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Conceptual Foundations of the Study

The foundation of this work is the concept of capital as capacity to produce output and income (including nonmarket income) over a succession of accounting periods. Investment, in turn, comprises outlays that maintain or increase output- and income-producing capacity. It follows from these definitions that the growth of real stocks of capital, broadly and inclusively defined, resulting from real net investment should be a major element in the growth of real income and product. As Johnson well stated at the 1963 OECD conference mentioned in the Preface, "The conception of economic growth as a process of accumulating capital in all the manifold forms that the broad Fisherian concept of capital allows is a potent simplification of the analytical problem of growth, and one which facilitates the discussion of growth policy by emphasizing the relative returns from alternative investments of currently available resources."[1] And since the saving that releases resources for investment depends importantly on income, the growth of capital is reciprocally related to the growth of income.

In his famous AEA presidential address, Schultz went so far as to suggest that the ratio of income to a comprehensive measure of capital stocks has been roughly constant through time.[2] He based this hypothesis on the observation that, while total tangible factor productivity had risen, intangible human capital also appeared to have risen relative to tangible capital stock and input. This suggested that the relative growth of intangible capital might largely explain the growth in the productiv-

1. Harry G. Johnson, "Comments," *The Residual Factor and Economic Growth*, Paris, OECD, 1964, p. 221.

2. Theodore W. Schultz, "Investment in Human Capital," reprinted in E. S. Phelps, *The Goal of Economic Growth*, New York, Norton & Co., 1969, p. 106.

ity of tangible factors (measured without allowance for increased efficiency due to education and other human investments), and that total capital growth might largely explain economic growth generally. Schultz's views were quite similar to those expressed in the latter 1950s by Fabricant and the present writer, as noted in the Preface. Although Schultz had measured the stock of educational capital, comprehensive measures of total capital were not available to permit him to test his hypothesis.

Unfortunately, the official national income and product accounts of most nations define and estimate investment exclusively with respect to tangibles—new construction, durable equipment outlays, and inventory accumulations—plus net foreign investment. The U.S. Department of Commerce domestic investment estimates are largely restricted to this day to tangible capital outlays of the private business sector. It is not yet standard practice in any country that we know of to include education and other intangible or human investments in the capital accounts. Yet the concept of human capital has an ancient and honorable lineage. As Kiker has documented: "Economists who considered human beings or their skills as capital include such well-known names in the history of economic thought as Petty, Smith, Say, Senior, List, von Thünen, Roscher, Bagehot, Ernst Engel, Sidgwick, Walras, and Fisher. Basically, two methods have been used to estimate the value of human beings: the cost of production and the capitalized earnings procedures."[3] But Marshall's dictum that capital should include only those classes of wealth that can be bought and sold in the marketplace constricted subsequent work on human capital, just as his emphasis on value theory under static equilibrium conditions tended to divert attention from the dynamics of economic growth analysis. Concern with capital formation was further narrowed by Keynes, who focused largely on tangible business investment, which he cast as the crucial volatile variable in his theory of the determination of national income in a market economy, again under largely static conditions.

Keynes's *General Theory* had the favorable effect of providing an impetus for the development of national income accounts in most countries of the world during the subsequent quarter century. But the structure of the national accounts, including the initial standard system of the United Nations (1953), reflected the Keynesian approach to explaining income determination, and incorporated a correspondingly narrow definition of saving and investment.

3. B. Frazier Kiker, "Human Capital: In Retrospect," University of South Carolina Bureau of Business and Economic Research, *Essays in Economics* 16, June 1968, p. 112.

The revised U.N. standard system of national accounts (1968) does provide capital accounts for each sector accommodating estimates of tangible nonhuman capital formation in each sector alongside those for the economy as a whole. It thus represents a considerable improvement over the more restricted U.S. official national income accounts. But what is needed now is a further restructuring of economic accounts to include human tangible (rearing costs) and human and nonhuman intangible investments in order to yield total investment of the nation, by sector. Further, the associated balance sheets and wealth statements must be developed to show the total tangible and intangible stocks of capital, human and nonhuman, by sector. Only this way can the economic growth theories of Schultz and the others cited above be tested and a more adequate empirical basis for growth policies developed. The present work may be regarded as a pilot study for determining the feasibility and usefulness of such restructuring of economic accounts and of developing estimates of total investment and capital stocks by type and sector.

An indispensable element of this endeavor consists of identifying and defining all of the significant constituents of total investment and capital. It is easy to define capital as output- and income-producing capacity and to theorize that the growth of real capital, so defined, should be the chief element in explaining the growth of real income and product. It is more difficult to define the components of total investment, distinguishing carefully between consumption and capital formation, and to specify the various types of investment in operational terms as a basis for estimation. This task is undertaken in the remainder of this chapter, and the relevant estimating methodology summarized in the following chapter. No attempt is made here to review the literature on the various types of investment and capital, although a number of references to basic works relating to the various areas will be given.

The Scope and Composition of the Investment and Capital Estimates

Delineated below are all the types of investment and associated capital that conform to our general concept, classified by the major categories in terms of which the estimates are presented—tangible (nonhuman and human) and intangible (nonhuman and human). The intangible investments (R&D, education, training, medical, and mobility expendi-

tures) are, of course, generally embodied in the tangible capital, nonhuman or human, so an alternative classification may be couched in terms of the human-nonhuman categories.

It will be noted that we include all investments made by all sectors and the resulting capital stocks financed or used by each in productive processes. This contrasts with the current Commerce Department approach, which counts as investment only the tangible capital outlays of the enterprise sector, including private nonprofit institutions, and new residential construction for owner-occupancy as well as rental (on the fiction that the homeowner is in the "business" of renting to himself). Inclusion of outlays by all sectors that yield a flow of services extending over more than one annual accounting period conforms not only to our comprehensive definition of investment, but also to a basic economic accounting rule that the estimates should be invariant to institutional changes. It is desirable that the investment, capital, and income totals remain unaffected as sources of financing the various investments shift among sectors (as in the case of public versus private education, for example), or as practices change as to ownership by nonbusiness sectors versus leasing from the business sector. Also, as one type of investment is substituted for another the total should be unaffected, which is only true if capital formation embraces all types of forward-looking outlays that may be substituted for each other at the margin.

TANGIBLE INVESTMENT AND STOCKS

Tangible investments, as distinguished from intangible ones, are material; they have body (human or nonhuman) and thus are "touchable." They are the carriers in which intangible investments are "embodied" and contribute to the quality, or productivity, of the tangible factors.

NONHUMAN TANGIBLES. These comprise what is traditionally considered "wealth"—structures, land and other natural resources, machinery and other durable equipment, and inventory stocks. It is this category that has been traditionally classified as investment, if made by the enterprise sector. But these outlays, and the resulting capital stocks, also yield a return when undertaken by the nonbusiness sectors, even though the return is generally nonpecuniary. In the household sector, residential real estate, automobiles, and other durable goods produce utilities either in furnishing direct pleasure or in aiding with household work. The latter is the case also with household inventories, which reduce shopping time. In the case of government, some of the struc-

tures, equipment, and inventories are required for the governmental functions of producing services for the community. As in private industry, the cost savings resulting from investments in new capital goods can be calculated. But much of the public capital represents "infrastructure," which provides direct utilities to the public, or facilitates production by the private sector. Some public capital (highway construction, for example) does both. The present value of future benefits to the public can be frequently at least roughly estimated.

Because of the economic value of the nonbusiness capital we impute a rental value to it by techniques described in Appendix B. This makes for consistency with the business sector, since the earnings of business capital are included in national income. Without imputed rental values the accounts would not be invariant to changes in institutional structure and practices. This is recognized by the Commerce Department in its treatment of new residential construction: it is all treated as investment, whether undertaken by real estate firms for rental purposes or by contractors or individuals for owner-occupancy. In the latter case, a rental value is imputed to the residences by the Commerce Department, so that income flows will not be distorted by changes in ownership patterns. But the same logic applies to all durable goods and other capital, as pointed out by Juster and others.[4]

For example, if governmental units lease equipment from private firms, the equipment purchased by those firms shows up as investment, and the rentals are included in income and product. If, on the other hand, the government purchases the equipment, these purchases are not identified as investment, and the rental value is not included in income and product (except for the maintenance and repair costs). Or, if households lease equipment or buy equipment services from private firms (e.g., laundromats), the capital outlays of those firms show up as investment, and the depreciation and net return on the investments are part of income and product. But if households buy the equipment, the purchases do not appear as investment (although they are part of consumer outlays), and the implicit interest and depreciation portions of the rental values are not included in income and product.

Logic and consistency require that purchases of structures and equipment, inventory accumulation, and outlays for natural resource development by governments and households also be termed investment; that the accumulated net investment enter capital stocks (or "tangible wealth") estimates; and that the rental value of capital be included in the income and product flows. This is merely an extension

4. F. Thomas Juster, *Household Capital Formation and Financing, 1897–1962*, New York, NBER, 1966.

of the treatment presently accorded owner-occupied residential structures and may be justified by the argument cited above—that shifts in sector ownership patterns should not affect investment, capital, or the associated income estimates.

HUMAN TANGIBLES. It is not yet conventional in estimating human investment and capital to include either the outlays required to produce the physical human being or those designed to enhance his productivity. For example, Bowman writes: "Training man's mind aside, the costs of forming human capital are primarily those involved in building his physical condition. But many of the outlays that have this effect are also consumption priorities of the first order, and in the minor exceptions any assessment of return on such outlays viewed as investment in producer capital is meaningless unless the men are slaves."[5]

Yet, it seems inconsistent to count the costs of educating a man as investment but not the cost of producing the physical being whose mind and reflexes are being educated and trained. As Fisher wrote: "The 'skill' of a mechanic is not wealth in addition to the man himself; it is the 'skilled mechanic' who should be put in the category of wealth."[6] And it does make sense to estimate rates of return on human capital at its total cost of production, as we do in Chapter 5, as well as on the capital created by education alone, as do Becker and others.[7] Indeed, these economists, who estimate the capital value of human beings by discounting future labor compensation less maintenance costs, are implicitly valuing the entire bundle of human attributes, physical and mental.[8]

Official national income estimates generally do not treat man as a means of production, only as the end. That is, neither rearing costs nor the intangible outlays that increase the productivity of human beings are counted as investments. Accordingly, no deductions from income are made for "maintenance" or "depreciation" of human capital, although this would be consistent with the treatment of nonhuman capital as advocated by Irving Fisher. In our accounts we follow his lead and include "rearing costs" and "intangible human investments" (discussed below) as capital formation, and deduct depreciation on

5. Mary Jean Bowman, *Economics of Higher Education*, HEW Bulletin 5, 1962, Chapter 6.

6. Irving Fisher, *The Nature of Capital and Income*, New York, Macmillan and Co., 1930, p. 9.

7. Gary Becker, *Human Capital*, New York, NBER, 1975.

8. Herman P. Miller and Richard A. Hornseth, "Present Value of Estimated Lifetime Earnings," Technical Paper 16, Bureau of the Census, U.S. Dept. of Commerce, 1967.

human capital from gross income. Further, in estimating net returns on total and human capital, we also deduct estimated maintenance costs from income. By so doing (as we shall see in Chapter 5), we arrive at average rates of return on total human capital that are quite similar to those on nonhuman capital.

Another argument for counting rearing costs as investment is that such expenses compete not only with consumption but also with other forms of investment in expanding capacity. Apparently the cost of rearing children reduces consumption of parents through an "abstinence effect," although the reduction is less than one for one.[9] It also results in a reduction in saving, and thus in the resources that would have been available for other types of investment. Most directly affected would be household investments in durable goods and in the extent of education and health care—although tangible and intangible human investments are also complementary to some degree. But since financial saving is affected, other types of investment, by other sectors, are also affected. Thus, since rearing costs are an alternative use of funds, they should be included with other forms of investment in studies of aggregate investment and its mix, by sector and type. This is particularly important for less developed countries with high birth rates, where rearing costs obviously reduce funds available for other investments, which quite likely promise higher rates of return.

Once the decision is made to estimate rearing costs, several key aspects of the variable must be defined. Should all children be included, or only those destined to enter the labor force? Until what age or stage of life should the living costs be included? Just what family costs should be allocated to the children being reared? On the first score, our decision is to include the rearing costs of all children. Some die before working age, and some never enter into productive activity. But in order to obtain a certain proportion of eventual labor force entrants from a given crop of babies, it is necessary for the parents and society to bear the cost of the entire cohort. Just as the cost of unfruitful mineral exploration or research must be spread over the successful output, so it seems reasonable to include the rearing costs of all children.

The human rearing span may be defined as the period from birth up to working age. Age fourteen has somewhat arbitrarily been chosen as the upper age limit, since the official U.S. labor force estimates included persons fourteen years of age and older at the time the

9. See William F. Ogborn, "The Financial Cost of Rearing a Child," in William L. Chenery, ed., *Standards of Child Welfare*, Sec. 1, Children's Bureau Conference Series No. 1, Washington, D.C., 1919.

estimates were made. Most states now designate sixteen as the upper age limit on compulsory school attendance, but work permits may be issued for youths under the legal working age. In some states school attendance is compulsory through the eighth grade, completion of which normally comes at age fourteen. Also, at age fourteen most children have attained their physical growth and have entered adolescence. As good a case, or possibly a better one, could be made for using age sixteen (now used in U.S. labor force data), or even eighteen, but statistically fourteen is better, since various population statistics are collected and tabulated in terms of age groups that end or begin with that level.

As to coverage, it should first be noted that we are trying to estimate the cost of producing the physical human being. Intangible investments affecting the quality or productivity of labor, such as costs of education and health care, are separately estimated and therefore not included in rearing costs in order to avoid double counting. The intangible investments have to be added to rearing costs to obtain total human investment.

Basically, we include the average variable costs of raising children to working age. This does not mean marginal costs, based on budget studies of families of varying sizes, since the "abstinence effect" of additional children causes marginal costs to fall below actual costs. Rather, consumption patterns based on studies of different age-sex groups have been used, as explained in the technical notes. Certain types of consumption, such as tobacco and spirits, have been excluded altogether, since their consumption is not usual among children under fourteen. Variable costs include increases in "fixed" costs incurred as families grow larger (as in the higher value of larger dwelling units and household furnishings and equipment), but tangible household investments are excluded to avoid double counting.

Finally, while fourteen is the approximate start of working age in this country, the actual commencement of regular work activity or labor force participation is occurring at increasingly higher average ages as the period of education is extended. But beginning with age fourteen we estimate the opportunity cost in terms of foregone earnings of students, as explained below. In terms of total human investment, the age selected to end the rearing period is not very important, since the opportunity costs of youths between fourteen and eighteen is little more than their subsistence cost.

The real gross stock of tangible human capital represents the accumulated rearing costs (in constant prices) at age fourteen for each cohort on a per capita basis, multiplied by the population in each cohort, and summed for all cohorts fourteen years of age and over. This

approach automatically takes care of retirement from the national population through death or emigration, and immigration is provided for by imputation of the same rearing costs as those used for the corresponding domestic cohort. Depreciation on tangible human capital is calculated on the same basis as that on fixed nonhuman capital goods to provide for comparability. But the estimates of retirement and depreciation can be better for human than for nonhuman capital because reasonably good actual population estimates are available for the former, while the latter are based largely on assumed lives.

INTANGIBLE INVESTMENT AND CAPITAL

The intangibles embrace the investments made primarily to improve the quality or productivity of the tangible human and nonhuman factors in which they are embodied. Like the tangibles, they must have a lifetime of more than one year—i.e., improve the quality of the tangible factor over two or more annual accounting periods. The accumulated intangible investments over their lifetimes (which may differ from those of the tangible carrier) represent the gross capital stock. Net stock estimates are obtained after depreciation rates consistent with those for the tangibles are applied to each year's gross investment and the resulting accumulated depreciation on each vintage of investment remaining in stock is summed and subtracted from gross stock.

While economists have been increasingly treating the various forms of intangible outlays enhancing tangible factor productivity as investments, estimates of the resulting capital stocks are a unique feature of the present study. The combined real tangible and intangible capital estimates, for each factor separately and in combination, represent the output-producing capacity resulting from the increase in both quantity and quality of the factors. The relative increase in the real intangible stocks provides a means of quantifying quality improvements and indirectly provides a means of measuring technological and organizational advance to the extent that this is associated with capital formation.

NONHUMAN INTANGIBLES. This category refers to the expenditures required to advance productive knowledge and know-how, including that incorporated in new or improved consumer and producers' goods and in productive processes and systems. In recent decades most of such investment has been included in the statistics on research and development (R&D) expenditures. R&D outlays eminently qualify as investment, since the part that results in cost reductions increases productivity and the part that results in new and improved consumer

goods increases satisfaction. However, it is often difficult to quantify quality change, and real product and productivity estimates are generally considered to understate growth to the extent that there have been net improvements in the quality of goods and services.

The National Science Foundation, the chief source of R&D estimates in recent years, uses the following definitions for the three major components that can usefully be distinguished.[10] (1) *Basic research* is that "in which the primary aim of the investigator is a fuller knowledge or understanding of the subject, rather than a practical application thereof." (2) *Applied research* is "directed toward practical application of knowledge." (3) *Development* is "systematic use of scientific knowledge directed toward the production of useful materials, devices, systems or methods, including design and development of prototypes and processes."

In some cases it may be difficult for respondents to demarcate the cutoff points between phases, particularly since R&D is not only a flow process but is also characterized by feedbacks from one phase to another. Further, different respondents may classify and report data using somewhat different criteria. Nevertheless, the NSF categories are broadly useful for analytical purposes.

While basic research is not directed toward practical applications, it clearly enlarges the pool of scientific knowledge which is continually drawn upon (and contributed to) by those engaged in practical invention and engineering development. As a whole, it seems fair to count basic research as well as related development activities as investment, with the cost of the "useless" research being borne by that which has an economic payoff—just as unsuccessful mineral exploration is part of the cost of the discoveries.

The real costs of R&D may be regarded as an input, resulting in an output of knowledge, ideas, and know-how, some of which may be incorporated in designs, prototypes, et cetera. The R&D output, in turn, becomes an input in the further investment process, whereby the ideas are translated into practical and commercially feasible products (consumer and producer), processes, methods, and systems which expand income-producing capability.

The sector estimates of R&D are based on the sources rather than the use of funds. Measured R&D includes only the formal activities of the various sectors. Some informal research and development, such as that of the lone inventor of the household sector, is not included. With informal activities becoming less important, the estimates would tend

10. *Reviews of Data on Research and Development,* No. 33, National Science Foundation, April 1962, p. 8.

to have some upward bias as a measure of all R&D activity, but this is probably of minor importance for recent decades. A possibly more important source of bias is a tendency for organizations to include more of their costs as R&D as this group of activities has become more clearly recognized and prestigious.

The pool of productive knowledge and know-how drawn on by producers is the capital resulting from R&D, which we measure at cost revalued to constant and current prices. Basic research results in accumulation of knowledge, which continues to be drawn on through the ages. But the applied research and productive knowledge and know-how developed through engineering has a finite life and is eventually supplanted by new applied research and related development. We take account of the finite lives of new products and technologies in preparing the estimates of the stocks of productive knowledge resulting from R&D, as explained later.

EDUCATION AND TRAINING. The dissemination of knowledge has long been recognized as an important form of intangible investment. The stock of knowledge and know-how embodied in human beings is an important source of income, both psychic and monetary. Increases in the knowledge of individuals, other things being equal, tend to increase their income-earning capacity. Thus, the costs of knowledge dissemination may be termed investment—they are associated with increased income and yield a return.[11]

Much education is general in nature, producing what Machlup has called "intellectual" and "spiritual" knowledge. Intellectual knowledge refers to the kind of general understanding of the natural world and human society and culture that is imparted by a "liberal" education. Spiritual knowledge concerns man's place in the universe and the basic values of life, as taught by philosophy and religion.[12] General knowledge is an important part of human knowledge, in part because it trains the mind and forms a basis for more practical knowledge, but, more importantly, because the understanding imparted by a liberal

11. See Gary Becker, *Human Capital,* for a discussion of the costs of and return to education; also Mark Blaug, *Economics of Education,* Vol. I, Baltimore, Penguin Books, Inc., 1968.

12. A portion of both religious and secular intellectual knowledge at any given time may not be provable, of course, or even demonstrable. This has always been so; it would be an impossible task to try to distinguish between the portion of education and knowledge that is "true" and that which is "untrue," or even to apply a pragmatic test as to what works and what does not. Presumably the latter is gradually weeded out, though perhaps not as rapidly as new errors take the place of old! See Fritz Machlup, *The Production and Distribution of Knowledge in the United States,* Princeton, Princeton University Press, 1962.

education enhances one's appreciation and possibly enjoyment of life. That the return to general education may be largely a psychic income does not invalidate the designation of the produced knowledge as capital, although it does mean that a portion of education is consumer rather than producer capital or wealth.

Some education and most training result in what Machlup calls "practical knowledge," or know-how. Most of this is designed to prepare people for particular types of productive activity—professional, managerial, production work, and so on. Obviously, practical education and training are expressly designed to enhance income-producing ability.[13] One might also throw in Machlup's additional category of "pastime knowledge," insofar as it increases one's skills in games and other recreational and social activities that yield a psychic income.

There is undoubtedly some pleasure associated with the educational process, as well as the pains that come from stretching the mind. The current net pleasure is generally adjudged to be small compared with the enhancement of future income, however, and most investigators have not attempted to reduce the investment cost by an imputed payment for current services; nor do we.[14]

Learning results not only from formal schooling and other more or less structured forms of education and training, but also from experience, both at work and in leisure-time activities and reflective periods. This type of unstructured, informal learning must elude the estimator. In what follows we shall discuss only the chief structured educational activities and their costs.

The main type of formal education is that carried on in the specialized institutions we broadly term "schools," not only the primary and secondary schools, but also colleges, universities, technical institutes, et cetera. The revenues of the private (nonprofit) schools are generally taken as a measure of the value of their services. In the case of the larger sector of public schools and private, nonprofit educational institutions,

13. As was stated by one of the early modern investigators in the field: " . . . the more advanced and prolonged the education, the more exclusively vocational its purpose, the more probable it is that the guiding principle will be that of ordinary economic gain. If this is true, it would seem clear that the abilities acquired through strictly professional education resemble capital very closely. These are cultivated for gain; and the investment is made in a market where competing savings will tend to force the returns on the cost of training to repay that cost with a profit, equal to that obtainable in other uses. Otherwise, the investment would take some other profitable form." (J. R. Walsh, "Capital Concept Applied to Man," *Quarterly Journal of Economics*, February 1935.)

14. See Theodore W. Schultz, "Investment in Human Capital," *American Economic Review*, March 1961.

the measure is the costs of their services, including imputed rental values of the structures and equipment.

An even larger cost than that of the educational institutions is the foregone earnings of students of working age (here taken as fourteen years and over, for consistency with the rearing cost estimates). This element, which, most economists agree, should be included as part of the educational investment, might also be viewed as an imputed compensation for the schoolwork of students in terms of opportunity costs. The complex assumptions and procedures for estimating foregone earnings are summarized in the next chapter and detailed in Appendix B-4a.

An important part of preparing workers for specific jobs is the training provided by the firm, governmental agency, nonprofit institution, or other organization employing labor. Some of the training or educational programs are formal, such as apprenticeship programs and management courses, requiring part or all of the employee's time for periods of varying length. Here the costs include the direct costs to the firm of providing the instruction, plus the compensation of the worker during the periods when he is not producing.

There is also informal training, sometimes called "breaking in."[15] Costs comprise the pay for the time spent by supervisors and others who assist in breaking in new employees, plus the expenses due to substandard production by new employees learning their new job assignments.

It may be noted that our approach of measuring training investment in terms of cost contrasts with that of Jacob Mincer, who estimates the value of on-the-job training indirectly via the human capital approach, using life-cycle earnings data.[16] The cost approach is, however, required for consistency with our other investment estimates.

In addition to more or less formal education in schools and workplaces, there are a number of structured, but more informal, means of learning. First, there are libraries and museums (other than those associated with schools), which are available to those seeking useful knowledge as well as immediate pleasure. Next, a portion of radio and television programs is educational in character; that portion of the imputed rental value of these household durable goods must be charged to education, as well as the direct cost of such programs. Some part of the contents of newspapers and periodicals impart "intellectual" or "practical" knowledge, to use Machlup's terminology. Teaching aids

15. See Grant W. Canfield, "Plan to Compute Your Labor Turnover Costs," *Personnel Journal*, August 7, 1959.

16. See Jacob Mincer, "On-the-Job Training: Costs, Returns and Some Implications," *Journal of Political Economy*, Supplement, October 1962.

such as phonograph records, moving pictures, and the like used in schools would be included in the direct costs of education, but some aids are bought for home use. Finally, there is frequently some education content in the programs of lectures and discussions sponsored by various organizations at their regular meetings, conventions, or other assemblages. Although precise estimates of these "incidental" types of education are not possible, some allowances are made for their costs.

The real gross capital stock resulting from general education and training can be viewed as the cumulative real costs per capita for each cohort, multiplied by the population in each. This can be revalued from constant to current dollars. In estimating net stocks, allowance can be made for "learning by doing" by not beginning depreciation allowances on the revalued costs of education and training until several years after completion of the education period (see Appendix B-4a). As with other human capital, that portion incorporated in the employed labor force can be segregated for production function analysis.

In the case of narrow, specific job training, our judgment is that these costs should be retired when the worker leaves the job, and depreciated over the average period workers retain given jobs (analogous to our treatment of mobility costs described below).

HEALTH AND SAFETY. Like education outlays, investments in health produce both monetary and psychic returns over future periods. The returns are associated with reductions in three factors: mortality, disability, and debility. The additions to labor compensation and national income from decreasing mortality as it prolongs working life have been shown to be very great.[17] Likewise, reductions in time lost at work (and at school) due to illness yield a quantifiable increase in income, although available man-day data are fragmentary. Decreased debility as a result of better health, or, conversely, increased levels of vitality undoubtedly increase productivity as well as psychological well-being, although this effect of better health would be most difficult to measure at all adequately. In general, the economic effect of health investment is chiefly on quantity of labor input rather than on quality.

While much of the expenditure on health and safety is genuine investment, it is also true that some medical outlays are useless, if not positively harmful, and that some are largely for current maintenance without longer-term benefit. Although we consulted a number of experts in the field, there was no consensus on the portion that represents investment. In the absence of firm evidence, we have taken half of all outlays for health and safety as representing investment. This ratio

17. See Selma Mushkin, "Health as an Investment," *Journal of Political Economy*, Supplement, October 1962.

makes it easy for those who favor a different proportion to adjust our estimates accordingly.

In counting half of health outlays as investment, we posit that both the prevention and cure of disease and other ailments produce benefits with respect to both productivity and well-being that extend beyond the year in which the outlays were made. One's general health in the future is usually better following expenditures for the avoidance or treatment of disorders than in the absence of such measures. Basic maintenance of human beings is performed by nature; to the extent that man is able to improve health and extend life compared with what the situation would be without medical programs, the costs of such programs are an investment with benefits that extend beyond the current accounting period.

We refer to both health and medical outlays, since environmental (usually public) health programs are an important part of health improvement, along with direct medical treatment. Other environmental factors affect health, particularly the adequacy of food, shelter, and working conditions. In a country as wealthy as the United States has been for some decades, improvement in those factors have probably not been of major health significance, certainly far less so than would be the case in poor countries. We do not count as investment any portion of those expenditures which have only an indirect and uncertain effect on health.

Our approach to the gross capital stocks resulting from investments in health and safety is the same as that regarding rearing costs, education, and general training. That is, we estimate the cumulative real investments per capita for each cohort, and sum for the population. Consistently with the other types of capital, depreciation is estimated by the double-declining balance method. Levels of net stocks would not be comparable if different depreciation curves were used. The stocks can be revalued to current replacement costs and reduced to the portion embodied in the active labor force. In the case of health, it should be noted that the stock relates to the condition of health over and above what it would be without the outlays, valued in terms of the cumulative costs at constant or current prices.

MOBILITY. Less systematic work has been done in this area of intangible investment than in the others. Therefore, the concepts advanced here are more tentative, and the estimates more exploratory in nature. In a dynamic economy individual incomes, and social income and efficiency, are increased as resources are shifted from industrial and geographical areas of declining relative demand to areas where the demand for inputs is increasing. The costs of transferring resources are a form of investment, for investment in mobility results in an increase in

the future income stream beyond what incomes would be if the shifts were not made.[18]

The costs of transferring nonhuman capital—in the form of obsolescence as well as of direct physical transfer costs (transportation and installation)—are already included in tangible capital outlays, but additional calculations have to be made for human mobility costs. These may be viewed as consisting of three components. First, there are the costs of periodic unemployment associated with dynamic changes resulting from shifts in tastes, technology, and resources. Next there are the direct costs of job search and hiring. Finally, there are the costs of migration and immigration, either as part of job search or as a step in taking jobs that are already found.

1. *Unemployment costs.* Apart from cycle-related unemployment, some unemployment is voluntary, chosen in the expectation of finding a better job (in which the monetary or psychic income is higher than in the previous one); but much of it is forced on the worker. The period of unemployment is one of search for new jobs, by definition. Some search for better jobs goes on while workers are employed, but we assume there is no significant opportunity cost of this time. However, we do count the opportunity cost of frictional unemployment as a social cost of the mobility required by a dynamic economy.

Frictional unemployment (including "structural" unemployment but excluding that due to insufficient demand) can be approximated by examining the unemployment rate in years of high-level demand. On this basis we have used 3 per cent (or the actual rate if less, as in the war years) to approximate the rate required for adequate mobility of labor in a dynamic, high-growth economy.

To the extent that imputed unemployment costs are not covered by either government unemployment compensation benefits or severance pay by former employers, they are counted as an imputed cost of the household sector. In addition to unemployment insurance benefits paid by government, the appropriate fraction of operating expenses of the unemployment insurance system are charged to mobility costs. Likewise, separation costs of employers, over and above special severance payments, are included as part of unemployment costs charged to the business sector.

2. *Job-search and hiring costs.* Private household costs of job search comprise payments of fees to private employment agencies and direct "job wanted" advertising and related costs.

18. For a theory of migration viewed as human investment, see R. F. Wertheimer, *The Monetary Rewards of Migration within the U.S.*, Washington, The Urban Institute, 1970. See also George Stigler, "Information in the Labor Market," *Journal of Political Economy*, Supplement, October 1962.

The hiring costs of employers, public and private, have been described as follows by the source of our data on average costs per new hire: " . . . A total of all direct and indirect costs specifically chargeable as expenses brought about by the procurement, selection, and placement of the employees. Typical expenses would include advertising, recruiting, testing materials, stationery supplies, wages and salaries of all employees exclusively engaged in employment activity and the appropriate percentage of wages and salaries of employees who spent a portion of their time on employment activities, pre-employment physical examinations, and appropriate allocation for departmental overhead."[19] An additional cost borne by governments is that of the appropriate portion of the expenses of the U.S. Employment Service and of other public programs that seek to facilitate worker mobility. One must be careful not to include any training costs in the hiring costs.

3. *Moving expenses.* In recent years estimates of the number of migrants, interstate and intrastate (between counties of the same state), and of the number of immigrants have become available. With respect to migrants, one must first determine how many are members of the labor force, employed or unemployed. We would assume that the unemployed bear their own moving costs. A portion of the moving costs of employed persons and their families is borne by the individuals; the rest, by their employers, private or public. The costs cover (a) transportation of persons and (b) moving of furniture and other household effects. Unfortunately, available data permit only crude estimates of these components of moving expenses.

In the case of immigration, the chief relevant cost is that of the Immigration and Naturalization Service. The travel costs of the immigrants are largely borne by themselves, prior to their inclusion in U.S. income as "residents." Once the immigrant becomes a resident his mobility costs are included in those described below.

With regard to the stocks of capital resulting from mobility costs (investments), it is necessary first to derive estimates of the average time elapsing between periods of unemployment, job search, and migration. To derive real gross stock estimates, the real mobility investments of each year are held in stock for the relevant periods of time, then retired. Likewise, depreciation is computed over the relevant time periods. The real stocks can be revalued to current prices by the deflators used to convert current dollar costs into real terms. It is not necessary to estimate the portion of stocks embodied in the active labor force, since the estimates are confined to labor force members in the first place.

19. *The National Underwriter,* August 7, 1959, p. 6.

Notes on the Capital Stock Estimates

Since market values are not available (nor could they be for human capital), stocks of capital are here estimated, as will have been noted, in terms of their real costs, revalued to current prices. This approach is followed in preference to estimating the present value of future income streams through discounting, which involves circularity when the capital estimates are used as a base for estimating rates of return, or productivity, as we do in Chapter 5. Further, it is much more practical to estimate capital stocks based on investment estimates; this approach can be used consistently for the nonbusiness sectors as well as for the business sector, and for human as well as nonhuman capital.

Also, the real investment and stock estimates do not include adjustments for changes in "quality" or output-producing capacity of new capital goods models from that of old models, except to the extent that real costs per unit differ. This approach is preferable for the purpose of estimating changes in factor productivity, as has been argued by Denison.[20] Nor do the constant dollar estimates represent the real factor costs of the capital, reflecting changes in productivity of the capital goods industries. Rather, they represent what it would have cost to produce the capital at base period prices and technology, exclusive of accumulated depreciation reserves in the case of net capital stocks.

We are aware of the objections that have been raised to aggregation in general and to aggregation of stocks of capital assets in particular.[21] Even if it were possible to obtain current market values of all capital goods, these would reflect future income-producing capacity imperfectly due to imperfect foresight, market imperfections, taxes, and so forth. For much the same reason, market values also fail to reflect the relative factor costs of production perfectly in the case of reproducibles (allowing for depreciation in the case of depreciable assets). In constant prices, the real stock estimates through time are subject to the index number problem to the extent that relative changes in prices and quantities are significantly correlated.

But the same objections apply to the national income and product

20. Edward F. Denison, "Theoretical Aspects of Quality Change, Capital Consumption, and Net Capital Formation," in *Problems of Capital Formation*, Studies in Income and Wealth 19, NBER, 1957.

21. See, for example, J. R. Hicks, *Capital and Time*, Oxford University Press, 1973; and, for an earlier summary of the discussion, M. Ishaq Nadiri, "Some Approaches to the Theory and Measurement of Total Factor Productivity: A Survey," *Journal of Economic Literature*, December 1970.

accounts, which are tremendously useful nevertheless for macroeconomic analysis. We believe the same to be true of wealth estimates: although they are imperfect, they are useful as scalars of broad historical trends in aggregates, structure, and relationships with associated flows and other variables. The very reasonableness of the analytical results attests to the value of the estimates. And as far as the index number problem is concerned, to the extent that the movements of real stocks and real product are affected in the same direction (which is likely), the capital-output ratios would be less affected by alternative weight bases than either variable separately.

Our net capital estimates in current prices ("depreciated reproduction costs," for fixed assets) approximate market values, assuming reasonably good foresight by the businessmen who made the investment decisions. The annual depreciation estimates are designed to approximate the decline in value of the capital goods as they age due to deterioration, obsolescence, and the shortening of the remaining useful economic lives. The part of gross investment needed to offset depreciation is required to maintain the net income-producing value of the capital intact. The net capital stocks, representing net income-producing capacity, are appropriate for use in net-of-return computations. They may also be used in constant dollar form for comparison with the associated real net product estimates in productivity calculations.

The net stock and net product estimates are, of course, sensitive to the depreciation formula chosen. Evidence assembled by Terborgh and others[22] on market prices of second-hand durable goods strongly indicates that values decline at a faster rate in the early years of life. Accordingly, we have used double-declining balance rather than straight-line depreciation. Although the evidence on depreciation relates chiefly to nonhuman tangible reproducibles, we have also used the same formula for depreciating human capital. Some evidence on this is cited in Appendix B-2a. Also, for purposes of aggregation it seemed important to us to use the same depreciation formula for all types of depreciable assets since the levels are substantially affected; straight-line depreciation results in higher levels of net asset value than declining-balance formulas. Growth rates of real net capital stocks, however, do not appear to be particularly sensitive to the depreciation formula used, so long as the same formula is applied to the components of aggregates.[23] Growth rates of both net and gross stocks are more

22. George Terborgh, *Realistic Depreciation Policy*, Chicago, Machinery and Allied Products Institute, 1954.

23. See John W. Kendrick, *Postwar Productivity Trends in the United States, 1948–1969*, New York, NBER, 1973, Appendix, Part I, pp. 159–162.

sensitive to length-of-life assumptions for the nonhuman depreciable assets.[24] Fortunately, in the case of human capital, demographic statistics provide quite accurate mortality information.

It has been argued that the depreciated replacement cost of fixed capital understates its true value as a discounted future income stream due to "externalities . . . uncertainty, information costs, risk aversion, and imperfect capital markets. . . . This would suggest, even apart from unmeasured capital inputs and (unexplained) 'residual factors,' we would find the value of capital growing through systematic capital gains which make capital at any point of time tend to exceed in value its original cost, adjusted both for depreciation and changes in price levels."[25]

In some firms and industries, however, the present value of capital is less than depreciated replacement cost, and there are capital losses. But even if Eisner is right in his view that, on net balance, present values exceed depreciated replacement cost, it does not necessarily follow that the differential increases over time. And even if it did his point relates to current dollar values, not to the real stocks in terms of which most of our capital-output comparisons are made. Nevertheless, his argument with regard to current values deserves further empirical investigation.[26]

For productivity analysis, it is generally preferable to relate real product to the comparable real capital stock estimates on a gross basis rather than a net basis. The real gross stocks represent output-producing capacity; gross depreciable stocks are maintained intact by the portion of gross investment that offsets retirements, and they grow to the extent that gross investment exceeds retirements. Their output-producing capacity will grow even more, of course, as their quality, or productive efficiency, improves through innovation, which is what the productivity calculations are intended to measure. Maintaining the output-producing capacity of structures and equipment as they age, of course, requires adequate maintenance and repair expenditures.

Some analysts believe that even with adequate maintenance the gross output-producing capacity of depreciable assets declines somewhat with age, and therefore they adjust their real gross stock estimates

24. See Robert C. Wasson, "Some Problems in the Estimation of Service Lives of Fixed Capital Assets," in *Measuring the Nation's Wealth*, Studies in Income and Wealth 29, New York, NBER, 1964, Appendix I, pp. 367–369.

25. Comments by Robert Eisner, member of the NBER staff reading committee, on the initial draft of this study, dated March 4, 1974.

26. An interesting approach comparing stock market valuations with original costs was taken by Vernon L. Smith, "The Measurement of Capital," in *Measuring the Nation's Wealth*, 1964.

accordingly for productivity comparisons.[27] We have not done so, preferring, instead, to consider changes in the average age of real depreciable assets as a possible factor in the explanation of productivity change.

Gross stock estimates in current prices may also be used as a base for estimating gross rates of return (net income plus depreciation allowances). The more interesting calculation, however, would seem to be the net rate of return, obtained by relating net income from depreciable assets, after allowance for depreciation, to the value of those assets as approximated by the depreciated reproduction cost.

27. See the BEA estimates of total factor productivity in the nonfinancial corporate sector of the U.S. economy, which average the real gross and net stock estimates as a basis for estimating capital input. (John A. Gorman, "Nonfinancial Corporations: New Measure of Output and Input," *Survey of Current Business*, 52, March 1972.)