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ON THE COMPARISON OF HUMAN CAPITAL AND PHYSICAL CAPITAL

R. S. Eckaus

Center for International Studies
Massachusetts Institute of Technology
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I. Introduction

Economic analysis of education potentially can contribute a great deal to the understanding required for the formulation of an educational policy which will make the best use of human resources and contribute most to economic growth. By no means all of the individually and socially significant features of education fall within the economic nexus to be sure but this does not preclude exploration of this nexus to learn what is important there. This book is itself an example of the forays which, to an increasing extent, are being made.

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

Thus, Part II will discuss educated labor as a productive capital factor in the economy and its particular characteristics. Part III will explore the implications of this analysis for the demand and use of labor with a higher education. The analytical approach will then be extended in Part IV to a consideration of the conditions of supply of labor with a higher education. Part V will conclude with a summarization of the implications of the foregoing discussion for the analysis of economic capital.

In this field, as in others, it is easier to ask questions than to find answers. However, it is also true, I believe, that there are now relatively few reliable guides for economic policy in education in part because the right questions have not been asked often enough and in a sufficiently specific form. When this is done, there is a much better chance of finding useful facts in the available information. This paper is mainly an attempt to pose the issues of investment in education in a manner susceptible to economic analysis. Some methods of developing a practical basis for resolution of the issues are also presented and discussed.

II. Educated Labor as a Capital Input to Productive Processes

Though it may appear somewhat strained to treat educated labor even in some limited aspects as if it were a capital factor, the vogue is increasing.[1] From the viewpoint of the individual or of society as a whole education has features similar to the production of physical capital goods. Both require the use over a period of time of facilities such as buildings, various types of materials, equipment, and other labor with various skills for their creation. Both necessitate the sacrifice of the output and income which might otherwise have been produced. Both, themselves, 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

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[1] See, for example, "Higher Education in the United States," The Review of Economics and Statistics, Vol. XLII, Supplement, August, 1960; P.C. Glick and H. P. Miller, "Educational Level and Potential Income," American Sociological Review, June, 1956; T.W. Schultz, "Capital Formation By Education," Journal of Political Economy, Vol. LXVIII, December, 1960, No. 6, pp. 571-583.

variations, the restrictions they place on labor capital formation and their implications for growth are, in large part, the subject matter of this paper. This section will compare the general features of educated labor treated as a capital input with physical capital. Subsequent sections will follow up particular aspects of these features.

To convey an appreciation of the significance of education treated as a process of capital creation in humans it is helpful to make an analogy with the natural resources of a nation: its land for farming, 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 become capable of producing crops, ores and power. After developmental work, natural resources become a kind of capital, each type 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 effort which must be applied to natural resources to make them into productive capital, but there is such a word for human resources. It is education. Applied or supplied over some period of time it will improve the productivity of labor and result in the performance of services which could not otherwise be obtained. In turning to analysis of the special characteristics of educated labor as a capital factor, it will be useful to refer to this analogy of human and natural resource development. It is a fruitful one and worth pursuing because it helps make plausible the use of economic concepts which might otherwise seem inappropriate.

For example, the point that the amount and quality of human capital in a society is dependent on the means of development can be made forcefully by use of the analogy to natural resources. These can never be fully known until their exploitation is under way. Investment in oil exploration and improvement of extraction techniques will actually change the known and available oil reserves. Land fertility is not a once-and-for-all unchangeable gift of nature. Fertilization and irrigation will increase fertility as will the 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. In a similar way labor skills are not only 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 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.

It is probably true that the different levels of education make different kinds of contributions to the uncovering of individual potentials. This is not a subject upon which an economist can comment with expertise but a college teacher can remark that even at that advanced level a great deal of exploration and discovery is going on.

There is still another reflexive or feedback effect of education on the amount of human skills which are available. This makes itself felt via the relation between education and the total size of the population and

labor force. There is no doubt that within many countries over a considerable range, educational levels and birth rates are inversely related. However, it should be kept in mind that in this relation education may not be the causal factor or, at least, not the only causal factor. It may, to some extent, operate only indirectly via its connection with income levels.

One feature of productive capital which is of great importance in determining its role in economic growth is its specificity with respect to use in producing some particular product. Or, to put it the other way round, its mobility as between industries. Many developed natural resources have a wide range of applications in production or they are applied in a wide range of industries. Fuel or other power resources provide perhaps the best example of this but fertile, well-watered land in temperate climates and many mineral deposits can also be used to produce a wide range of final products. This is not always the case, however. Potash, for example, is mainly a fertilizer and has a limited range of other applications. When the processes of synthetic nitrogen fixation were developed in the early period of this century, the significance was vastly changed of what had been a great natural resource of Chile. A completely similar phenomenon is the obsolescence of physical capital due to a change in technology or a transfer of demand from the commodity the capital produced. Generally, the greater the range of applications 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 wide range of uses is less likely to become obsolete than a complicated machine lathe highly specialized in its design for producing some particular part.

It is not easy to generalize about the relative inter-industry mobility of educated labor because of lack of organized information about this feature of it. The distinction between the various levels of education is only partly also a distinction between the ranges of application of the education. Certainly the range of usefulness in production of the lower levels of education is very broad. It cannot do everything, however, and there are countries with a high rate of literacy which find themselves with a shortage of skilled labor and professional persons. Still, most human capital is probably unique as compared to most types of physical capital. More education permits greater specialization, to be sure, but it does not in that way limit the range of fields in which individuals are useful. In many ways, the opposite is true; "education is broadening" in a vocational as well as a cultural sense. Thus, persons with a higher education may become "narrow specialists" but that is not a matter of necessity and there is no reason to suppose that it customarily happens that way. In fact, rather the reverse seems to be true.

The distinction between general education, on the one hand, and vocational or special education, on the other, is, in part, a distinction as to whether it prepares for further education but the distinction has another sense as well. The distinction also refers to the specificity to particular lines of production of the skills created. Though vocational education as a term is most commonly used to describe development of skills in particular crafts or trades, much of higher education is also vocational in the sense that it prepares for a particular type of occupation. Even the general education at the college level, the liberal arts education, has

as an important aspect its function as a vocational preparation. The professional and graduate degrees may seem more specialized but actually have a wide range of applicability. The range of potential openings for a mechanical engineer, for example, is very broad and the lawyer's education seems to transcend even the wide, legal field. 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 those acquired in higher education than in the manual and technical trades; however, even in the latter there is undoubtedly a considerable carry-over.

There are, of course, instances in which changes in technology or, perhaps, demand for the product, have eliminated the need for and, therefore, the value of certain human skills, and when human capital could not be shifted with ease from one occupation to another. These instances may even be historically important but it is difficult to form a judgment about this with any precision. Certainly most of what has been written on the subject of technological unemployment is highly impressionistic and there have been few attempts to quantify and measure the changes which have occurred. In some of the changes which have eliminated particular types of industry as, for example, the displacement of handloom weavers by a mechanized textile industry which is now continuing in India, the skills required in the new industry are, in some part, the same as in the old. Of course, many fewer persons are required due to the large increase in productivity so a substantial obsolescence of human capital is still involved.

It is tempting to generalize that such obsolescence is a greater danger and happens more often at lower rather than higher levels of skills

and, in particular, happens relatively rarely in the field of higher education. Certainly it is easier to think of more examples of such obsolescence in handicraft skills than in professional skills. Yet it does happen there also. There are M.D.'s whose specialty has been substantially reduced in scope by the development of new drugs. There have been similar developments in certain fields of engineering which have lost much of their former vogue in part due to changes in technology or demand for the particular product. The specialization in railroad engineering problems is one example.

Yet it is clear that an essential feature of human capital is its greater adaptability as compared to physical capital. Machines do not learn. People do and the more they learn the wider the range of their potential productivity.

Of all the features of human capital which are distinctive as compared to physical capital, the most significant must be the role of "non-economic" factors. This is a terminology which could be interpreted both as an understatement or the reflection of gross pretentiousness on the part of the economist as it lumps together in a residual class all manner of influences which 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 non-economic factors must be taken into account and their economic significance analyzed. The most convenient way to do this at this stage of knowledge is to consider them together.

Though labor is hired mainly on the basis of an economic calculation which takes skill requirements and education into account, that is usually not the only factor in making the contract. Nor is education itself pursued

by individuals solely as the result of a calculation of the rate of return achievable. Many, though not all, of the non-economic aspects of labor can be summed up by the economist in saying that education is like a consumption good as well as like the process of investment. 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 abstract from the non-economic elements in the education process and concentrate only on the implications of such factors. A few examples will illustrate the point and that is as much as one can hope to do in a short essay.

Education carries prestige independently of its economic significance in many societies, although this often differs with the extent of the education. 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 by his own reading. As a less obvious but important example one might cite the flow of students toward the physical and natural sciences in recent years and the relative decline in the movement into the medical profession. Yet the latter profession remains at the top of the income heap. The prestige of the physical and natural scientist is reflected not only in the pursuit of that education by students but in the hiring policy of business. Industrial research has been quite 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.

Such factors are by no means entirely absent from the equipment and construction policies of business; to be sure, there are fads and fashions there as well. However, the non-economic features of physical capital are seldom presented as the main justification of its existence as is often true for 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 aesthetic or religious or anything else. Public investment in physical capital is another matter. Here the motives may be quite similar to the motives for sponsorship of public schools and so on.

As far as the hirers of educated labor are concerned, the non-economic motives, to the extent they operate at all, are probably more significant for the more highly educated labor than for labor with the lower levels of education. For persons obtaining education for themselves it is harder to generalize. Certainly a basic education is commonly regarded as an absolute prerequisite for the achievement of personal, non-economic goals by the individual and his guardians at an early age. Higher education is also heavily overlaid with "non-economic" significance, though perhaps not as much as is somestimes assumed, in the discussions of the value of a liberal arts education, for example.

Two essential features of labor as a factor of production tie the non-economic aspects of education closely to its economic aspects. First of all, its qualities as a productive input can not be divided and used separately. A man is a man and when he works with a spade or a machine he is also a little bit of an entrepriser, a citizen, a member of a family 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. There is no way we can extract the metal and leave the dross; it is always all there together. 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 consumption 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 which has been acquired. In this respect individuals in their acquisition of education are always like small proprietors whose business fortunes are not separable in law from their personal fortunes.

The impression is not intended that all the "non-economic" aspects of labor can be summed up and analyzed as if they constituted simply another consumption good. Opportunity for social advancement is not just a private consumption good and considered as a public consumption good, it is a most unusual one. Since social advancement is related to incomes, it is associated with education when treated as a capital factor but it does not depend only on economic achievement.

Another unique feature of labor is its inalienability; more bluntly people cannot sell themselves. This means that the viewpoint of the individual and the society he composes is going to be different from the viewpoint 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 they must always do so having in mind that there is no way in which they can 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 the individuals nor with an overall vision of the society.

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 the military service may be required to devote some minimum time to those services, but the requirements are limited. The more general obligations of citizens for the education received are not well defined and only in part because the general social benefits are also not well defined. 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 to those of the business firms for which he works or of society as a whole.

Education has so far been considered in terms of its ability to reproduce skills and thus create human capital as a consumption good and as an instrument of social policy. It is still 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 of these features.

Research and development are very much in the foreground of national policy these days and educational policy is centrally involved.

It is useful in order to bring education within the scope of economic analysis to consider it 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 an evaluation of their comparative significance. The purpose of this section has been to describe in a general way the features of human capital which 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.

III. The Requirements for Educated Labor for Economic Growth

Education can be the equivalent both of a consumption good providing personal satisfaction and an investment good which contributes to the production of other goods and services. In considering this latter aspect of education in this paper we now ask questions similar to those conventionally asked about physical capital and economic growth: Is our rate of "investment" in human capital, i.e., 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, teachers of various types in the proportions

which are most effective in aiding U.S. economic growth? Recent developments in the world abroad which have disturbed the complacency of the U.S. 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 in this country.

However, such questions are also being asked in the less developed nations of the world, perhaps with even more pressing requests for answers. They start from much lower levels of income and under great pressure to improve their economic performance. There is less "leeway" in the system since they have very small amounts of any type of educated labor and, therefore, they can less afford mistakes.

The questioning of educational objectives has also led to a new concern with educational methods. This is an area into which this paper will not attempt to step. It will be enough if it can help, in part, to define the goals. These are, in the present context, the needs for human capital for economic purposes, as inputs of a particular kind of productive resources to production processes.

The questions as asked above are not the most common formulations of such educational issues. Usually these are posed in such terms as: "Shall we spend more on education?" "Shall we subsidize medical education or give 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 it is not at all certain and situations may arise in which they do compete.

Moreover, these latter questions do not recognize another possibility: 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. It is that the optimal combination of investments and, therefore, the best answer to the question of how much of what kind of investment to achieve a particular rate of growth, is that which imposes the least sacrifice of consumption possibilities, including in this the education which may come under this heading. It is not because sacrifices are to be avoided at all costs that the criterion is posed this way but rather because there is no way in which they can possibly be avoided and they should be minimized.

Education like any other activity requires productive resources; some types require more than other types but, in any case, the more there is, the more the resource requirements. Many of the resources can be used for other purposes and there is a good deal of possible switching as between types of education at both lower and higher levels. Resources for education, and for all other types of activity, are not unlimited; in any year there is just so much. 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 make sacrifices. The sacrifices may only be 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 re-employed and, if one line of activity is chosen over another, the second is making sacrifices. One has only to follow closely the politics of various anti-recession measures to realize how well the various economic interest groups realize this is no abstraction as they maneuver for a more preferred position.

This reasoning indicates the inadequacy of those statements of educational policy whose content amounts to the maxim that, "the more, the better." Having more of investment in education in general means giving up some amount of something else. Anyone is entitled to the opinion that U.S. society ought to give up some of its other consumption or investment in order to have more of investment in human capital and there may be grounds in the relative wealth of the U.S. to believe that such sacrifices are "easier" in the U.S. than other countries. Unless such opinions are grounded 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 methods. Again, this is not to deny its other significances but only an attempt to treat the former aspects on its own merits. Nor does this approach imply a narrow view of the contribution of education to economic activity which 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 more the better" maxim, on which so much discussion of educational policy seems to be based, is demonstrated also by its lack of operational power. At every level of practical decision-making, from local school board through state boards to the federal Congress, there are the constraints of limited resources which must be spread among such areas as welfare projects, again partly consumption but partly investment for further growth and, say, highway construction, which also falls into the two categories. It is important for people to have opinions as to whether all or part of these expenditures should be changed to indicate the desired direction of movement. But again the question finally must be asked, "How much?" taking into account the alternative investments possible.

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 against which to judge partial policies or rules of thumb to determine if they are at least moving 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 factors will determine the relative cost of achieving various targets and there is some substitution between them on this basis just as the consumer substitutes between meat and cheese depending on the relative costs.

There is one other type of knowledge which is necessary for the formulation of decisions as to the amount of resources which should be directed toward education to create 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 achieve production targets. Essentially it is information about technology in a very general sense. It requires quantitative knowledge about all the inputs for various outputs. This includes data on the productive resources, human and otherwise, required for the creation of human capital, via education, and physical capital of various types, as well as consumption goods. Of course, the questions about the relative mobility of human and physical capital raised in section II above would also have to have answers.

Given all these kinds of information the economist can visualize a grand, synthetic program which results from an optimizing procedure 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, the best use of natural resources and so on. 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 we would have in formulating an investment policy for physical capital. The technological and consumer information specified above for that grand program just does not exist and most of it cannot be achieved except at high cost. Moreover, given the scope and the complexity of the relations involved, it would be quite impossible to solve that huge optimizing program subject to all the constraints involved.

The problems may be more obvious if viewed in relation to the less developed countries which do undertake to consciously and explicitly formulate an investment policy not only for the government sector but at least as a guideline for the private sector. In the U.S., on the other hand, the most significant government action in formulating investment policy is in the field of education, and physical investment planning is left mainly, though not exclusively, to the private sector. Of course, investment in education in this country is, likewise, by no means an exclusively governmental decision or 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, i.e., with the formulation of comprehensive, optimal physical investment programs. They do not completely succeed due to the analytical and data problems mentioned above. They "make do" with approximative, rule-of-thumb procedures as we must in formulating a policy for investment in education.

The approximative procedures which economists have developed do enable them to know something about the characteristics of that grand, synthetic program. Thus, it is possible to develop some knowledge to provide at least rough 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 they might yield.

One method in use is to estimate the returns due to investment in labor and compare those with the returns elsewhere in the economy.[1] Since an optimal policy 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. The most serious of these is the inability to estimate all the returns to only that education which contributes to economic production. Wages and salaries are certainly not entirely adequate for this particular purpose. This suggests that there

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[1] See G. Becker, "Underinvestment in College Education," American Economic Review, Papers and Proceedings, Vol. L, No. 2, May 1960, pp. 346-354.

is a serious logical problem of composition 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 followed and refined for what information it can provide so long as there is the appropriate care with conclusions.

One of the most common and most powerful methods used by economists in determining overall physical capital requirements for growth is the application of some ratios of marginal capital requirements to prospective increases in outputs. Though these ratios have been the subject of a great many studies, they have a number of serious faults even putting aside the many difficult accounting problems which makes their use suspect. They are calculated on a historical basis and are bound to reflect a particular past composition of output and patterns of investment undertaken. Since change in these patterns is usually one of the objectives of growth, the use of such historical ratios creates a bias in the results. There are also such problems as adjustment for less than full utilization of capacity and of taking into account the changing importance in different years of additions to existing plant and equipment and completely new installations. Yet 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 which might otherwise be impossible to achieve.[1]

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[1] See P. N. Rosenstein-Rodan, International Aid for Underdeveloped Countries, Center for International Studies, M.I.T., Cambridge, Mass., January, 1961.

A rough adaptation of this method, comparing trends in enrollment and openings in the professions, is used by Professor Seymour Harris in coming to his conclusions about the dangers of "overeducation." This method, however, again fails to distinguish between the various functions of education and assumes all such education is only for the economic purpose of creating the optimal amount of human capital. Yet it is possible that further work in this direction will eventually also pay off. Only recently has an estimate appeared of the "Capital Formation by Education,"[1] prepared by Professor T. W. Schultz of the University of Chicago. Yet these estimates suffer from a number of defects in both concept and measurement which must be repaired before they can be used to answer the kind of questions posed above. It is necessary to say that these defects are, in part at least, already recognized by Professor Schultz.

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 which are foregone by society when individuals, instead of working in the labor force, remain students. Such costs are naturally greater at the higher levels than lower levels of education. In computing these, some carefull overall "social accounting" must be done. Professor Schultz estimates the opportunity costs essentially by computing the average returns of the lost hours of work of a typical student. He recognizes the potential criticism that the method is a "partial equilibrium" approach

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[1] Journal of Political Economy, Vol. LXVIII, No. 6, December, 1960, pp. 571-584.

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, Professor 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 related to overall output and used to project the changes required in one due to a substantial change in the other.

Nor should the total foregone earings necessarily be used to estimate the opportunity cost of the years spent in education to society. That is not even a true estimate in the differences in total national income due to the withholding of labor from the working force. What also must be taken into account is the possible return to the savings which might have been generated if additional income had been available to the family. The different levels of consumption which might otherwise have been maintained need also to be taken into account. Perhaps nothing better could have been done for the U.S. for 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 does not.

Though Professor Schultz recognizes that a part of the education given and received is really a consumption 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 which is essentially used as a consumption good, it could yield productive services just like the education

intended primarily to create productive human capital. Therefore, it too should be added to the capital stock created by education. This would be hard to maintain, however, in the face of the well-known differences in the returns to 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, of course, and, therefore, it is, in general, not recorded by Professor Schultz's statistics. Yet no one would argue that this is not a significant type of human capital. Much of it is obtained by more or less formal on-the-job or apprenticeship training programs and even that acquired in more casual ways still has a different status than the general socializing effects of pre-school training. So, on the one hand, Professor Schultz's estimate includes a certain amount of consumption services and excludes a certain amount of what undoubtedly is productive human capital.

Finally, the approach adopted by Professor Schultz starting from the side of the education which is "given" to students assumes implicitly that all that education is used. In 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 Section II above 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 which is not used. For example, in the process of becoming a lawyer, a student may first become an engineer in what 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 ways of selecting and placing students, to be sure, and it is not clear that extensive and intensive education is always the cheapest means but some amount of education for this purpose may be inescapable.

It is clear also that not all students in the labor force use the maximum amount of education which they receive, that is, some human capital is unemployed. This is only partly because it was created in the process of selection and placement. Some education systems just make mistakes, though when they do it is not only, perhaps not even primarily, the fault of the educational system itself as 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 become petty clerks in the midst of a dearth of human capital with technical skills. In the U.S., when teachers leave their profession to take jobs for which they do not require all the skills they have acquired, we have another example of the unemployment of human 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 amounts of labor with different degrees of education required to operate the processes in combination with materials and capital equipment. This is the idea mentioned above that there are production functions for the various components of the national product which indicate the outputs which are achievable for alternative combinations of inputs. Conventionally in economics all labor is treated as one homogeneous input. When considering the economic requirements for education it is necessary, however, to distinguish the different types of labor in terms of their different degrees of education, including vocational training. Only disaggregation of labor 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 disaggrated inputs of labor with different amounts of education specified, along with other factor requirements.[1] 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 more than usually detailed studies were done of manpower

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[1] See R. S. Eckaus, "The Factor Proportions Problem," American Economic Review, Papers and Proceedings, Vol. XLIX, May, 1959, pp. 642-648.

requirements by industry. These 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 labor with different degrees 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 the following information was available: (1) a complete listing of employment in each of the various job categories and (2) a description of each job category in terms of the educational levels required, on the average, for that job type. It would then be possible by running through all the jobs and the employment in each to classify all employment into 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 a "replacement cost" estimate of the human capital. It would omit that education which was obtained essentially as a consumption good, only for the personal satisfaction obtained. It would also omit any unemployed education. If the objective were to provide a basis for estimating the marginal technical requirements for education of an expansion in the economy, these omissions would be desirable. However, this approach would also omit the amount of education which has to be provided in the performance of the

searching and selection functions described above. It also omits the educational requirements for that component of the population which does not get 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. For the first requirement of an occupational distribution by industry the population census must be used.[1] In 1940 for the first time and again in 1950 some reasonably detailed information on occupations was 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 the 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 provided 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.

For the description of the educational levels required on the average in various jobs an impressive compilation of information exists in the Estimates of Worker Trait Requirements for 4000 Jobs.[2] Again, however, it provides only approximately the data desired since it contains estimates

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[1] U.S. Bureau of the Census, Occupation By Industry, 1950 Population Census Report P-E No. 1C.

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

SCALE OF GENERAL EDUCATIONAL DEVELOPMENT

State of development involving capability to immediately function 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 non-verbal 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 philosophy, such as Kant, Whitehead, Korzybski. - Literary works, such as Stein, Elliot, Auden.
6	Apply principles of logical or scientific thinking to define problems, collect data, establish facts, and draw valid conclusions. Interpret 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 of Literature, 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 common sense 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 common sense 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

Level	Reasoning Development	Mathematical Development	Language Development
2	Apply common sense understanding to carry out spoken or written one- or two-step instructions. Deal with standardized situations with only one or two, 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 common sense 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.

of the length of training required on the average for effective performance in a particular job category. It does distinguish the Specifically Vocational and the General Education requirements for each job. Yet the Specific Vocational training times cannot be easily translated into units comparable to conventional school years. Likewise the General Educational Development requirements are described quite generally in terms of levels of language and reading skills, mathematical competence and general reasoning ability. These levels again are not easily translatable into conventional school years.

In spite of the limitations of the data and the problem of its translation, the method provides a description of educational requirements which is not otherwise available. This description, moreover, is closer than any other to the type of data which the economist would ideally like in order 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 which would be used if the technology of all production processes could be described in terms of the alternative amounts of the various inputs required 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 involved the assumption that a particular job in 1940 and 1950 required the same vocational skill and general educational requirements.

Tables I and II tabulate overall results of the study and permit some interesting comparisons. The requirement for a higher education to

provide the general educational development levels needed is limited to a small fraction of the labor force and this fraction did not change much between 1940 and 1950. In the former year it was 7.1 per cent of the labor force; in 1950 it was 7.4 per cent of the labor force.

Not all of the longer specific vocational training periods can be identified with higher education though many, and particularly those running over four years, usually can. These involved only 3.3 per cent of the labor force in 1940 and 4.2 per cent in 1950. Some part of the vocational educational training periods of from two to four years also represent college preparation but these cannot yet be distinguished from long apprenticeship programs, and so on. 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 also to require a college education as general background as well.

The method used is weak on several grounds due to data problems. It was noted above, for example, that no allowance could be made for upgrading of jobs as between 1940; 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.

It is interesting to note that there was a general upward movement of the educational requirements of the labor force both in general background and specific vocational requirements. The average schooling required of the labor force for general background purposes was 9.7 yrs. in 1940

and 10.1

TABLE I

GENERAL EDUCATIONAL REQUIREMENTS OF THE U.S. LABOR FORCE IN 1940 AND 1950

General Educational Development Scale [1]	School Grade Equivalent [2]	1940 Labor Force		1950 Labor Force	
		Number	Per Cent	Number	Per Cent
1	0	583,240	1.3	119,220	0.2
2	4	3,478,758	7.7	3,118,640	5.7
3	7	8,778,560	19.6	9,067,170	16.5
4	10	19,254,902	42.9	24,584,300	44.7
5	12	9,597,940	21.4	14,019,460	25.5
6	16	2,313,240	5.2	2,775,180	5.0
7	18	844,420	1.9	1,322,510	2.4
	Total	44,851,060	100.0	55,006,480	100.0
Average Years of School Required		9.7		10.1	

[1] For the interpretation of this scale the following Table is reproduced from Estimates of Worker Trait Requirements for 4000 Jobs, p. 111.

[2] These 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 GED scales has been conflicting. I do not offer this translation as a definitive one.

TABLE II

SPECIFIC VOCATIONAL TRAINING REQUIREMENTS FOR THE U.S. LABOR FORCE IN 1940 AND 1950

Specific Vocational Preparation Range	1940 Labor Force Number	1940 Labor Force Per Cent	1950 Labor Force Number	1950 Labor Force Per Cent
1 - Short demonstration only	644,875	1.4	256,980	0.5
2 - Anything beyond short demonstration up to and including 30 days	7,488,960	16.7	11,544,540	21.0
3 - Over 30 days up to and including 3 months	5,931,798	13.2	4,249,320	7.7
4 - Over 3 months up to and including 6 months	10,271,960	22.9	13,055,320	23.6
5 - Over 6 months up to and including 1 year	1,941,740	4.3	2,785,080	5.1
6 - Over 1 year up to and including 2 years	7,865,902	17.5	7,919,520	14.4
7 - Over 2 years up to and including 4 years	9,210,585	20.5	12,957,350	23.5
8 - Over 4 years up to and including 10 years	1,495,240	3.3	2,318,370	4.2
Totals	44,851,060	100.0	55,086,480	100.0
Average Years of Training Required	1.66		1.72	

years in 1950. The average specific vocational requirements was 1.66 years in 1940 and 1.72 years in 1950. This also provides a basis for comparison of the relative significance of general education and specifically vocational preparation in the training of the labor force. Altogether then, in 1940 a worker required, on the average, 11.4 years of both general and specifically vocational education; in 1950 it rose to 11.9 years, or by less than 5 per cent.

Another way of assessing the general significance of higher education is in terms of the number of school years it involves as compared to the total school years required for the general education of the labor force. In 1940 higher education occupied only 3.2 per cent of all the necessary school years; in 1950 it was 3.4 per cent.

A still more significant economic assessment of the relative significance of higher education in providing the general background necessary for the labor force is obtained by estimating its total costs relative to that of the other levels of education. This, in turn, requires an estimate of the costs per student of the different types 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 only direct resource costs were estimated from the article by Professor T. W. Schultz by dividing his data by the number of students at each level. The costs of elementary, high school, and college computed that way were in 1940 related in the ratio 1 : 1.9 : 5.8, respectively, and in 1950 in the ratio 1 : 1.9 : 4.2 respectively, indicating, by the way, a

relatively lower rate of increase of the cost of inputs into college education. This helps explain why, in terms of direct resource costs, the higher education requirements of the labor force would have been 14.2 per cent of the total resource costs, while in 1950 they would have been only 11.0 per cent of such costs.

Finally, the required amounts of higher education can be at least partially compared with those actually possessed by the labor force. From the 1940 and 1950 Census of Population the number of employed persons with four or more years of college was computed at 5.9 per cent and 7.4 per cent of the employed labor force respectively. The corresponding requirements for general education as read from Table I were 7.1 per cent and 7.4 per cent of the labor force. This indicates that in 1940 some of the labor force which required the equivalent of a college education did not have the formal training and 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 these may have been systematic over or under-evaluation of the job requirements in the U.S. Employment Service ratings. It is likely that there were systematic upward biases in both occupations reported and educational attainments. Taking all these into account it is nonetheless useful to find that as yet there is little "unemployment" of this kind of education at or above the college level among 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 aggregated but the approach can be developed into a method for estimating current requirements for an expanding economy. Though certainly imperfect the method seems capable of forming a more concrete basis for educational policy than any heretofore available.

However, it will not solve all problems and, for example, not one of what is the most pressing of contemporary educational issues: "How much higher education should be directed toward the training of persons for research and development?" This problem has already been alluded to above. One of the major difficulties in coming to an answer 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 conventional approach seems feasible. It will always be a decision shrouded in uncertainty.

IV. The Supply Conditions of Human Capital

This section will analyse the economic motivations for the acquisition of education, that is, the conditions of the formation of human capital to be used in production processes. As mentioned before, we maintain the distinction between the educational process, on the one hand, and its outputs, educated labor or human capital, on the other, and do not deal with the economics of the educational process itself as, for example, with the allocation of resources between teachers' salaries and equipment.

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 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 of supply. In the same way the physical capital actually used in an economy depends not only on the investment opportunities but the amount of savings and foreign investment which goes on.

The "non-economic" influences in these decisions were mentioned in Part II above. They should be recalled here since education obtained for "non-economic" reasons is often indistinguishable and, therefore, substitutable for education obtained for economic motives. It seems most likely that in the U.S. and many other countries the consumption demand for education is income elastic. That is, expenditures on education rise with income. It is more difficult to say how such expenditures behave as the cost of education changes. As between countries the amount spent for education of different degrees 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

demand for education for this purpose will be the center of discussion in this section.

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

(1) the foregone wage income, or the amount which could otherwise be earned by the student if he were not engaged in schooling;

(2) the foregone interest income or consumer satisfaction lost on the amount of money which has to be paid out as a direct or indirect cost of the education;

(3) the differential in earnings over the future of the individual as the result of the education which is the difference between the future stream of incomes with the additional education and that which 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 and, secondly, whether there are likely to be significant variations as between the decision-making by individuals and the optimal decisions for an economy.

Compulsory education, of course, eliminates the need for individual or family decision-making. The state in one way or another decides what is "right" for its citizens. Of course, not all countries have or can enforce compulsory education laws. The lower the level of family income, generally the more significant the loss of any foregone income 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 by acquiring experience and skill are limited this foregone income will rise with age but level off at the point where the individual achieves maturity as a laborer. One effect of economic growth by increasing the opportunity cost in income foregone is, therefore, to discourage individuals from investing in education and this effect probably becomes more important with higher than lower levels of education. The same reasoning applies to the significance of the interest income or consumer satisfaction foregone due to expenditures on education.

On the other hand, one would expect that the differences in income resulting from education would be more important for low income levels and rise with economic growth. The "discount factor" which is applied to these higher future incomes might vary just the other 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 are probably more important at the higher rather than at the lower levels of education. The relative infrequency of higher education and lack of experience of it probably combine to make its pay-off seem more uncertain than the return to lower levels of education whose skills are more obviously and widely in use. Historically it is also usually true that in those countries in which economic growth has been achieved personal economic success has been widespread among a substantial portion of the population with a higher education. This experience will also tend to reduce the general appraisal of the pay-off to higher education.

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 the economy as a whole. The difference between the calculation by individuals and for society as a whole is due in part to what economists call "external economies," effects on incomes which are not transmitted through and, therefore, not calculable from the price system. For example, it is quite possible that even minor improvements in production methods which do not require professional engineering skill to develop are more likely to emerge from a labor force which has a high school education on the average than a grade school education. This clearly would be a reason for society to invest in the further education. However, no individual worker could possibly claim a higher wage for his investment in a high school education on this account as the effect is due largely to the mutual stimulation of workers with the high school education.

Another reason for the difference in the calculation of the worthwhileness of education for the individual and for the economy 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 to providing college educations than no loans at all but it cannot be claimed that it is the best system of financing more higher education. As mentioned above, there are substantial risks for any individual or family in financing education. Human capital is not regarded as paying off with the certainty of investment in physical capital or natural resources. Part of this uncertainty is the result of ignorance and can be reduced by adequate dissemination of knowledge of 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 the family cannot be expected to be able to know his future. Thus, they could not be expected to decide on more education as would society as a whole because on the average education pays off. Even at the college level the uncertainties in the student's own mind and those of his family are still very great. In part they are an essential characteristic of the age group.

The risks of default as they are evaluated by college lending officers or by government acting for society can be reduced by aggregating them and transferring the responsibility to a central organization, just as in a regular insurance scheme. But the risks as seen by the individual and his family cannot be transferred as long as there is a personal obligation.

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

The difference between the economy view and the firm view helps explain why relatively little education is really financed by business and that which is business financed is likely to be highly specific. Though the economy viewed as a whole will reap all the benefits of educating its citizens, firms

which educate will not necessarily, due to the inalienability of human capital mentioned in Part II. There are relatively few instances in which a firm can be sure of a pay-off to educating workers. If the education is quite specific a firm may be sure that no other firm can use it, but it can never be sure of even a full recovery itself. There are, of course, examples of educational programs sponsored by firms. There are also societies in which the firm-employee relationship is so close as to make such programs more feasible than in the U.S. 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 creation of new knowledge. It is, however, even more uncertain than the development of the customary skills. Thus, economic calculations for private and individual financing of education for this purpose in turn are likely to be even less reliable than for the conventional training.

These rather pessimistic views of the adequacy of private support for higher education in particular must be checked against the calculations which have been made of the pay-off to investment in higher education. Calculations as those by H. S. Houthakker and G. Becker[1] 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 that this rate is not an entirely accurate

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[1] H. S. Houthakker, "Educational Income," The Review of Economics and Statistics, Feb., 1959, pp. 24-28; G. Becker, "Underinvestment in College Education?" American Economic Review, Papers and Proceedings, Vol. L, No. 2, May, 1960, pp. 346-354.

measure of the return on investment in education either for the economy or society. It does not include an allowance for the costs to the individual or society other than foregone income. Inclusion of such costs would lower the rate still further.

In part the low rate can be explained by the fact mentioned above, that not all the return to education is received by the educated labor. There are wide benefits to society which it does not capture. 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. The latter, involving as it often does a Ph.D. program, is notoriously badly paid. That it nonetheless continues to attract personnel must in large part reflect non-economic or "consumption" as well as investment motivations.

Therefore, in addition to the "external" effects of labor education which cannot be transferred to labor via market mechanisms, it is not even clear that this mechanism accurately imputes to labor all it would achieve in a perfect market. One implication of the discussion of Part II is that there are inevitably serious departures from such a market in characteristics of the demand for education and the products it produces. Economists long ago recognized the existence of such elements in the labor market when labor was divided into categories of "non-competing" groups. The terminology is somewhat unfortunate but nonetheless suggestive. Monetary returns do not encompass and adequately measure all the rewards to the individual and to society of education.

V. Summary

There are no easy guides or even good rules of thumb for determining the educational policy optimal for economic growth which also fulfills all the other social burdens of education. The patterns which now exist represent the influence of tradition and 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 much longer validate such behavior.

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

However, a conclusion which emerges most clearly from the foregoing discussion is that educated labor, 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 the 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 U.S. 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 signalling that there are too many teachers, that the resources we have would earn a higher return if shifted elsewhere. Yet we quite rightly do not believe those signals. As pointed out above there are a lot of 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.

This does not mean that economic analysis is inappropriate or that market mechanisms cannot be used to shift resources in education. As stated at the outset and demonstrated in the course of the discussion economics has much to offer here. To be successful in this field, however, and to help form optimal social policy, economic analysis must fully appreciate the uniqueness of the human resource.