BIBLIOGRAPHIC DATA SHEET

1. CONTROL NUMBER	2. SUBJECT CLASSIFICATION (695)
PN-AAK-061	JE10-0000-0000

3. TITLE AND SUBTITLE (240)

Human resources development planning

4. PERSONAL AUTHORS (100)

Kehrer, K.C.

5. CORPORATE AUTHORS (101)

AID/PPC

6. DOCUMENT DATE (110)	7. NUMBER OF PAGES (120)	8. ARC NUMBER (170)
1967	47p.	

9. REFERENCE ORGANIZATION (130)

PPC

10. SUPPLEMENTARY NOTES (500)

(In A.I.D. Discussion Paper no. 15)

11. ABSTRACT (950)

12. DESCRIPTORS (920)

Human resources
Social impact analysis
Social change
Planning
Economic development
Education for development

13. PROJECT NUMBER (150)

14. CONTRACT NO.(140)	15. CONTRACT TYPE (140)
PPC	Res

16. TYPE OF DOCUMENT (160)

70

AID 590-7 (10-79)

370.19
K26

PN-AAK-061 File

A.I.D. DISCUSSION PAPER NO. 15

A.I.D.
Reference Center
Room 1656 NS

OFFICE OF PROGRAM COORDINATION - A.I.D.

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D.C.

Office of Program Coordination

A.I.D. Discussion Paper No. 15

HUMAN RESOURCES DEVELOPMENT PLANNING

Kenneth C. Kehrer

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March, 1967

Introduction

This paper was prepared for the Office of Program Coordination as part of the 1966 Summer Research Project sponsored by that office. It is intended to serve as an introduction to the rapidly expanding body of literature on the economics of education. The knowledgeable reader will find little that is original in the pages that follow. What will be found, however, is an attempt to integrate the literature, with a view toward evaluating it from the perspective of the planner. The essay seeks to find policy guidelines in the literature.

Human Resources Development Planning:

An Introduction

by Kenneth C. Kehrer

The growing awareness of the contribution of improvements in the quality of human resources to the process of economic and social development has become increasingly evident. The pace of development is seen as depending upon the amount and quality of education (both formal and informal) embodied in the population, just as it depends upon the amount and quality of machinery and other fixed capital. Economists and planners had been more narrowly concerned lest lack of skills become a bottleneck to growth; the current concern makes explicit the resource allocation problems under conditions of scarcity.

These problems take a very practical form: Planners must decide what fractions of development and recurrent budgets to allocate to the education sector. Resources scheduled for this sector must be partitioned into those available for the formal education system (schooling), and those allotted to training programs and more informal processes of education. Portions of the schooling funds must be designated for each stage of the system. Competing demands for those funds arise even within the primary school subsector, and decisions must be made among such uses as teacher' salaries, buildings, equipment, and textbooks.

Educators, for their part, can urge increased investment and operating budgets for education, but they surely will get less than is required to improve quality, extend coverage, and reorient the content of education as quickly as they would like. Moreover, planning the development of an education system is complex: it is necessary to take into account not only the funds likely to be available both in the coming year and for several years thereafter, but also the comparative costs and effectiveness of different types of education; the rate at which different types of facilities can be constructed, and the possibilities for the development and manufacture (or importation) of textbooks and equipment; the number of teachers of different levels of qualification and training available, and the rate at which more could be trained or imported; the number of qualified students expected to be available to enter different intermediate and advanced courses in the next few years; the comparative drop-out and failure rates of different courses of education, modified for expected improvements; and a host of other factors affecting the feasibility and costs of expanding and improving different parts of the system. Both because resources are scarce, and because the problems are so complex, educators are becoming increasingly interested in techniques which will permit them to take the relevant factors into account systematically, and to make judgments as to which are the highest priority problems on which to concentrate funds and attention.

In response to these kinds of questions, there has emerged a body of literature -- "human resources development planning". This is an umbrella concept, sheltering quite disparate methods of inquiry. They

are similar, however, in that they view education as an investment which will lead to increases in Gross National Product or social welfare.

The purpose of this report is to summarize briefly several of these types of research which have recently begun to develop techniques for deciding how much of a developing society's scarce resources should be allocated to education and training, as well as determining the relative emphasis to be placed on different levels and types of education. The report will indicate, for each of five major types of research:

the question(s) which the research seeks to answer
the techniques used to answer the question(s)
the major limitations of the approach

The report also refers to several of the most important studies of each type, and their major conclusions, for further reference.

THE RATE OF RETURN TO EDUCATION

(i) The question. What is the net value (expected benefits minus costs) to an individual or the economy of different kinds and levels of education and training?

This is essentially two questions: one focuses on the decision of an individual, while the other concerns choices by society. Both the personal profit and the national productivity orientations seek to weigh alternative uses of resources; the alternative which maximizes the difference between expected gain and loss, expressed as an average annual rate of return on the cost, is regarded as the best investment.

(ii) The research technique. As in all techniques of this type (systems analysis, operations research), the usefulness of cost-benefit analysis depends on the analyst's ability to identify all the costs and benefits, and to express alternatives in commensurable ways.

Much of the research conducted to date has consisted of attempts to identify the costs and benefits of kinds and levels of education; dollar value has been taken as the yardstick in most cases.

When the question focuses on the individual, the future stream of gains attributable to an extra period of education can be compared with the costs incurred in obtaining that increment. Since a dollar received in the future is less valuable than a dollar received today, the future stream of gains must be discounted by an appropriate factor, analogous to an interest rate. The rate which equates the costs incurred in a given year with the discounted stream of benefits is the "internal" rate of return. The person making the decision can then compare various internal rates of return on different courses of education and training. He may also weigh an extra year's schooling against an investment in real or financial assets. The rates of return will presumably provide guidelines toward rational economic action.

For the individual, the discounted future stream of extra earnings attributable to education is frequently taken to be the relevant concept of benefit. But these extra earnings may understate the benefits of an increment in education. Education may lead to benefits which exceed the extra money incomes earned by the educated. Jobs which require

relatively more education may be the "preferred" jobs. If this is true, the analyst should add a dollar sum which approximates this nonmonetary attraction to the total benefits. Part of the value of an extra period of education may be the option it gives one to continue still further up the education ladder. The value of this option will vary with the rate of return on higher educational stages, and the probability that the option will in fact be used. Viewing education as a series of related steps, Weisbrod [40] demonstrated that the expected rate of return on primary education in 1939 would rise from 35 percent to 52 percent in the U.S.

In arriving at a measure of benefit, the analyst generally compares lifetime after-tax earnings of people who have had relatively more education with those who have had relatively less. But this may attribute increases in earnings to education which may actually have been caused by systematic differences in intelligence, ambition, family connections, mortality rates, or unemployment experience. Becker [3] has demonstrated that adjusting U.S. data for differential ability reduces his estimate of the rate of return on college education from 11 to 9 percent. Denison [13] reduced the observed earnings differentials by two-fifths as an arbitrary attempt to correct for the possible overstatement of the benefits of education.

Identifying the costs of education can also be a major problem. For studies of the private rate of return, only the costs incurred by the individual (or his family) appear to be relevant to his decision to obtain more or less education. A large part of the costs borne by the individual are "opportunity costs" -- costs which are approximated by

the income that he could have earned if he had been working instead of being in school. Schultz [31] has found opportunity costs to be about 60 percent of the total costs of high school and college education in 1956.

Education is also a source of present and future pleasure. Treating expenditures on education as an investment neglects the consumption aspects of the educational experience, reflected in the evidence that many people thoroughly enjoy schooling. The impact of education on consumption also appears to endure beyond the period of schooling, extending the range of leisure activity. Schultz has suggested elsewhere [33] that the value of these consumption components should be identified and subtracted from total costs in any study of the rate of return to education as an investment. Bruton [11] has agreed with this approach, but it has been criticized by Bowen [5] on the grounds that it is difficult to estimate the consumption element of educational costs. Even if the consumption costs could be conceptually separated from the investment costs, he argues, the information would be of little use since one could not decrease the consumption expenditures without at the same time cutting back on the investment expenditures on education. Bowen suggests, alternatively, that the worth of these consumer experiences be estimated in money terms, and that they be added to the benefits in the cost-benefit calculation. This method encounters difficulties too, for the evaluation of the consumption part of education depends upon the preferences of individuals and society as a whole, with respect to both education and other kinds of

consumable experiences. Lewis [22] has asserted that a developing country cannot afford the luxury of the consumption components of education.

A set of similar studies has questioned whether society as a whole is investing the proper share of its resources in education. These studies assume that earnings reflect productivity in a market economy, and look at differentials in earnings as an index of the impact of education on economic development. Along with other types of cost-benefit studies, analysis of the social rate of return to education shares many of the problems pertaining to the private rate, discussed above.

The relevant concept of cost here clearly appears to be all costs, including public subsidies. Problems arise on the benefit side, however, due to the existence of "external economies" and the nonmonetary attractions of educationally-heavy occupations.

External economies (often called indirect benefits or social benefits) consist of those benefits which are not confined to the individuals receiving education; rather, they spill over to the economy as a whole. Society may gain more from the education of ten more college students than the simple sum of their discounted future increases in income. For example, some other persons may earn higher incomes because of the further education of these ten. Possibilities include their employers,

subordinates, or families. Education may move individuals to perform acts which give pleasure to others. Failure to allow for these kinds of external consequences of education would distort any attempt to assess its relative costs and benefits.

Then too, education is inextricably associated with advances in knowledge, which has important economic effects. The social and political external benefits which society as a whole receives may also have certain economic effects. Weisbrod [40] has suggested that these savings might be estimated by means of "avoidance costs". If it were not for education, society might have to pay more for police protection, traffic control, and medical care (as opposed to prevention).

As society becomes more affluent, people tend to place more and more weight on the nonmonetary attractions of a job or career. Since a disproportionate share of these attractive jobs are open only to college graduates, the social rate of return should take the value of this benefit of education into account. Villard [39] has suggested adopting an upward revision of the benefits, as in the individual rate of return calculations. Bowen [5] disagrees, arguing that the important consideration is whether or not the nonmonetary attraction to the employee is a cost to the employer. No revision of the benefits is called for if attractions like "prestige" only change the willingness of people to enter different occupations at different fixed pay scales. But if the employer offers subsidized housing, travel, lush offices, generous paid vacations,

or other fringe benefits which increase his costs, the rate of return should be adjusted upward.

Bowen's arguments neglect the possibility that the nonmonetary attractions of certain jobs may be detrimental to the income or rate of growth of income of a society. Others [5][30], including Balogh [2] and Lewis [22], have asserted that the attractions of white-collar jobs in underdeveloped countries have diverted workers away from preparation for the technical and mechanical occupations which are so necessary for development.

These controversies ultimately hinge on whether the benefits under review are those which enter into a standard measure of economic well-being like GNP, or a less narrow concept like social welfare. Nonmonetary attractions of educationally heavy jobs would raise the rate of return on education expressed in terms of social benefits, but not always in terms of GNP.

Since the benefits of education occur over time, and a sum earned tomorrow is worth less than the same sum earned today, rate of return studies encounter the problem of choosing an appropriate discount factor. Such a factor could be applied systematically to any future stream of earnings to determine its present value, i.e., the amount that those future earnings could be sold for today. The "market rate" of interest is often suggested as the proper discount rate in theoretical discussions. In practice, however, there are many interest rates, each reflecting the ability of different types of borrowers to gain access to

resources. Bowen [5] has suggested that individual calculations utilize the rate of interest that individuals face in the market as a discount factor, while social decisions should be based on future returns discounted by the cost which the government incurs in borrowing. This raises interesting possibilities inherent in the availability of foreign aid. If the government of a developing nation can obtain soft term loans or grants for the purpose of improving its educational system, Bowen's criteria would suggest using a very low discount factor, or not discounting future income at all.

Alternatively, Becker [3] has used the average rate of return on private investment in physical capital as a discount factor, but this overlooks the existence of differences in risk between investment in factories and in people. It is also possible that the government may not possess opportunities for investment which are as lucrative as those of the private sector. This controversy over discount rates stems from the realization that rate of return comparisons are highly sensitive to the choice of the rate. Using U.S. data for 1950, Houthakker [19] has shown that the saleable value at age 14 of a college education varied from $280.989 using a zero discount rate, to $30,085 using a rate of 8 percent.

(iii) The limitations. The rate of return approach has great appeal because it offers a means of determining the extent to which individuals should obtain further education, and the amount of education which society should underwrite. There are, however, serious limitations to this kind

of analysis. These concern two aspects of the use of current earnings data in the calculation of benefits. On the one hand, present differences in the earnings of one occupation relative to another may not persist into the future. On the other, current earnings may not be an adequate measure of the productivity of a worker.

The structure of relative earnings among occupations is expected to change over time as relative scarcities change. Suppose high schools had to pay higher salaries to attract and keep relatively scarce science teachers than to hire abundant history teachers. The observed rate of return on a specialization in science would be greater than the return on a history concentration. Drawing a policy prescription from this evidence, it would appear that more science teachers should be trained on the margin. Individuals who opt for this training might be surprised later in life to discover that abundant science teachers were then earning less than the scarce history teachers.

The existence of divergent rates of return on preparation costs for alternative professions may set into operation market forces which will tend to destroy those differences. In the course of development, the income structure of occupations changes substantially and rapidly. It is not clear how accurately current or historical rates of return predict future rates. Renshaw [30] and Machlup [24] expect future rates of return to be lower than present ones, due to the phenomenon of diminishing returns. An increase in educational attainment, they argue, takes

place only by lowering the average ability or motivation of the entrants and graduates. Others also expect the past to be a poor guideline, but feel that it understates future returns. They see the dawn of an era in which education and knowledge will become increasingly important.

The evidence, however, supports the proponents of the rate of return approach. Miller [26] has found that the returns on increments of education do not fall over time as an increasing proportion of the population obtains education. Becker [3] has also discovered nearly constant rates of return on education between 1940 and 1950. Renshaw admitted that factors like dynamic technological progress could produce such results. It thus may be plausible to predict future rates of return on the basis of current ones.

Whereas the existence of such constant rates of return may be adequate justification for a personal decision to obtain more of a specific kind of education, it may not be a correct indicator for social or government expansion of education expenditure. This is because earnings may not measure productivity. High rates of return on a medical education or the study of probate or tax law reflect the high earnings of the practitioners, rather than the social productivity of these professions. The high incomes are the result of barriers to entry into the profession, or confusing laws and arrangements which necessitate the services of duly licensed specialists or "insiders." Society could instead choose to remove restrictions on entrance into medical school, or change the laws which create economic advantages for a few.

This question is further muddled by the realization that all education gives the recipient some monopoly power over a non-recipient. An economist can earn a relatively high income because he has worked at understanding a set of problems; if the answers to those problems were common knowledge, it is doubtful that the rate of return on a Ph.D. in economics would be as high.

Others [5] [15] have pointed out that high salaries may be paid although they are unnecessary for recruitment. Wage structures may be determined by tradition, or they may reflect the former colonial wage scale which distorts the present day allocation of human skills in the underdeveloped countries. Harbison and Myers [15], and W.A. Lewis [21] have described how earnings in Africa are set abnormally high, in order to prevent a drain of educated human resources to Europe. Bowen [5] has cited a problem which occurs more frequently in modern industrial nations. Employers might engage in "conspicuous production," hiring, say, college graduates for jobs which don't require college education.

The criticism of the rate of return approach on the grounds that current earnings are poor guidelines to future social productivity is especially telling in the context of the less developed countries. There the wage structure is particularly distorted. Hollister [17] has emphasized the misallocations of labor resources which occur when wages do not provide employers and employees with cues for decision-making.

Also damaging to the rate of return approach is the failure to account adequately for the interaction between the education of one person and the benefits which others receive from it. Certain kinds of education may be complementary (e.g., that of doctors, nurses, and laboratory technicians). Educating one group but not the others may be fruitless. In cognizance of these complex interactions, it is widely held that society's return on education expenditures is greater than the sum total of individual returns on the same expenditures. Attempts to investigate these relationships border on (1) studies of the residual in economic growth on the one hand, and (2) correlations between levels of education and economic development on the other.

THE RESIDUAL IN ECONOMIC GROWTH

(i) The question. How much has improvement in the quality of labor contributed to economic growth in the past?

The quality of the labor force is expected to rise as its members receive more and better education and training. This approach seeks to isolate the impact of education and training on the historical growth rate of GNP. The procedure used, however, is indirect; the contribution of improvements in the quality of labor is generally found as a residual.

(ii) The research technique. Economists traditionally identify two kinds of physical inputs in the production process: capital and labor. The analyst asks what the contribution of these identifiable factors of production has been to the historical rate of growth of output. Given

the latter, he calculates constant price indices of the amounts of capital and labor actually used in production during the period in question.

Since he is interested in the contribution to output growth of both capital and labor, the analyst wishes to combine these two indices into one overall arithmetic index of inputs. To do so, he takes a weighted average of the original indices, using the share of output earned by the owners of capital as the capital weight, and weighting the labor input index by labor's share of the output.

The composite input index is then compared with a constant price output index. Simply subtracting the rate of growth of the inputs from the rate of growth of output yields the residual.

What is this residual? Although it has been attributed to many things, it has most often been identified with improvements in the quality of labor, the impact of education and increases in knowledge, or technical progress. Other possible explanations of this residual include improvements in the health of the labor force and in the conditions under which labor works, progressive historical improvements in the quality of machines or management, increase in the size of firms, and new products. Abramovitz has called the residual a "measure of our ignorance."

How large is the residual? Kendrick [20] performed the calculations outlined above for the U.S. economy from 1889 to 1957. He found that the output index increased at an average annual rate of about 3.5 percent, compared to the 1.9 percent per annum increase in the combined

input index. This left a residual of 1.6 percent, which Kendrick called "total factor productivity." Hence 46 percent of the rate of increase in total output is not attributable to the rate of growth of capital and labor. The residual is quite large.

Kendrick's study also examined the contribution of the residual to increases in productivity or output per unit of labor input. Using data for the private sector of the economy, he attributed only 20 percent of increases in productivity to increases in the amount of capital used by each worker on the average. If only one fifth of increases in output per worker are brought about by increases in capital per worker, the remaining 80 percent is the unexplained residual.

The size of the residual and the uncertainty about its components have been a challenge to further research. One method of gaining insight into the puzzle of the residual would be to trace out the implications of specific assumptions about the nature of the way inputs are transformed into outputs in the production process. Solow [34] and Massell [25] both assume that productive enterprises are exactly reproducible, and that inventions and technical change proceed in such a way that they do not, in and of themselves, change the relative use of capital and labor.

Although they utilize different data sources and perform slightly different adjustments to allow for unemployed machines, Solow and Massell obtain virtually identical results. Solow's finding was that the residual contributed 87 percent of the increase in output per man hour; Massell found that 90 percent of increases in productivity in the U.S. economy

from 1915 to 1955 were attributable to the residual. That is, if doubling the inputs used in production exactly doubles output, and if technical progress has a neutral effect on the relative use ofinputs, almost nine-tenths of historical increases in productivity are unexplained by the traditional inputs.

Another approach to the problem posed by the residual would be to attempt to disaggregate it into recognizable elements. Denison [13] identifies inputs other than capital and labor, and subtracts the rate of growth attributable to all identifiable inputs from the total rate of growth of output. The resultant small residual is called the effect of advances in knowledge. Denison makes separate estimates of the impact on output of factors like formal education and the growth of the size of firms. Thus he is able to reduce the size of the residual by explicitly considering factors which had been lumped together elsewhere.

In estimating the contribution of schooling, Denison [13, Ch. 7] uses the rate of return approach of the last section. On the basis of 1949 data, he compares the average earnings of males over 25 with the amount of formal schooling they have obtained. The average differences permit calculation of an average rate of return on extra education. This rate of return is then used to relate net changes in the stock of educated people to the influence of improved labor quality on the growth rate. For the period 1929-1957, Denison calculates that the rate of increase in GNP due to the education of the labor force alone was .68 percent. Since GNP

grew at the rate of 2.93 percent per annum, education of the labor force accounts for almost one-quarter of output growth. Rising educational attainments of the labor force accounted for more than 40 percent of the increase in per capita income.

Harberger and Selowsky [14] have used Denison's approach in the study of an underdeveloped country. Although they considered official investment rate projections for Chile implausibly high, they nevertheless found official projections of growth rates to be attainable. This was because increases in the quality of labor as the result of education were expected to add .93 percent to the Chilean growth rate during each of the years from 1967 to 1970.

As one of the steps toward that conclusion, Harberger and Selowsky calculated rates of return on several stages of education. In Chile, special education beyond the primary level appears to have the highest payoff, 29 percent per annum. Primary education itself was found to return 24 percent on its costs, while the rates of return on secondary and university education were 16.9 and 12.2 percent, respectively. These returns were combined in a weighted average rate of return to education of 21.8 percent, which was called the "marginal efficiency of educational capital." Information about the changing size of the labor force, and the amount of education they had experienced, permitted calculation of the contribution of improvements in labor quality to the growth rate.

(iii) The limitations. Studies of the residual have dramatized the importance of education in the process of economic growth. This success

of the analysis of residuals may also be a weakness. The emphasis on rates of growth of GNP has perhaps occurred at the cost of underemphasis of other social goals. In the economic sphere, a society also has objectives with regard to price stability, full employment of labor, the distribution of income, and the composition of output. The work reviewed in this section has not attempted to analyze the impact of education on these areas of concern.

The research performed by Kendrick, Solow, and Massell fails to take into account the interaction between capital and technical progress. The capital input series essentially reflects the exact duplication of old machines in the manufacture of new ones. In these studies there is no way to allow for the fact that newer machines are usually better than their older counterparts. Thus, estimates of the contribution of capital may be too low, and the size of the residual may be exaggerated.

The work originated by Denison has attempted to sort out these kinds of interrelationships, but the methods of calculation employed have frequently been questioned [15], [8]. Though Denison and Harberger and Solowsky claim to measure improvements in labor quality derived from education, they include only formal education in their analyses; informal education and on-the-job training are neglected. In addition, the returns computed in the course of these studies are private, not social, returns. No effort is made to understand the contribution which education and work experience make to increased mobility and adaptability, and hence to more

rapid application of advances in technology.

To the extent that the residual approach uses rates of return and draws policy prescriptions from historical behavior, it is subject to the limitations discussed earlier. Moreover, unless one is willing to assume with Denison that an extra day of education at, say, the primary level has the same effect on GNP as a day spent at any level (even post-graduate), this form of research appears to add little to the policy-making framework. That is, decisions about the allocation of resources to education which were based upon rate of return calculations would not gain substantial insights by also undertaking analysis of the residual. Harberger's work has demonstrated new uses for this technique, however, and it may not yet have been pursued far enough.

The residual has established the relative significance of education in economic growth. Dissatisfaction with the large portion of unexplained phenomena, and a desire to understand the causal relationships prompt an interest in statistical inference. Pursuing Denison's study in a behavioral direction, one would encounter the attempts to correlate indices of education with indices of development.

THE CORRELATION BETWEEN EDUCATION AND DEVELOPMENT

(i) The question. Is there a systematic relationship between a society's educational attainment and the level of its GNP?

Since expenditures on education are expected to increase incomes, questions arise as to what the nature of this relationship is. Will a

nation which devotes a relatively large share of its resources to educating its labor force always obtain relatively higher levels of GNP? Will it obtain extra income immediately, or only after some delay? Does the same relationship hold among industries, and among firms?

(ii) The research technique. Simple correlation analysis is applied in the search for these relationships, either cross-sectionally, or over time. Statistical tests are used to judge the strength of the relationship.

Perhaps the easiest correlation to envisage is the one expected between education expenditures and GNP over time. Schultz [32] and Harris [16] have attempted correlations of this kind for the United States. Their hypothesis, that levels of expenditures on education are related to (or cause) levels of GNP in the same year, has come under attack by Bowen [5]. He argues that education is a long-lived asset; the recipient of education earns (or contributes) a higher income for most of the rest of his life. Thus the economic effect of an increase in education expenditures should not be sought in the year of its disbursement. GNP may even be lower that year, due to the diversion of labor resources from factories to schools. Education expenditures today should instead be related to future rises in GNP.

The choice of an appropriate time lag for the regression model is a difficult one. Most choices are either arbitrary or designed to obtain the neatest results, after trying a host of alternatives. Rather than adopt these indefensible positions, an alternative is suggested by the nature of the lagged response. The level of GNP ten years from now is

seen to depend partly on education expenditures last year, partly on those of this year, partly on next year's expenditure, etc. In other words, the level of GNP in a given year depends upon the total stock of educated persons in that year. This stock is the result of all past additions to education minus any attrition.

Schultz [31] [32], who has provided the creative leadership for much of the study of the economics of education, has attempted to measure the stock of educational capital for the United States. His suggestion to weight younger persons more heavily than older ones when adding up the stock of education has been criticized by Bowen. The weighting procedure is correct if one wishes to know the salable value of education, Bowen asserts, but it is not desirable for the relation of current educational attainments to current GNP. This controversy appears to hinge upon whether educational units are commensurable over time.

Opinions on the intertemporal quality of education vary markedly. Denison [13] concluded that a graduate of eighth grade today is equivalent to a 1910 college graduate. At the other extreme, Machlup [24] contends that the quality of a given grade deteriorates with the dilution of the quality of students brought about by the drive toward universal education. When the length of compulsory education is changed from, say, six to eight years, schools merely stretch the same educational content over two extra years, to cope with the new seventh and eighth graders who have less ability or motivation on the average than their predecessors. Denison's conclusion

actually stems from an assumption of constant quality of education per day over time. Doubling the number of days spent in school per year, he asserts, should have the same effect on output as doubling the number of years of schooling.

Another way to investigate the education-income relationship is to observe the differences among countries. Svennilson, Edding, and Elvin [35] have attempted inter-country correlations between per capita GNP and enrollment rates. The latter are the number of students enrolled in a particular grade or stage of education expressed as a percentage of all students whose age qualifies them for it. Bowman and Anderson [10] also look at international comparisons of income and education levels. They first divide countries into three groups according to their index of energy potentials per capita. This was used as a proxy for productive potentials; energy potentials are independent of past capital accumulation, the quality of labor, and socio-economic attitudes and organization. For each group, GNP per capita was correlated in turn with each of the following variables: (1) the percentage of adults who are literate, (2) the percentage of population in post primary school, and (3) the percentage of population, age 5-14, enrolled in primary school (primary enrollment rate). Their study also tried to correct for agricultural potential on the basis of cultivated hectares per capita. Despite all of this careful work, neither the Bowman and Anderson study, nor the work of Svennilson, Edding, and Elvin produced very strong conclusions. To be sure, GNP per capita was positively related to indices of education, but there was considerable dispersion.

In a recent study, McClelland [23] has attempted to use a dynamic approach to cross-country analysis which allows for the introduction of the time lag. He compares enrollment rates in one period with growth rates in a later period. Grouping the countries studied by an electric power index, in the manner of Bowman and Anderson, he observes that countries with higher university enrollment rates in 1950 achieved greater increases in per capita income during the 1950s. These differences allow him to calculate an annual rate of return on extra university education of 12 percent. McClelland also concludes that countries with higher secondary enrollment rates in 1930 grew more rapidly during the 1950s than countries with lower rates.

This study is weakened by the lack of an attempt to correct for other factors which might have caused the higher growth rates of GNP per capita. Then too, McClelland's results would be reversed if the U.S. and Canada were excluded from the study. His analysis is severely challenged by Bowman [8] [10] who found that income in the 1930s explained enrollment rates in the 1950s better than schooling in the 1930s explained income in the 1950s.

Little work has been accomplished in the area of inter-industry or inter-firm analysis. Cross-sectional correlations between the training or education of workers and the profitability of firms or industries await further study. Economic theory would not expect a systematic bias between profitability and the use of highly trained manpower. If a strong relationship were uncovered, an explanation would certainly be necessary. Casual

empiricism suggests that a correlation exists between profitability and the percentage of a firm's labor force who have training beyond the secondary level. The more profitable industries, however, may also be the ones with a high degree of market power; or they may be engaged in Bowen's conspicuous production, or both. Clearly, further study is needed here.

(iii) The limitations. The correlation analyses are subject to chicken-egg controversies, for while it can be shown that countries which invest relatively more in education reap higher rates of growth of national income, it can also be demonstrated that nations which have high levels or rates of growth of income tend to consume more education. An example of this two-way causation problem is the correlation calculated by Schultz [32] between expenditures on education and GNP. The coefficient obtained through regression analysis indicates that expenditures on education grew 3.5 times as fast as income. The significance of this coefficient may be that as people attain higher incomes, they tend to spend a larger portion of it on education. Or it could reveal how much extra education was necessary to obtain a given increase in GNP. Both of these propositions are undoubtedly true to some extent, but the work reported on in this section cannot disentangle the relationship in the absence of other information.

The cross-country work of Svennilson, et al. does serve some useful purposes, however. Planners in a developing nation are able to look at their own educational programs in the perspective of the experience of

other countries. Countries with the same per capita income and socioeconomic characteristics can yield information on what levels of education may be possible, on the one hand, and necessary, on the other. The current levels of education in more advanced countries can give planners a general idea about future demands, and the experience of these countries can also be instructive.

There is a danger, however, in regarding the levels of educational activity associated with advanced countries as norms. It is doubtful whether current or historical patterns of educational development in these countries are to be considered optimal. Many developing countries may have over-invested in education, as Anderson and Bowman [9] and Lewis [22] have suggested. It is also probable that the more complicated levels of technology associated with today and tomorrow will require higher levels of education at every stage of development then have been observed historically. Since the effectiveness of education appears to depend upon the extraschool environment, more education would be required in a primitive rural area than in a city to achieve equal results. In any case, identical education expenditures in two countries would imply equal educational output only if teachers, buildings, and other resources were used with the same efficiency.

Ignoring all these problems, McClelland [23] observes that the successful growth cases among the less developed countries were those in which enrollment rates ranged from 10 to 20 per thousand in the population. He also found that university enrollment rates are about 2 per thousand for those less developed countries which are growing rapidly. He thus concludes

that these levels of education should be the targets of the more stagnant LDCs.

Inter-firm and inter-industry correlations may prove interesting, for one would not expect the chicken-egg problem to be as severe as in the more aggregative education-GNP correlations. The usual view of the behavior of firms does not suggest that they would hire educationally heavy inputs in order to enjoy their presence. Firms which hire a disproportionately large number of scientists or other highly educated people presumably do so to increase profits. Even if there is some conspicuous production, it cannot be as pronounced as the consumption attitudes toward education among individuals.

Correlation analysis suffers from many of the same problems as the rate of return studies. It is forced into assuming that a great many other things are equal. The external benefits of education are not explicitly considered. For example, in the cross-country correlations, no attempt was made to measure the effect of education in one country on the incomes of other countries. Bowen [5] concludes that simple correlations of this kind cannot give us any information about the quantitative dimensions of the contribution of education to development.

In the face of all of these difficulties, planners have still managed to design and attempt to implement programs for human resources development in the past, and they will continue to do so in the future. What methods of analysis have they utilized? One set of studies is designed to assess the demands of the economy for skilled workers. Other kinds of analysis have set their goal to be the supply of these skills.

FORECASTING AND PLANNING FOR MANPOWER REQUIREMENTS

(i) The question. What is the quantity and composition of additional skilled persons needed over the planning period in order to support the desired rate and pattern of economic development?

The production of goods and services requires capital and labor; the production of certain kinds of goods and services requires certain kinds of machines and labor. Labor is differentiated by skill, and skills are usually obtained over the course of time through formal or informal processes of education and training. Given the output goals of an economy, it is necessary to determine how many skilled workers in each skill category will be needed, just as one estimates the requirements for the number and types of machines. Similar to the manner in which one anticipates the need for the use of capital by planning to produce domestically some items and import others, the successful implementation of the plan depends upon the ability of the society to produce the necessary mix of skills.

(ii) The research techniques. There are essentially three methods of forecasting manpower requirements: (1) employer surveys, (2) analysis of the experience of more advanced countries, and (3) use of fixed-coefficient projection techniques.

Surveys of employers' expectations of their future needs are rapid methods of obtaining useful planning information. The survey can be restricted to those industries which are expected to expand, and the information may be

collected inexpensively. The shortages revealed by employer surveys may, however, be relevant only in the short run. Employers probably possess shorter planning horizons than is suitable for decisions made on behalf of the whole society. The immediate nature of employers' perceived demands is important with regard to skills which require long periods of training. An educational system cannot be asked to give three years of training to a person required next month.

The experience of other countries, whether similar or more advanced, can also yield information about the size and composition of skilled labor pools that may be required in the course of a country's growth. Again, planners must be cautioned against relying on the pattern of skills observed in other countries, for most of the same reasons that reliance on the enrollment rates of others may be inappropriate. The range of possibilities for substitution among inputs in the production process is often quite wide. This substitution can take place between labor and machines, and among labor of different skills. The value of looking at skills used in other countries depends upon the range of substitution permitted by available technology, as does the entire manpower forecasting and planning exercise.

Some production processes are characterized by fixed coefficients--i.e., the amount of labor necessary is determined once the amount of capital to be employed in the operation is known. A good example is the ordinary shovel. It is generally set into operation by the use of one worker. Less than one worker will not do, and more than one worker using a shovel may be

almost as bad as none. Other production processes are capable of using a wide variety of combinations of men and machines. The use of fixed-ratio projection techniques thus pertains more to the former processes.

The methodology of projecting manpower requirements with fixed ratios has been described exhaustively by Sugg [38] and Parnes [27]. First, it is necessary to obtain an estimate of total employment for the target date. This can be accomplished in several ways. If the planner is fairly confident that he can predict future investment, he can estimate future employment on the basis of fixed incremental capital-labor ratios. Alternatively, the planned investment figures could yield the level of increased output when divided by incremental capital-output ratios. The amount of labor necessary to achieve those increases in output can then be obtained with the use of assumptions about productivity (output-labor ratios). These anticipated levels of employment can be corrected for observed trends or any other relationships the analyst can discover between employment in various industries and other economic indicators.

The projection of employment of undifferentiated labor thus should take into account any anticipated changes in demand, hours worked, or productivity. The level of aggregation chosen usually depends upon the information available, but a detailed analysis of the projections by sector or industry is desirable. By disaggregating, allowance can be made for changes in industrial structure which occur as industries grow at different rates.

It is then necessary to determine the skill composition of the projected employment by industry. This is accomplished by applying existing

or anticipated occupational composition patterns for each industry. Data availability will again determine the choice of skill detail, but attention should be addressed to the skills which require long periods of training.

In practice, as in the Mediterranean Regional Project of the OECD [28] [29], fixed-ratio projections are adjusted on the basis of the experience of other countries and surveys of employers.

Once the manpower requirements have been forecast, it is possible to trace their implications for the educational system and training institutions. The requirements can be compared with the expected supply by the target date, and shortages and surpluses of various occupations and skills can be ascertained. On the basis of these projected gaps, the educational planners can expand some activities and curtail others.

An essential link, however, must be forged conceptually before supply can be contrasted with demand. It is necessary to determine the amount of education and training required by each occupation. The translation of the demand for labor differentiated by skills into the composition and duration of education has never been accomplished satisfactorily. Even the detailed job analysis and exhaustive listing of educational qualifications for very specific occupations by the OECD [27] have proven inadequate.

The problem is that very few jobs require a specific combination of ability and training. Most skills fall between two extremes: occupations which require only a short period of observation, as opposed to jobs which require the mastery of precise operations which can only be learned over a

considerable time span. Not only must the duration of training be decided upon, but the choice must be made between formal and informal education. There appears to be a wide range of substitution between educational qualification and job experience in many occupations. The type and length of training required for, say, a shoemaker will also vary with the kind of capital he has available on the job. Simple tools require a process of training, and perhaps a trainee, quite different from that demanded by automatic machines. The problem is further complicated by the observation that general education often enables a person to grasp specific instruction more readily.

(iii) The limitations. There are some [5] who would assert that manpower planning does not belong in this survey, since it is not directed at assessing the economic contribution of education. This line of argument is misleading, for if manpower requirements are interpreted in their strictest sense, all of the economic contribution of certain activities could be assigned to education. For example, a modern jet airliner could not get off the ground unless there existed a technician or crew trained to fly it. In this case, if the training failed to take place, the airplane would make no economic contribution; the entire economic contribution of the airplane in service could be attributed to the training of pilot and crew.

But how well should the pilot be trained? A minimum amount of training is necessary to enable him to get the plane aloft, and return it safely to the ground; but beyond that, should he be a first-rate pilot? Or should he be second or even third-rate? The manpower forecasting and

planning technique no doubt assumes that training requirements are more specific than they really are. There is enough substitutability in economic activities to negate the existence of fixed coefficients, but the opposite extreme may be even further from reality. Workers of different skills are not perfect substitutes for each other.

Manpower planning implies that the levels of economic activity which have been forecast could not take place without the specified training. This is not completely correct, but it is probable that the activities could not take place very well without the required skilled workers. Braton [11] has argued that there is evidence that substitution is far from perfect among skills in an LDC, so the manpower forecasting and planning approach may thus be relevant for its needs. He cautions against always assuming that the education sector will or should respond to the needs of the production sector. Often the latter will initiate an activity in response to the existence of a pool of skilled labor resources.

The record of manpower forecasts, however, has been rather poor; major projections have been substantially inaccurate. Bowen [5] has suggested that they tend to understate the future demand for labor of various skills, due to the rapid pace of scientific developments. Difficulties are also encountered in projecting the employment of people with general training. Even where the notion of fixed coefficients is approximated, as in the case of engineers, the graduates of training programs may thwart the planners by not entering the occupations for which they were trained.

In the course of a recent attack on the foundations of manpower projection, Bowman and Anderson [9] agree with the earlier criticism by Bowen [5] and Hollister [17]: manpower planning is only a partial method of analysis, since it ignores costs. It may be true that employers will need workers of specific skills, but are they willing or able to pay for them? Manpower planners have often been guilty of identifying shortages and proceeding to train the appropriate number of workers regardless of cost. Decisions to train additional workers or to expand educational facilities, under conditions of scarcity, require the balancing of costs and benefits.

Manpower planning has been accused by its several critics of misleading students in their career choices and creating a rigid pattern of staffing whereby all positions in a society are filled according to strict educational qualifications. More relevant is the criticism that manpower planners frequently assume that formal education in vocational and technical schools is the only source of middle level manpower. This neglect of the possibilities for on-the-job training and skill upgrading has contributed to inaccurate forecasting, and wastefulness, since technical schools are very expensive.

The Mediterranean Regional Project of the OECD was a large-scale manpower planning effort in six Southern European nations. The framework for the study is discussed by Parnes [27], and there are country reports, of which Turkey [29] and Spain [28] are representative. Hollister [18] has criticized the project for concerning itself too narrowly with educational

planning, at the expense of programming and implementing activities.

With the exception of Bowman and Anderson, who find it totally useless, the critics of manpower forecasting and planning believe that this kind of analysis has a role in decisions about the allocation of resources to and within education and training.

The manpower approach is a unique method of obtaining information that can be incorporated into broader types of analysis; manpower policy should be integrated with overall social and economic policy.

EDUCATION PLANNING MODELS

(i) The question. Education planning models do not attempt to answer a general question; rather, they are designed with specific questions in mind. The complex interrelationships of an education system are simulated, in order to provide a framework for testing the consequences of alternative policies and investment patterns over time. A model can be used to discover which alternative best achieves particular objectives. Models may be designed to generate consistent plans, assess the feasibility or costs of a proposed plan, or point out the bottlenecks to further educational development.

(ii) The technique. All education models share the characteristic of expressing the interrelationships of the education system in algebraic form. This means that all important flows of students, teachers and the services of equipment, textbooks, and buildings are explicitly related to each other in quantifiable ways. For example, the enrollment of sixth graders in 1971 equals the number of fifth graders in 1970 times the progression rate (or

one minus the wastage rate). The progression rate is thus the sixth grade enrollment in one year divided by the fifth grade enrollment of the previous year, and the wastage rate is the sum of the drop-out and failure rates.

Other examples of these specified relationships readily come to mind. The supply of teachers required for a particular grade in a given year is equal to the enrollment in that grade during that year, divided by the appropriate pupil-teacher ratio. Recurring costs per pupil are equal to the total cost of teacher salaries plus textbooks plus materials plus maintenance, all divided by the level of enrollment.

Once the relationships have been stated algebraically it is possible to begin assigning numbers to the various symbols. The purpose of the model will dictate which variables are assigned values, and which will be determined in the solution of the model. Values must be assigned to the parameters, which relate the variables to each other. These numbers may be taken from history, or they may be set by policy. For example, drop-out rates can be those observed historically, or extrapolations of recent trends. Policy decisions could be reflected in, say, pupil-teacher ratios. Solutions to the model can be made subject to constraints on resource use; even social and political constraints can be built into the model, if they can be quantified.

The early educational planning exercises were supply models. Targets were accepted as given (often by independent manpower projections), and the problem they addressed was the investigation of alternative methods of supply. Timbergen, Correa, Bos, and others at the Netherlands School

of Economics were in the vanguard of these efforts. Much of the work which was carried out under Tingergen's [36] direction, however, consisted of the application of pre-existing economic models to the problems of education. In essence, the Tinbergen models investigated the paths followed by key variables in response to changes in assumptions.

The most complete supply model has been developed by UNESCO with the cooperation of ECAFE [37]. It was designed as a tool to aid the Asian member nations in developing educational policy. After specifying, quantifying, and programming the relationships, it became possible to observe the implications of changes in the educational system, almost instantaneously. The costs of new programs became readily apparent, in spite of the long time spans they embraced.

Although they did it in a sophisticated way, these models were only looking at half the problem of allocating resources efficiently in the education sector. They dealt solely with the cost or supply side of the problem, in much the same way as the manpower projections dealt only with the demand side. To be sure, Correa [12] considered both sides of the problem, but even there the first part of his book was devoted to the supply of labor, and demand considerations were postponed until the latter part. The integration of supply and demand into one model had to await quite recent developments.

Linear optimizing models have been applied to human resources development planning by Adelman [1], Bowles [6] [7], and Benard [4]. The models used by Benard and Adelman encompass the entire economy, but

they give detailed attention to the education sector. Using data from Argentina, Adelman's model efficiently allocates investment resources to both education and real capital. Solution of the model results in the optimal pattern of production, imports, and exports in the several sectors of the Argentine economy over time. With respect to the education sector, the model determines the number of graduates from each of the various schools, and allocates these graduates to different sectors of the economy, in response to their labor requirements.

In contrast with Adelman's general equilibrium model, Bowles takes the resource flows from the rest of the economy as given, and attempts to allocate those resources efficiently among educational activities. His study of Northern Nigeria incorporates variations in educational policy, such as the increased use of audio-visual equipment, or the introduction of team teaching. Among the constraints on his solutions are politically determined minimum levels of secondary enrollments, and limits on the pace of expansion of facilities.

In order to make decisions about resource allocation, these models require a criterion. Bowles seeks a solution which will maximize the contribution of the educational system to future (discounted) national income. Adelman similarly attempts to maximize the discounted sum of GNP, but in other trials she experimented with maximizing the growth of GNP between a base year and a target year. In another set of runs, she minimizes the discounted sum of net foreign capital inflows, an approach which is of interest to those concerned with foreign assistance. It is interesting to

note that, in the operation of both models, technical and vocational education was a bad investment; the benefits derived from them failed to cover their cost.

Perhaps the most significant aspect of this new approach is its promise as a means of integrating the other techniques of human resources development planning. Not only have demand and supply been brought into the same model, but the work of others has been incorporated.

Bowles has permitted a choice between producing teachers domestically and importing them, an innovation of Tinbergen. To arrive at the productivity of various kinds of education, Bowles calculates rates of return, and then proceeds to assume that these rates will remain constant. Dividing the labor force into three skill categories, Adelman borrows from the manpower planners by assuming fixed productivity ratios in each category, and refusing to permit labor in one category to substitute for any other. The output-skilled labor ratios are derived from correlations between education and income. Unlike Bowles, however, her model does not have constant rates of return from each stage of education; the returns are allowed to vary with the relative scarcity of the skills (supply) and the growth of various sectors of the economy (demand). Bowles follows Tinbergen and the OECD in skipping over the differentiation of the labor force by skills. Instead they specify labor by educational attainment.

As other models are developed and enlisted in the search for policy guidelines, this groping toward a synthesis of planning techniques may continue.

(iii) The limitations. Models may become quite sophisticated, but they are only as powerful in generating solutions as the knowledge built into them. To the extent that the recently developed models synthesize the various techniques of human resources development planning, criticism of the models is criticism of the state of the entire field.

For example, if one argues that Bowles's assumption of perfect substitutability among different kinds of educated labor is unrealistic, one is actually quarreling with the advocates of a fixed rate of return. Studies conducted to date have assumed either no substitution, or perfect substitution among skills. The truth lies somewhere in between, and studies of the elasticity of substitution between skills are clearly required.

The particular objectives which the models maximize are subject to the same lengthy criticism as the rate of return analysis. Since the models use this kind of analysis to determine the desirability of different stages and types of education, they also fail to account adequately for noneconomic social benefits, the consumption aspect of education, external economics and complementarities. Bowles and Adelman, like the other analysts discussed in this paper, find it easier to deal with formal education, and tend to ignore the economic contribution of on-the-job training, in-service programs, and extension activities.

Adelman's investigation of the relation between output and labor differentiated by skill is a fresh approach to the correlation problem. Efforts like this may yet provide a bridge between rate of return analysis and the manpower requirements approach. Further clues may be provided by

inter-firm correlations. More detailed information about the range of possible substitution among skills could be useful as constraints on the perfect substitutability models. Since manpower projections tend to understate the future requirements for skilled workers, they might also be effectively utilized as a constraint, providing a floor on the formation of skills.

Very little is known about the translation of the requirements of producers (labor differentiated by skill) into the composition and number of school graduates. Most studies avoid this problem by specifying labor demanded by the production sector in terms of educational attainments. But just what precisely does an increment of education change in a man? This question is acute enough with respect to how education relates to economically useful skills, let alone how it influences the total man. A greater understanding of the relation between education and development is undoubtedly dependent upon our knowledge of how a person's economic and social activities are transformed by his educational experience.

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