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HUMAN CAPITAL AND ECONOMIC GROWTH

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ABSTRACT

Individuals differ in both inherited and acquired abilities, but only the latter differ among countries and time periods. Human capital analysis deals with acquired capabilities which are developed through formal and informal education at school and at home, and through training, experience, and mobility in the labor market.

Just as accumulation of personal human capital produces individual economic (income) growth, so do the corresponding social or national aggregates. At the national level, human capital can be viewed as a factor of production coordinate with physical capital. This implies that its contribution to growth is greater the larger the volume of physical capital and vice versa. The framework of an aggregate production function shows also that the growth of human capital is both a condition and a consequence of economic growth.

Human capital activities involve not merely the transmission and embodiment in people of available knowledge, but also the production of new knowledge which is the source of innovation and of technical change which propels all factors of production. This latter function of human capital generates worldwide economic growth regardless of its initial geographic locus.

Contrary to Malthus, economic growth has not been eliminated by population growth. Indeed, spatial and temporal patterns of the "demographic transition" appear to be congruent with economic growth. Human capital is a link which enters both the causes and effects of these economic-demographic changes.

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HUMAN CAPITAL AND ECONOMIC GROWTH*

I. Introduction

As an economic concept human capital is at least two centuries old, but its incorporation into the mainstream of economic analysis and research is a new and lively development of the past two decades. The need for this development became apparent in the 1950's, when the application of empirical economic research to the concerns about economic growth and about income distribution revealed major defects not only in our understanding of each but also in our way of thinking about these matters. Two types of findings were especially significant: (1) The observed growth of conventionally measured inputs of labor and capital was by far smaller than the growth of output in the U.S. and in other countries for which long time series were available, and (2) Data on personal income distribution, which began to appear with greater frequency and detail, showed that the variance of labor incomes, rather than the "functional" differences between returns to labor and to capital, represented the major component of personal income inequality.

The development of human capital theory was a response to these twin challenges. This response did not require a revolution in economic theory or a resort to extra-economic explanations which economists sometimes invoke when answers to pressing questions escape their competence. It merely involved the abolition of two simplifying, but as it turned out unduly inhibiting assumptions: (1) the restriction of the concept of capital to physical

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capital, even after a more general definition was provided by Irving Fisher,[1] and (2) the assumption of homogeneous labor which underlies both the concept of functional income distribution and the measurement of labor input in manhours.

Fisher's definition of capital as any asset that gives rise to an income stream requires the inclusion of human capital, even if it cannot be bought and sold (it is, of course, rented), and even though investments in such capital often involve non-market activities. But non-market activities are not necessarily extra-economic. To the extent that they involve costs and returns, whether explicit or implicit, they are amenable to economic analysis, even if measurement problems are difficult. The contribution of human capital theory to economics does not lie in a reformulation of economic theory, but in pushing back the boundaries of economics beyond the sphere of market transactions. The payoff is now apparent in both of the problematic contexts: (1) At the macroeconomic level, the social stock of human capital and its growth are central to the process of economic growth. (2) At the microeconomic level, differences in individual human capital stocks and in their growth can explain much of the observed variation in the wage structure and in the personal distribution of income.

The application of the human capital concept to economic growth and to labor economics were initially pioneered independently.[2] The concepts are the same, and are applied basically to the same problem: individual economic growth at the micro-level, and growth of the economy at the macro-level.

II. Human Capital and Personal Economic Growth

Individuals differ in both inherited and acquired abilities, but only the latter clearly differ among countries and time periods. Human capital analysis deals with acquired capacities which are developed through formal and informal education at school and at home, and through training, experience, and mobility in the labor market. The central idea of human capital theory is that whether deliberate or not, these activities involve costs and benefits and can, therefore, be analyzed as economic decisions, private or public. The costs involve direct expenses and earnings or consumption foregone by students, by trainees, and by workers engaged in labor mobility. Since production and consumption benefits from these activities accrue mainly in the future, and are for the most part quite durable, the costly acquisition of human capacities is an act of investment. Deterioration of health and erosion or obsolescence of skills represent the depreciation of human capital which is offset, though not indefinitely, by maintenance activities such as the production of health and retraining.

The general categories of human capital investments can be described in a life-cycle chronology: resources in child care and child development represent pre-school investments. These overlap and are followed by investments in formal school education. Investments in labor market mobility, job choice, job training, and work effort occur during the working life, while investments in health and other maintenance activities continue throughout life.

1. School Education

Initially, investment in school education has been the subject of almost exclusive attention by human capital analysts. While economists

since Adam Smith recognized the importance of education as a type of private or social investment, only recently have economists undertaken rigorous conceptual and statistical examination of the evidence on costs, returns, and rates of return to education.

The costs of education borne by the student or his parents consist not merely of tuition and other school expenditures, but also of foregone earnings--the loss of what the student could have earned if he had spent the school years in gainful employment instead. Beyond early schooling, foregone earnings are the largest component (over a half) of schooling costs.

As in the analysis of physical capital, the difference between the discounted future returns and costs represents the profit or loss on the investment. Gains do or ought to induce further schooling and losses discourage it. Another way to represent this decision making process is to calculate that rate of interest which makes the profit equal to zero, that is, it makes the investment just about worthwhile. This rate is called the internal rate of return on the investment; further schooling is encouraged if the internal rate of return on schooling exceeds the rate on alternative investments. The advantage of this approach is that while individual discount rates are not observable, internal rates of return can be calculated given estimates of costs and of earnings streams. Comparisons of rates of return to education with rates of return on other (say in business capital) investments, can indicate the desirability of existing allocations or of changes in them, since equality of rates in all types of investments are required for a social optimum.

It is understood, of course, that relevant concepts of costs and benefits are real, that is not restricted to pecuniary terms. Education itself

may be attractive and it may enhance future enjoyment of life, apart from the monetary gain.

Employers pay higher wages to the more educated workers because their skill and productivity are seen and experienced as greater than that of less educated workers. In the absence of strong barriers to supply, the wage differential translates into a rate of return comparable to those on alternative human or other investments. Increases in demand favoring more educated workers raise the rate of return on schooling, inducing growth of enrollments until the increased return has been reduced back to an equilibrium level. Autonomous increases in supply, given no changes in demand, reduce the rate of return to education and thus become self-limiting. The estimated rates of return to schooling in the U.S. have remained relatively stable in the past several decades despite the continuous growth of educational attainment, suggesting that the trend is mainly a response to the continuous growth of demand for educated labor.

If financial and social barriers to education are stronger than in other fields of investment, the rate of return on education exceeds that on physical capital. Reduction of these barriers brought about by widespread growth of family incomes and by public policy has also been a factor in the long-term growth of education. As an example, the growth of education in the U.S. between 1890 and 1950 was accompanied by a decline in the rate of return to education, to levels which no longer exceed the return to business investment.[3]

A recent survey of estimates made in 32 countries[4] shows that rates on physical and especially on human capital investments are higher in developing countries (LDC's) than in the industrialized (DC's). This is

perhaps not surprising as it reflects the greater scarcity of capital in LDC's. More interesting is the finding that rates of return to human capital exceed the rates on business capital in LDC's, while if anything the opposite appears to be true in the DC's. Evidently, the scarcity of human capital is significantly greater than the scarcity of physical capital in the LDC's.[5]

The calculations that are available do not include non-pecuniary or "consumption components" of costs or of returns. To the extent that these are positive and important in the benefits of schooling (an assumption dear to the hearts of educators), the rates are underestimated, though the pattern of their historical changes need not be affected.

An important distinction is made between private and social rates. Thus, in calculating private rates, costs and returns to students and their families are computed from after-tax data, and schooling costs do not include public financing of schools. In contrast, the calculation of social cost is based on before-tax earnings, and school costs are total costs of the relevant school system (per student) regardless of the source of financing. The real difficulty in calculating social rates of return is the problem of measuring externalities. To the extent that the gain to society exceeds the sum of gains to students, social returns are underestimated. An assumption of public policy which is difficult to verify and to quantify is that such externalities are substantial and positive.

It is often suggested that these externalities include, among others, informed and responsible citizenship, communications skills, lawful behavior, and standards of health. The existence of such externalities is invoked to justify public efforts to stimulate educational investments. Such efforts

can take the form of a publicly owned school system and/or direct subsidies to students. The extent of required support is always debatable, as the magnitude of externalities is unknown.

There are also other reasons for public intervention. This is the concern with the distribution rather than with the total volume of educational investments. Helping children of the poor to acquire a minimal degree of earning power is an objective for which schooling is also viewed as an instrument. Since poverty is often viewed as a relative concept, the amount of minimal universal government supported education has been progressively lengthening as average education (and income) have increased. It is not always clear, however, to what extent these policies are efficient in alleviating poverty. There is some evidence[6] that public spending on primary education tends to be redistributive toward the poor, but that above that in LDC's, and above secondary education in DC's, the opposite is likely to be true, on balance, since children of the poor are less likely to acquire higher education.

2. Post-school Human Capital Investments[7]

There is no reason to believe that human capital investments cease with the termination of schooling. The educated have higher earnings, but the earnings are not fixed. They grow over the working life, albeit at a decelerating pace. This growth is additional to, and largely independent of economy-wide trends in earnings. These patterns of growth also differ among persons whose education is similar.

The economic interpretation of lifetime earnings growth is as follows: Wages of a worker are proportionate to the size of his human capital

stock. Thus, wage differentials among workers are due primarily to differences in human capital stocks, not in the "rental price" employers pay per unit of the stock. The individual's human capital stock grows over the life cycle by means of investment, which is initially in schooling, later in job choice, job training, job mobility, and in health. At any stage, the level of earnings depends on the size and utilization of the human capital which accumulated up to this point, and its growth depends on the rate of net additions to the stock, that is, on the net investment rate. The deceleration in the rate of growth which is observed in individual earnings reflects the rate of decline of investments as the worker ages. Investments diminish over time because (1) benefits decline as the payoff period (remaining work life) shortens, and (2) the opportunity costs of time, which is an input in the learning process, are likely to rise over the working life. While gross investment proceeds at a slackening rate throughout working life, net investments (gross minus depreciation) vanish or turn negative earlier. This happens when depreciation (including obsolescence) begins to outstrip maintenance, a progression which eventually brings about retirement.

An alternative interpretation of the earnings profile is that it is an intrinsic age phenomenon; initial productivity growth corresponds to inherent biological and psychological maturation, while later stability and decline are due to first stable then declining physical and intellectual vigor. In the perspective of human capital, this view is incomplete since it explains the earnings profile solely by a life-cycle pattern of the depreciation rate, seen as negative in early years, zero in middle life, and positive in later years. There is evidence, however, which

indicates that this inherent age-depreciation factor affects earnings only to a minor degree, except at teenage and in the near or post-retirement years; in data where age and length of work experience are statistically separable, levels and shapes of earnings curves are mainly a function of experience rather than of age. Moreover, earnings profiles differ by occupation, sex, and other characteristics in systematic ways that cannot be attributed to aging.

One may also interpret the shape of the earnings profile as a "learning curve," or a reflection of growth of skills with age and experience known as "learning by doing." This view is not at all inconsistent with the human capital investment interpretation, as long as opportunities for learning are not costless. Since more learning, hence a more steeply rising wage is available in some jobs compared to others, qualified workers would gravitate to such jobs if learning were thought to be costless. In consequence, entry wage levels in such jobs would be reduced relative to entry wages elsewhere, for workers of the same quality, thereby creating opportunity investment costs in moving to such jobs. Thus, it is not merely training on the job (formal or informal), but also the processes of occupational choice that give rise to investments beyond schooling. Similarly, geographic mobility and other labor turnover in search of higher real earnings represent investments in human capital.

It follows that barriers to occupational choice and to job mobility reduce the opportunities for investment in human capital. The elimination of such barriers increases individual economic growth and the overall efficiency of allocation of resources in the economy, hence total product.

Empirical economic research indicates that the relation between schooling and post-school investment is positive: More educated people invest more in the labor market. One interpretation is that ability and opportunity factors which induce individuals to have more schooling affect their post-school behavior similarly, even though the correlation is far from strict: Abilities and opportunities change over the life-cycle, and there is a fair amount of substitution between the two forms of skill accumulation. Another interpretation is that schooling improves the efficiency with which people can absorb learning on the job, leading thereby to greater job investments. This hypothesis is consistent, in a dynamic context, with evidence on the so-called "worker allocative effect" propounded by Schultz (1975) and Welch (1970).[8] Their proposition that education promotes the adjustment to technological change has been documented, mainly in studies of agricultural production activities. The more limited macro-economic evidence of a positive relation between rates of return to schooling and rates of economic growth is also suggestive.[9]

3. Preschool Investments and Women's Education

Inherited abilities, or what is called the "original" endowment is an important part of the human capital stock, yet the line between heredity and environment is by no means clear. Much of the physical and intellectual deficiency shown by infants born in poor conditions can be avoided by improved nutrition of mothers and sanitary environments for childbirth. Similarly, subsequent child care represents an investment in better adult health and so in greater productivity of the adult worker.

Especially in low income countries, the effects of a healthier child rearing on adult productivity are double: Not only is a healthier adult

more productive but he also lives longer![10] Consequently, the incentives to invest in lengthier schooling and training increase, since with the lengthened payoff period, the profitability of such investments increases. Thus, it is inappropriate to view reductions in mortality with alarm as a cause of the "population explosion." The mitigating effects on population growth and improvements in work quality eventually predominate, since the costs of investing in child quality, including health and education, represent a powerful force toward reduction of family size, given the families' limited resources. Indeed, research has shown that even at the same level of family income, children in smaller families tend to be healthier, more intelligent and better educated.

Much of the accumulation of a person's human capital takes place in the home, particularly during the pre-school stage of the life-cycle. It appears that education of parents is a significant influence in this process, even after controlling for family income and numbers of siblings. This suggests that aside from expenditures on schooling and health, child care is also an important qualitative input into the production of human capital. The time inputs are usually those of the mothers who take the major child care responsibilities and reduce their market activities to engage in them. The consequent reduction in their earnings may be viewed as a partial measure of opportunity costs of these investments. So viewed, the opportunity cost of child care is greater for more educated women. The observed positive effects on children's health, intelligence, education and future earning power may thus be viewed as an indirect return on the investment in maternal education.

An important consequence of the larger opportunity cost per unit of

time spent in child care by more educated mothers is the reduction of total time so spent. This is accomplished largely by a reduction in the number of children. The strong inverse relation between fertility and education of mothers has been documented repeatedly. Thus the growth of women's education and of their wages induces declines in fertility coupled with increased investments in the resultant smaller number of children per family.

Since, in most countries, even educated women spend less time in the labor market than men, the direct earnings benefits of education are smaller for women. From this point of view, it might seem that the provision of equal amounts of education to both sexes is wasteful. However, if better educated mothers produce greater human capital in children and a better quality of family life, apart from contributing to family money income, educational equality need not be questioned. Indeed, it is rarely questioned as a matter of public policy.

It appears, however, that private schooling decisions are still very much influenced by the expected participation in the labor market, and therefore by the directly expected payoff in earnings. In the U.S. sex differentials in enrollment now appear only at the postgraduate university level. In Latin America and in other LDCs there remains a pronounced differential above primary school enrollment.[11]

III. Human Capital and National Economic Growth

1. Human Capital as a Factor of Production. The micro-economic analysis of investment in human capital is the underpinning of our understanding of the contribution of human capital to the aggregate level of income and to its rate of growth. The micro-economic view is most directly applicable to the analysis of labor heterogeneity and of the resulting wage structure. Given sufficient labor mobility, wages tend to be similar for the same human capital stock in various employments, regardless of differences in size and quality of other factors of production in such employments. Equilibrium wage differentials within the economy may therefore be viewed as reflecting solely differences in individual magnitudes of human capital stocks. Although international mobility of labor is not negligible and it mitigates somewhat the disparities in wages of the same human capital in different countries, national wage levels differ because of differences in volumes of human capital as well as of other forms of capital. For the understanding of macro-economic differences in levels and in growth of income it is best to start with the view of human capital as a factor of production alongside physical capital in an aggregate production function.

The traditional trinity of factors of production contained land viewed as fixed, "original and indestructible," labor measured in numbers and hours, and capital restricted to tangible plant and equipment. It is now well recognized that this conception is false. The notion of a quantity of land as a fixed factor of production has already been discarded prior to the realization that the measurement of labor in manhours is entirely inadequate. As T. W. Schultz has emphasized,[12] differences in amount and "original quality" of arable land (in terms of land-population ratios) do not at all

nelp in accounting for differences in income levels among countries. Experience and research have shown that it is not the quantity and the original endowment of land, so much as the improvement or modernization of agriculture that matters. Inferior raw lands and even deserts have been transformed into superior productive resources, while total acreage declined. Investment in modernization of agriculture is a capital investment, and the capital nature of land is now fully recognized.

The capital nature of the sources of labor services is now also receiving its proper recognition. The inadequacy of the traditional view of labor in the field of growth accounting is well known. But the biases went beyond description to affect policy: The misunderstanding of the nature of expenditures on health, education, labor mobility, and information as consumption which reduces saving lead to investments in steel mills rather than in people.

Land, by itself, is no longer a limiting or critical factor. But the quality and behavior of people is increasingly recognized as such. Indeed, it appears that indexes of human capital, such as average levels of education, are more strongly correlated with average income levels across countries than measures of physical capital per unit of labor.[13] Although suggestive, this finding is not conclusive since the demand for education as a consumer good is income elastic. In this sense, education is an effect rather than a cause of income. The role of education as a cause, however, is evident from the micro-economic findings that the relation between education of persons and their own future income is strong and largely unaffected by parental income, even though parents' income does affect the amount of education their children receive.[14]

Some critics question the inference that education increases productivity from the observation that it increases wages, and still others assert that schools do not affect skills but serve merely as a filter to sort differences in ability which exist independently of schooling. If so the micro-economic relation between education and income would not carry over to the economy as a whole. This argument is contradicted by research: Studies of empirical production functions have shown that not only differences in wage rates but differences in productivity are related to differences in education and training of the labor force across states, regions, and over time.[15]

This is not to say that the screening or sorting function of education is unimportant or unproductive. Indeed, the search for talent by the school and by the student are activities no less productive than the search for any other scarce natural resource. Human capital is augmented both by learning and by selection. The interaction of the two is efficient: The more able student learns more at the same cost.

The view of human capital as a factor of production coordinate with physical capital implies that its contribution to growth is greater the larger the volume of physical capital. This relation is symmetric: The contribution of physical capital is larger the higher the average level of human capital. In this light, the success of the Marshall Plan in Europe and the failure of foreign aid to LDC's are perhaps not surprising. To quote Harry Johnson: "Europe had available the industrial and commercial organization, and the skilled people required for modern industry; what it lacked was precisely physical capital which was largely destroyed or obsolete. The problem of LDC's was different: They lacked virtually everything

necessary for a higher standard of economic productivity, and the injection of only one element (physical capital) was found to be both wasteful and disappointing."[16]

For the more recent period the problem of absorption of massive amounts of physical capital in the human capital-poor OPEC countries is another example of the significance of complementarity between the two forms of capital. But, while physical plant and equipment can be acquired or built quite rapidly, the development of a significant and broadly based level of human capital of a nation is a lengthy process which involves profound social and cultural changes.[17]

The framework of an aggregate production function makes it clear that the growth of human capital is both a condition and a consequence of economic growth. The growth of human capital raises the marginal product of physical capital which induces further accumulation of physical capital, thus raising total output both directly and indirectly. Conversely and symmetrically, the growth of physical capital raises the marginal product of human capital. This produces an increased demand for human capital relative to unskilled labor, if human capital is more complementary with physical capital than is unskilled labor.[18] The resulting increase in the skill wage differential exceeds the increase in (opportunity) costs, so the acquisition of human capital by students and workers becomes more profitable. As already indicated, the continuous long-term growth of human capital in the U.S. and elsewhere is consistent with this interpretation of supply responses to growing demand.

The differential shifts in demand for skilled and unskilled labor implied by the complementarity hypothesis also tend to produce the well known

skill differentials in unemployment rates, observable in most countries which experience economic growth. The greater cyclical stability of employment of skilled labor is also consistent with the hypothesis that skilled labor is complementary with fixed plant and equipment. Actually, recent research suggests that both wages and employment of skilled labor are relatively insensitive to the business cycle, because human capital acquired on the job contains elements of firm specificity which make separations unprofitable to both workers and firms.[19]

Growth of human capital is also spurred on the supply side by growth of family incomes. Since markets for financing of human capital investments do not exist, growth of income enables larger numbers of people to self-finance their human capital investments. In poor countries, these financial restrictions create monopolistic advantages for the children of the wealthy, and high rates of return on human capital. Both are reduced by the spread of education made possible by growing incomes. However, human capital growth due to growth of family incomes is eventually self-limiting, when rates of return become sufficiently depressed in consequence of "overeducation." Public subsidies are also self-limiting in the same sense, and they may become unprofitable from a social point of view (when the social rate of return on human capital drops below the corresponding rate on physical capital) before they inhibit private incentives. It follows that for a sustained growth of human capital we must look to increasing market demands for skills and technology.

2. Human Capital and Technology. Although the effects of human capital growth and some of its causes can be described in the framework of an aggregate production function in which technology is fixed, few will argue against the view that growth of technology is the ultimate force which propels all factors of production by increasing their productivity. A fixed technology may be maintained for analytical convenience by viewing all technical change as embodied in human and in physical capital.[20] Whether or not such a device is purely semantic, I think it is helpful to distinguish between the stock of human capital as a standard factor of production and the stock of knowledge as the source of technology. Human capital activities involve not merely the transmission and embodiment of available knowledge in people, but also the production of new knowledge which is the source of innovation and of technical change. Without new knowledge, it is doubtful that larger quantities of existing physical capital, more widespread education and health would create a continous growth in productivity on a global scale. In a fundamental sense, modern economic growth is a result of the scientific revolution, that is, of the growth of systematized scientific knowledge.

The geographic origin and spread of the industrial revolution since the 18th Century supports this view and the pivotal role of human capital in generating and facilitating it. The industrial revolution started with the scientific revolution in the Northwest of Europe and spread most rapidly to those areas where educational development has made the transfer of technology most feasible.

It is clear now that the process of growth and diffusion is worldwide. Human capital as embodiment of skills is a convenient conceptualization of its role as coordinate factor of production in its contribution to national economic growth. Human capital as a source of new knowledge shifts production

functions upward and generates worlwide economic growth.

Even though "knowledge knows no boundaries," its utilization requires local adaptation which is more costly the more dissimilar ("distant") the economies and societies to which it is transmitted. Moreover, as technical progress continues, the slower the diffusion the wider the technological gap between the initiators and the "latecomers." Consequently, the capacity to absorb and to adapt new technology requires an increasingly specialized and sophisticated labor force backed by a broadly educated population. For reasons that certainly make sense in the technology exporting countries, the imported modern technology is capital and skill intensive. Thus, problems of "labor absorption" are added to the difficulties of absorbing modern technology.[21]

Yet, the disadvantages of factor bias are transcended by the advantages of being able to skip several generations of technology in a short time. At any rate, it is only the most modern technology that is truly available. Older vintages which may be more labor intensive are not usable without complementary or ancillary industries which are obsolete. Even if the initial effects on the creation of highly productive employment are relatively small, the simultaneous adaptation of human capital by job training and some job redesign can help to widen the process. Initially, the pressure of modernization is most acutely felt at the highest education levels: specialized scientists, technicians and researchers are needed to adopt, master, and modify the new technologies. But only widespread educational growth, especially at basic levels of literacy and numeracy can lead from islands of modernity to a complete transformation of the economy.[22]

III. Human Capital and Population

According to Malthus, economic growth can only be sporadic: It is self-defeating, since it produces population growth which in turn swallows all the gains. This theory has long been contradicted by empirical evidence. The notion that this hypothesis may be applicable to LDC's which was entertained by some is also being discredited by events. Economic growth has not been eliminated by rapid population growth in these countries.

Moreover, the patterns of population change associated with the "demographic transition" in the West are now being visibly repeated in the rest of the world.[23] Indeed, the congruence of spatial and temporal patterns of economic growth and demographic change suggest an important interaction between the two. Human capital is a link which enters both the causes and effects of economic-demographic changes.

Human capital, or population quality, was left out of Malthusian theory. The theory actually omits any economic motivation. It presents a strictly biological view of mortality as a mechanism which adjusts numbers of people to available resources. The contrary facts of economic growth and of the demographic transition have led to a reformulation of population theory in terms of parental decisions about numbers and "quality of children."[24] In primitive, premodern regimes of very high mortality, especially in an agricultural setting, unlimited fertility may be viewed as a rational response, which is also (or therefore?) culturally sanctioned. Declines in mortality, brought about by public health measures or by higher levels of living bring about the need for family size decisions, given the family's limited resources. Implicitly such decisions must consider both material and "psychic" costs and returns from children. Intention-

about human capital formation in children, or child "quality" play a part in the decision. Given the family budget, resources spent on "quality" compete with the number of children the family might otherwise want. This trade-off becomes pronounced in the context of economic growth which raises the payoff to human capital formation.

In the West, mortality reductions initially resulted in increased fertility but after a long lag, they were followed by fertility declines. Surviving average family size grew initially, but eventually declined to the present-day low levels. Roughly speaking, family size begins to decline when fertility rates drop more sharply than mortality rates. Although even exogenous declines in mortality tend to induce declines in fertility, it appears that for birth rates to fall more than death rates, the additional stimuli of economic growth and of widespread education are necessary.

This generalization is supported both by the history of DC's and by current experience in LDC's. An intercountry analysis of changes during the past decade (1965-1975) in Latin America[25] showed that declines in birth rates were positively related to declines in death rates, but the declines in births were steeper than the declines in deaths only in countries whose rates were above average during the decade and educational enrollments of the population aged 5-14 were significantly above average at the outset. The regression analysis shows that at a rate of 2% growth of per capita income the enrollment rate must be at least 80%, to generate a reduction in family size. With a growth rate of 3%, the minimum enrollment rate is 60%.

But what is there in the process of economic and educational growth that makes incipient incentives toward reductions in family size widespread, effective, and progressive? In a way, the emergence of strong growth implies that some of the cultural inhibitions to rationalism have already weakened. More directly, economic theory contains three implications of economic growth which point to deliberate reductions in family size: (1) urbanization, (2) the rising cost of time, and (3) educational growth:

(1) Since demands for agricultural products are relatively income and price inelastic, the growth of productivity reduces the demand for farm labor, which in turn flocks to cities in search of employment and higher wages. With children less productive and more costly to raise in the city than on the farm, incentives of migrants to limit family size are strong.

(2) The growth of wages in the labor market attracts people from non-market activities (households and subsistence sectors) to the labor market. To the extent that child-rearing is a time-intensive activity, increases in market wages represent a rising foregone cost of time spent in child care rather than in gainful work. Therefore, incentives of women to limit family size and to enter (or stay in) the labor market appear and grow. This is especially true of educated women, since opportunity costs increase with education. A strong negative correlation between education of mothers and family size has been widely documented.[26]

(3) With growing incomes and industrial demands for literate, disciplined, and skilled labor, both private and public demands for education increase. At the family level, the demands for prolonged education of children represent an additional incentive to substitute "quality" for the quantity of children, as the reduction in numbers of children increases

the available family resources per child. The inducement to invest in quality and in greater future earning capacity of the children is strengthened by increased life expectancy as it constitutes a lengthened "pay-off period" on the investments. In turn, when the educated children become parents, they tend to have more favorable attitudes and more information about birth control behavior and greater demands for education and health of their children.

In sum, we should expect growing urbanization, education, female labor force participation, and declining family size to follow economic growth. Such trends are, indeed, widely observed under conditions of sustained economic growth, although intensities and time lags in these processes can and do differ from one setting to the next. For example, growing market wages may induce women into the labor market without reducing their fertility, if the extended family and cheap domestic service can help in child rearing, and if the nature of work, such as farming or cottage industry are not incompatible with the immediate presence of children. Also, for a time, growth of wages may reduce fertility without increasing the labor force: This happens when women employed in the occupations just described including domestic service move to better paid factory work. All the same, the extended family institution and the occupations compatible with uninterrupted mother's child care eventually decline as incomes and education continue to grow, and all the predicted effects become apparent as they do in the industrially developed countries.

The significance of these demographic events for the quality of labor is twofold:

(1) High birth rates imply an age distribution of the population heavily weighted toward youth. For example, close to one-half of the Mexican

population is less than 15 years of age. This represents a heavy burden on the economy, since the consumption and educational needs of the young population are paramount, and their economic contribution small. Continuation of declines in birth rates will change the age distribution toward a more productive labor supply.

(2) Beyond improving the quality of the labor force via changes in age distribution, reductions in the size of large families apparently also affect educational progress, as was already alluded. Families with fewer children can more readily afford educational expenditures. If the frequency of large families is greater among the poor, the induced demographic changes have important positive effects on the future distribution of income and on social mobility.

In this brief exposition it was not possible to do more than sketch the theory and allude to some of the empirical research which documents the vital and manifold role of human capital formation in personal, national, and global economic development. I think it is fair to conclude that even if substantial levels of human capital may not be a prerequisite for an acceleration of economic growth at a certain time and place, the concurrent growth and diffusion of human capital appear to be necessary to insure sustained economic development.

Footnotes

1. Irving Fisher, The Theory of Interest, Macmillan, New York, 1930.

2. For an exposition of these origins see Paul J. McNulty, The Origins and Development of Labor Economics, pp. 192-200, MIT Press, 1980. The works cited are: Jacob Mincer, "Investment in Human Capital and Personal Income Distribution," Journal of Political Economy, August 1958, Theodore W. Schultz, "Investment in Human Capital," American Economic Review, March 1961, and Gary S. Becker, Human Capital, Columbia University Press, 1964.

3. Findings in Becker, op. cit.

4. George Psacharopoulos, Returns to Education, Elsevier, 1973. Table 5.3, p. 86 shows that in a sample of countries whose per capita income was under $1,000 in the early 1960's, the average rate of return on education was 19.9% and on physical capital 15.1%. In countries with higher income, the educational rate of return was 8.3% while the rate on physical capital was 10.5%. An estimate for Mexico at about that time was 21.9% for education and 14.0% for business capital. These estimates appear in Martin Carnoy "Rates of Return to Schooling in Latin America," The Journal of Human Resources, Summer 1967.

5. Indeed, in a recent meticulous study, "Perspectives on Capital and Technology in Less-Developed Countries" (1978), Arnold Harberger shows that around 1970 rates of return (social or private) on physical capital no longer differed between advanced and less developed countries. One may speculate that the growth of international investments has led to this result. Does this mean that physical capital is no longer scarce

in developing countries? Not at all, its quantity is still limited by the scarcity of human capital: An increase in the latter will raise the rate of return on the former, increasing the demand for it until marginal returns on both forms of capital have equalized.

6. See World Bank, World Economic Report, 1980, pp. 49-50.

7. This section draws on my "Human Capital and Earnings," in Economic Dimensions of Education, a Report of the National Academy of Education, May 1979.

8. Theodore W. Schultz, "The Value of the Ability to Deal With Disequilibria," Journal of Economic Literature, September 1975. Finis Welch, "Education in Production," Journal of Political Economy, February 1970.

9 Carnoy, op. cit., and Psacharopoulos, op. cit.

10 For an empirical study of India, see Rati Ram and Theodore W. Schultz, "Life Span, Health, Savings, and Productivity," Economic Development and Cultural Change, April 1979.

11. See World Bank, op. cit., p. 47.

12. In his Nobel Lecture, "The Economics of Being Poor," published in Journal of Political Economy, August 1980.

13. Anne O. Krueger, "Factor Endowments and Per Capita Income Differences," Economic Journal, September 1968. Also Psacharopoulos, op. cit.

14. For a survey of U.S. findings see Mincer, op. cit. Similar findings are shown by Carnoy, op. cit. for Latin America. However, his data contain father's occupation, rather than parental income.

15. For references, see Mincer, op. cit. Also, World Bank, op. cit., p. 38, and Victor J. Elias, "Sources of Economic Growth in Latin American Countries," Review of Economics and Statistics, August 1978.

16. Harry G. Johnson, On Economics and Society, University of Chicago Press, 1975, p. 283. Japan should be added to the European example in this quotation.

17. See Lawrence Stone, ed., Schooling and Society, Johns Hopkins University Press, 1976; and John C. Caldwell, "Mass Education as a Determinant of Fertility Decline," Population and Development Review, June 1980.

18. Some evidence is provided in Zvi Griliches, "Capital-Skill Complementarity," Review of Economics and Statistics, November 1969. Complementarity of human capital with technology would produce the same results. This is stressed in Schultz (1975), op. cit., and Welch, op. cit. Evidence from time series is provided in Manoucher Parvin, "Technological Adaptation and Income Growth," Ph.D. Thesis, Columbia University, 1963.

19. See Becker, op. cit. Also, Jacob Mincer and Boyan Jovanovic, "Labor Mobility and Wages," in Sherwin Rosen, ed., Studies in Labor Markets, University of Chicago Press, 1981.

20. See Zvi Griliches and Dale W. Jorgenson, "The Explanation of Productivity Change," Review of Economic Studies, July 1967.

21. The problem of "labor absorption" has apparently been overstated in the literature on economic development. According to Harberger (1978), "it is not true that the less-developed countries are

condemned by modern technology to use (in their modern sectors) capital and labor in proportions that are very similar to those employed in the advanced economies." His own estimates show that modern sectors are several-fold more labor intensive (per unit of capital) in LDC's than in advanced economies.

22. See Anderson and Bowman in Stone, op. cit. Also, J.C. Caldwell, op. cit.

23. See Figure 5.3 in World Bank, op. cit., p.64.

24. See the compendium edited by T. W. Schultz, Economics of the Family, University of Chicago Press, 1975. Also, World Bank, op. cit., Caldwell, op. cit., and the NBER Conference edited by Richard Easterlin, Population and Economic Change in Developing Countries, University of Chicago Press, 1976.

25. Jacob Mincer, "População e Força De Trabalho," in Revista Brasileira Da Economia, December 1975.

26. See Schultz, Easterlin, Caldwell, op. cit.