expanded program of loans to college students to finance their education. Such a program would go further toward providing college educations than would no loans at all, but it cannot be claimed that it is the best system of financing more higher education. As was mentioned above, there are substantial risks for any individual or family in financing education. Investment in human capital is not regarded as paying off with the certainty of investment in physical capital or in natural resources. Part of the uncertainty concerning the worthwhileness of education is the result of ignorance and can be reduced by adequate dissemination of knowledge

concerning opportunities. Part of the risk expectation, however, has a firm actuarial basis. The potentialities of individuals reveal themselves only slowly and the process of education includes their maturation. The individual student at elementary- and secondary-school levels, or his family, cannot be expected to be able to know about his future. Thus, they could not be expected to decide on more education just because *on the average* education pays off, though society as a whole can make this decision on the basis of averages. Even at the college level the uncertainties in the student's own mind and in his family's are still very great.

The risks of default on student loans, as they are evaluated by college lending officers or by government acting for society, can be reduced by aggregating the risks and transferring the responsibility to a central organization, just as in a regular insurance plan. But the risks in the eyes of the individual and his family cannot be transferred as long as he or his family is obligated to repay the loan.[12]

This argument also leads to the conclusion that a general loan program would have a bias against low-income families, assuming differences among different income groups in willingness to take risks. Thus, a general loan program does not achieve the objective of equalizing educational opportunities. In addition, since there are regional differences in incomes, the biases would have differential regional effects on the availability of higher education.

The difference between society's view and employers' views helps explain why relatively little formal education is financed by business and why that which is business-financed is likely to be highly specific. Though society as a whole will reap all the benefits of educating its citizens, firms that finance the education of their employees will not necessarily receive the full benefits, owing to the inalienability of human capital. There are relatively few instances in which a firm can be sure of a full payoff for educating the workers. If the education is specific enough, a firm may be sure that no other firm can use it, but it can never be sure of a full recovery itself. There are, of course, examples of educational programs sponsored by firms, and there are societies in which the firm-employee relationship is so close as to make such programs more feasible than they are in the United States. The ultimate vesting of ownership of his labor with the individual forestalls general reliance on business sponsorship, however.

One of the important products of higher education is the discovery of new knowledge. New breakthroughs in knowledge are, however,

[12] See William Vickrey, ch. 16 of this publication.

more uncertain than is the development of the customary skills. Thus, economic calculations for private, individual financing of education for research are in turn likely to be even less reliable than they are for conventional training.

These rather pessimistic views of the adequacy of private support for higher education must be checked against the calculations that have been made of the payoff on investment in higher education. Calculations such as those by Houthakker [14] and Becker [15] suggest a rate of return on investment which, on the face of it, is not higher than that which is available for many types of physical capital. However, it should be noted here, as Becker and others have done, that this rate is not an entirely accurate measure of the return on investment in education either for the individual or for society. It does not include an allowance for the costs to the individual or to society other than forgone income. Inclusion of such costs would lower the rate still further.

In part the low rate can be explained by the fact that not all the return on education is received by the educated workers. There are wide benefits to society which the rate does not take into account. In part it reflects the mixture of consumption and investment motives in individual education. Since the figure is an average, a profession-by-profession survey would show a higher rate for some, say medicine and law, than for others, say college teaching. College teaching, involving as it often does the previous earning of a Ph. D. degree, is notoriously poorly paid. That it nonetheless continues to attract personnel must in large part reflect noneconomic or "consumption" motivations as well as those of investment.

Therefore, in addition to "external" benefits of education of the labor force, which cannot be transferred to labor's price market mechanism, there are indications that the market mechanism does not accurately impute to labor all the returns it would in a perfect market. One implication of the discussion in part I of this paper is that there are inevitably serious departures from such a market in characteristics of the demand for education and its products. Economists long ago recognized the existence of such elements in the labor market when labor was divided into categories of "noncompeting" groups. The terminology is somewhat unfortunate but nonetheless suggestive. Monetary returns do not encompass and adequately measure all the rewards of education to the individual and to society.

[14] H. S. Houthakker. Educational Income. *Review of Economics and Statistics*, 41: 24–28, February 1959.

[15] Gary S. Becker, cited in footnote 6 of this chapter.

IV. Summary

There are no easy guides or obviously good rules of thumb for determining the educational policy that is optimal for economic growth and also fulfills all the other social goals of education. The patterns that now exist represent the influence of tradition and of occasional crises more than they indicate rational planning or allocation of resources by a reasonably effective market mechanism. Some areas of higher education have nonetheless been successful in meeting the needs of society; other areas have obviously not been. Though we have muddled through in the past, the internal and external pressures on our system will not validate such behavior much longer.

It has been useful to make the analogy between human capital and physical capital because the analogy suggests the critical issues that need to be analyzed. It is a suggestive analogy because it indicates the appropriate tools of analysis that need to be applied in determining the optimal allocation of resources to education for economic growth.

However, a conclusion that emerges most clearly from the foregoing discussion is that an educated labor force, though undoubtedly a productive capital resource, is not really like most physical capital as far as its market characteristics are concerned. It is quite different in terms of the demands for its services and in the conditions of its supply. It would be misleading to think otherwise. A final example will help illustrate this point. There has been a good deal of concern in the United States in recent years over the adequacy of the quantity and quality of teaching personnel even at the elementary- and high-school levels. Yet studies of the rate of return on the investment in teachers as a form of human capital would undoubtedly show, as the previously quoted aggregative studies have shown, that this rate is low relative to other rates of return available in the economy. Taking the market mechanism at face value, it would seem to be signaling that there are too many teachers and that the resources we have would earn a higher return if shifted elsewhere. Yet we quite rightly do not believe those signals. As was pointed out above, there are many good reasons why the market mechanism by itself would not lead to optimal resource allocation in this field. Human capital is not like physical capital in a number of ways and cannot be expected to behave as if it were. Economic analysis, if it is to help form optimal social policy, must fully appreciate the uniqueness of the human resource.