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The contribution of human capital to economic development: Some selected issues

by

Jere R. BEHRMAN

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Preface

The 1990s opened up some new perspectives for the welfare of the developing countries. For many of them external events should prove to be more favourable than in the 1980s, although for a considerable number the external sector is unlikely to be a source of dynamism and the foreign exchange constraint will continue to be severe. Some countries are experiencing a radical transformation in economic and social development towards the liberalization of all markets, greater openness to the external sector, a different emphasis in market regulation, and towards greater political pluralism. An apparent novelty of this situation is that political pluralism and economic liberalism were rarely joined in the past. Whether there has been a major cultural shift based on a belief that markets are indeed less likely to fail in delivering the goods than are governments, or whether the identification of political and economic liberalism will be short lived, remains to be seen.

Currently, however, the widespread parameter changes in economic and social policy making appear drastic and it must be expected that they will call the objectives and instrumentalities of government intervention in the economy into question. The perceived nature of the desirable form of regulation of financial markets, goods and, most importantly for the ILO, labour markets will also change, although the process of change is likely to be spasmodic, uncertain and perhaps contradictory. In any event, democracy can, and often does, select a market-based production system as socially desirable but can nonetheless expect the public sector to play a greater role in the social field. This may be a question of regulating private activities, it may be one of the extent of government, social and infrastructural expenditure, all of which is important both for human capital development and employment generation. If the latter, there is then scope for considerable disagreement about trade-offs between the steps necessary to provide the government with the resources it needs and their effects, through generating distortions in production and savings, on the efficiency and sustainability of the productive system and the generation of employment. Furthermore "government failure" may arise in social sector development where programmes may be insufficiently thought through, implemented or followed-up.

Against this background the ILO has initiated a number of studies to pick up, as it were, the themes of old issues in a new setting of liberalization. The issues in question are those of investment in human capital, of rural-urban linkages, of gender inequalities and of labour markets and labour regimes. The present study by Jere R. Behrman stresses that despite the emphasis given to human resource development in current economic thinking the details of the relationship between higher levels of skills and education on the one side, and economic development on the other are unknown. Conclusions concerning the need for public policy intervention to support human resource development, on efficiency grounds, are often insubstantially based. Behrman concludes that government activity in this field should be focused on areas where the government is likely to have a comparative advantage. These could include analysing information, regulating local monopolies, providing essential

infrastructure, supporting experiments, supporting human resource activities where there is very good evidence of external benefits and helping human capital investment for the poor by means that promote efficiency.

Peter Richards
Employment Strategies Branch
Employment and Development Department

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The contribution of human capital to economic development: Some selected issues

by

Jere R. Behrman*
University of Pennsylvania

Introduction

There is increasing emphasis on the role of human capital in economic development. This increased emphasis originates in part in the "new economic growth" academic literature in which human resources play a critical role in productivity growth; in part in the view of some writers that the essence of development is the enhancement of human resources, such as in Griffin and McKinley (1992), and in part in more applied emphasis on human resources, such as in the UNDP annual *Human Development Reports* and in several of the recent World Bank *World Development Reports*.

But, despite this increased emphasis on human resources and related empirical associations between human resource indicators and attainment of various goals in developing countries, there are many lacunae in our knowledge about the details of the nature of the interrelations between human resources and development. The purpose of this essay is to reflect on some of the issues about the contribution of human capital to economic development; to indicate what we do and do not know about them; and to suggest approaches that may be informative about them. Such an effort, of course, builds upon the present writer's knowledge and perceptions, and thus unavoidably reflects some personal idiosyncracies and knowledge of the relevant literatures.

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*Behrman is the William R. Kenan, Jr. Professor of Economics at the University of Pennsylvania. This essay was written while serving as a consultant to the Employment and Development Department of the International Labour Office. It builds on Behrman (1990a), also written for ILO, Behrman (1990b-c, 1993a-d), Behrman and Rosenzweig (1993, 1994) and a number of other studies to which references are made, as well as on interactions with many colleagues and collaborators, including Nancy Birdsall, Howarth Bouis, Anil Deolalikar, Andrew Foster, Emmanuel Jimenez, Elizabeth King, Victor Lavy, Robert Pollak, Mark Rosenzweig, David Ross, Richard Sabot, Paul Schultz, T.N. Srinivasan, John Strauss, Chalongphob Sussangkarn, Paul Taubman and Duncan Thomas. The responsibility for all interpretations given in this essay rests solely with the author and publication does not imply endorsement of the opinions expressed in this essay by the International Labour Office.

This paper is organized in two parts. Part 1 considers the tripartite foundations for good social science empirical analysis in the particular context of human resources and development: theory, data, and estimation. These three dimensions of empirical social science analysis are critically interrelated. Theory provides the framework for systematically exploring various dimensions of human resources and development; points to what data are needed for such explorations; and identifies some of the probable estimation issues that should be addressed. Data, of course, are essential for empirical analysis, they limit the extent to which analyses can be undertaken and shape most of the estimation problems. Thus, the estimation problems reflect implications of theory and the data that are or are not available, such as variables that may not be observed in the data or are measured only imperfectly in the data.

Part 2 considers a range of questions regarding both the impact of human resources and the determinants of human resources. How does the impact reflect the context in regard to physical investment, market development, macro-strategy, and international economic policy? What is its relation to sustainable growth? Are there important gender, ethnic or other demographic differences in the impact of human resources? Can human resource explanations of the impact be identified from other possibilities, such as screening and signalling? What is evidence regarding externalities or other market failures? What is the nature of interactions among human resources? Are there important productivity-equity trade-offs in human resource investments? How important is family background in the determination of human resources? How important is the state of credit and labour markets? What are the origins of gender, race, and other differences in human resource investments? To what extent are cultural preferences more important than price differences? How effectively are human-resource related services provided? What determines the effectiveness of such service provision? To explore these questions requires building upon the tripartite foundations of theory, data and estimation techniques that are discussed in Part 1.

Part 1. Foundations

Section 1. Frameworks for the analysis of human resources and development

Good theories about human resources and development abstract the essence of complex empirical phenomena in ways that lead to a number of testable empirical propositions about behaviour. They thereby provide analytical frameworks for understanding and for testing hypotheses about these phenomena. The word "frameworks" is used because there is no encompassing single theory that includes all the relevant dimensions of the relations between human resources and development. Instead there are a number of theories that illuminate different dimensions of the relations between human resources and development. We begin with aggregate theories in the "new neoclassical growth model" style that motivate some of the increased interest in the relations between human resources and economic development, and then turn to micro-theories that underlie some dimensions of the behaviour determining investments in human resources, the returns to those investments, and the provision of services related to human resource investments. Finally, we consider the justification for policies related to human resources.

A. Aggregate models of human resources and development

Aggregate growth models shape the intuition that many academic economists have about long-run growth, in part because of the simplicity and elegance of such models. In neoclassical growth models the rate of return on investment and the rate of growth of per capita product are decreasing functions of the level of the per capita capital stock and, over time, wage rates and capital-labour ratios converge across countries. That is, initial conditions or subsequent disturbances have no long-run effects on output and consumption. For instance, an exogenous reduction in the capital stock causes increases in the prices of capital assets, which induces an offsetting increase in investment. In the absence of technological change, per capita product converges to a steady-state value with no per capita growth. These results follow directly from the assumption of diminishing returns to per capita capital in the production of per capita output.

In the past decade the so-called "new neoclassical growth models" of Romer (1986), Lucas (1988), Azariadis and Drazen (1991), Stokey (1991) and others have emphasized the possibilities of diverging growth rates among countries, ongoing per capita growth in equilibrium, and multiple equilibrium growth paths.[1] At the heart of this literature are investments in human resources and assumptions about externalities of human resource stocks, that is, effects that are not transferred through markets, returns to scale to human resources, or learning-by-doing that increases productivity differentially by product (i.e. a

[1] Some commentators question how much is new in this literature. See, for example, Raut and Srinivasan (1992).

lot for "high-tech products" but not much for traditional manufacturing, such as textiles).[2] This literature has provided a set of more systematic frameworks that appear more consistent with some of the important stylized facts about growth than do the neoclassical models. It has provided a better aggregate rationale for interest in human resources among analysts with an applied bent and has renewed interest in the aggregate relations between human resources and development among more academic economists.

B. Micro-frameworks for the analysis of human resources and development

The aggregate theories noted above help to motivate interest in human resources and development and, in particular, in the role of externalities and scale economies and how they may be related to product composition. But they do not provide much explicit guidance for analysis of behaviour at the micro-level at which human resource investments are made, at the levels of households, individuals and firms, and human resource-related service provision. Micro-theories provide frameworks for analysis at these levels. In this section we summarize briefly some of these micro-analytical frameworks: those related to behaviour determining investments in human resources; the returns to those investments; and the provision of services related to human resource investments.

B(i) Becker's Woytinsky Lecture on the determinants of human resource investments

Households and individuals are the proximate sources of demand for human resource investments, given their predetermined assets, production functions for human resources, and current and expected prices for the inputs used in human resource investments and for the outcomes of the production process. These demands reflect the equating of expected marginal benefits and marginal costs (both in present discounted terms) for human resource investments in a given individual as in Becker's (1967) Woytinsky lecture. Because of diminishing returns to human resource investments, since individuals have given endowments (genetic and environmental)[3] and since,human resource investments take time (such as schooling and training), greater investments imply greater lags in obtaining the returns and a shorter post-investment period in which to reap the returns from the investment. On the other hand the cost of human capital investment may increase because of the increasing opportunity costs of more time devoted to such investments (especially for schooling and training) and because of the increasing marginal costs of borrowing on financial markets. These two considerations come into equilibrium when the present discounted value of expected marginal benefits equals the present discounted value of expected marginal costs.

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[2] For more details, see the articles indicated in the text or the surveys in Behrman (1990a), Lucas (1993), Raut and Srinivasan (1992), and Romer (1989, 1993).

[3] The term "endowments" is used to mean characteristics that are given independent of behavioural decisions. Genetically determined innate ability and innate health robustness are examples.

The marginal benefit of human resource investment may be higher for one of two otherwise identical individuals, because one:[4] (1) has greater endowments (e.g more ability and drive) that are rewarded in schooling and in post-schooling labour markets, due to some combination of genetic and home environmental factors;[5] (2) has better health and a longer expected life due to complementary investments, so that the post-investment period in which that individual reaps the returns to the investment is greater and therefore the expected returns greater; (3) has human resources investments options of higher quality (e.g. access to higher quality schools or health services) so that the marginal benefits to a given level of investment are higher, and the equilibrium investments greater;[6] (4) has greater marginal benefits to a given level of such investments because of labour market discrimination that favours that individual due to gender, race, language, family, village, or ethnic group; (5) has returns to human resources investments that are obtained more by the investor or the relevant decision maker (e.g. if traditional gender roles dictate that children of one sex, but not the other, provide old-age support for their parents, parental incentives may be greater to invest in children who are likely to provide such support); (6) has greater marginal benefits to a given level of such investments because of greater externalities from the human resource investments of others in the same labour market; (7) has greater marginal benefits to a given level of investment because of being in a more dynamic economy in which the returns to such investments are greater; or (8) lives in a more stable economy so that the discount rate for future returns is lower and thus the marginal benefit of future returns greater. Some of these possibilities tie directly into the new economic growth models (e.g. the first is consistent with Stokey's 1991 emphasis on the heterogeneity of individuals, the sixth with the externalities emphasized in this literature, and the seventh with a product composition more conducive to learning-by-doing as in Lucas 1988 and Stokey 1991).

The marginal cost of human resource investment might be lower for a number of possible reasons that can be illuminated by comparing two otherwise identical individuals; except that one individual: (1) has lower-cost access to educational and health services related to such investments because of closer proximity to such services or faces lower user charges; (2) has lower opportunity costs for the time used for such investments (e.g. due to gender specialization in household and farm tasks performed by children); (3) is from a household with greater access to credit because of greater wealth or status or better connections; (4) faces lower utility costs of such investments because of cultural norms that favour some activities associated with such investments more for some individuals than for others (e.g.

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[4] For some of these comparisons (e.g., the last three) the otherwise identical individuals would have to live in different economies.

[5] This means that to obtain an estimate of the impact of human resource investments on some outcome, one cannot just consider the association between the human resource investment and the outcome (i.e., the association between years of schooling and wage rates), but one must control for the endowments underlying the different human resource investments.

[6] If the investor (or the investor's family) must pay for greater quality, investment does not necessarily increase with a higher quality option. What happens to the equilibrium investment depends upon where the marginal cost curve for the higher quality option is in addition to the location of the marginal benefit curve.

in some societies, it is not thought desirable that girls past puberty intermingle with males outside of the family in transit to school or in school so that the preference costs of schooling are lower for boys than for girls).

This simple framework systematizes three critical, common sense, points for identifying the impact of human resource investments on outcomes of interest, such as labour productivity.[7] *First*, human resource investments are associated with a number of individual, family, and community characteristics. To identify the impact of human resource investments on a particular outcome, it is important to control for these other characteristics (section 3A). *Second*, empirically observed returns to human resource investments are those for a given macro-economic, market, policy, and regulatory environment (section 4E). *Third*, the marginal benefits of human resource investments in a particular individual may differ depending upon the point of view from which they are evaluated: i.e. (i) there may be externalities such as those emphasized in the "new neoclassical growth models" (section 1A) so that the social returns differ from the private returns (section 4H); (ii) there may be a difference between who makes the investment decision (e.g. parents) and the person in whom the investment is made (e.g. children) which may result in gender differentials in incentives for investments in children given traditional gender roles in old-age care for parents (section 5B); (iii) some forms of human capital investment may have general returns and others may have returns only in specific enterprises.

B(ii) Evaluating the impact of human resource investment

Human resources are posited to have positive impact on such outcomes as labour market and household productivity. One natural way of evaluating the impact of human resources would seem to be to estimate directly the underlying production functions. A second approach is to estimate conditional demand functions. Conditional demand functions depend on prices and assets that are determined from the point of view of the household and on schooling. To obtain good estimates of the effects of schooling in such relations, however, there must be control for the behaviour that determines schooling itself. A well specified production function gives the impact at the margin of increasing human resources, given all of the other inputs into the production function. Generally this impact depends upon all of the other inputs, so, for example, the marginal productivity of a worker with high school education of a given quality depends on the stock of physical capital and technology with which the worker works. With good estimates of the appropriate production functions the impact of human resources could be evaluated with considerable confidence. Good production function estimates are difficult to obtain, however, because of unobserved inputs (e.g. inherent ability, motivation, soil quality, inherent health) and the simultaneous determinations of outputs with inputs (section 3B). Phenomena such as learning-by-doing (emphasized by Lucas and Stokey, see section 1A) also may be difficult to capture empirically with information usually available.

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[7] And for understanding under what conditions there may be efficiency reasons for governments or for private firms to subsidize human resource investments (section 4H).

Mincer-type earnings functions: The most common framework for estimating the private rate of return to time spent in school in terms of labour market outcomes is due to Mincer (1974). In the simplest case earnings depend only on the years of schooling. In equilibrium, the present discounted values of the earnings from the two options of either zero years of schooling (Y_o) or a chosen amount "S" years of schooling (Y_s) are equated, which implies a semilog earnings function:

$$(6) \quad \ln Y_s = \ln Y_o + r S,$$

where r is the private rate of return to the time spent in school. There are numerous estimates of such expressions that purport to measure the private rate of return to time spent in schooling (section 4B).[8] How does this expression relate to the production function for earnings discussed earlier? Implicitly it assumes that the impact specified in that production function with respect to schooling is independent of all other inputs (e.g. ability, motivation, other inputs, technology). Thus strong assumptions are made such that, for example, ability and motivation have an impact on earnings only through their effect on schooling. An alternative interpretation of the above relation (6) is as a hedonic wage function (Rosen 1974, 1977, Tinbergen 1951, 1956) so that the coefficients are the market valuations of attributes. Estimation issues remain, however, if any of these attributes reflect choices (e.g., schooling).

B(iii) Supply considerations for the production of human resources

An important component of the marginal cost of human resource investment is the private marginal supply price paid by users of human resource services such as schools, training programmes, and health clinics. The higher this price, *ceteris paribus*, the less the equilibrium human resource investment. The private marginal supply price for human resource-related services, in turn, reflects the public marginal cost minus net marginal subsidies.[9] Such subsidies often are non-zero so that the provision of such services increases fiscal deficits, which has contributed to increasing recent concern about more efficient provision of these services.

For such services to be provided efficiently, the resources used must be employed fully, used well in an engineering sense, the production input combinations must be selected so that the ratios of the marginal products of any two inputs equals the ratio of their social costs, and the output combinations must be chosen so that the ratio of the incremental social costs of any two outputs equals the ratio of their social marginal values to users. If any of these conditions are not met, service production of equal value to society can be produced using less resources simply by appropriately reallocating those resources.

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[8] There also are many "internal rate of return" calculations from comparing average earnings streams of cohorts with different schooling that are based on assumptions similar to those necessary for the Mincerian earnings function.

[9] The public marginal cost may not be the same as the social marginal cost if there are distortions in the prices that the public sector pays.

Section C. Justification for policies related to human resources

Basic goals of developing economies are often characterized as (1) increasing the command over resources of members of those economies and (2) achieving an appropriate distribution of the command over resources. Human resources may be effective means for attaining both of these goals as well as the goal of the enrichment of the human resources themselves. In any case human resource-related policies are often advocated and, indeed, implemented. An important question, therefore, concerns the bases for making such policy decisions.

An important part of the answer to this question depends on exactly what is the social objective function, what are the distributional weights in that function, and to what extent human resources *per se* as opposed to (or in addition to) the broader command over resources are in that objective function.

Economists have something important to say about how resources can be used more productively to pursue the agreed-upon objective of a society, whether these objectives stress marginal human resource investments because of the values of human resources *per se* or because they increase the more general command over resources, and however marginal human resource investments in the poor are weighted relative to those for people who are better off. Economists have something important to say because the objectives are always pursued subject to resource constraints, so there is an advantage in using the available resources more rather than less effectively.

Such considerations, in a static world, lead to emphasis on policy interventions that are sensitive to economic efficiency.

A number of considerations can be noted, using the example of a school system for illustration. *First*, that efficient allocation, input and output choices are interdependent. Suppose that society changes the relative values of incremental cognitive achievement for reading versus mathematics because of a perception that scientific skills will be relatively even more important in the future. If the production relations for producing increments in mathematics cognitive achievement are more intensive in the use of teachers, the demand for teachers' services increases at given input prices. (If all school authorities make such a shift, however, the relative price of teachers' services relative to materials probably will increase, to offset in part such a shift.)

Second, there is a *policy hierarchy* in which it probably is desirable to lessen or to eliminate any inefficiency by making changes that as directly as possible address the inefficiency (e.g. Corden 1974). If too little schooling is occurring from a social point of view, then, for example, schooling expansion could be encouraged by subsidizing the production of paper, since paper is used in textbooks that are used in school. But such a subsidy would add distortions and inefficiencies by encouraging too much use of paper in other uses, and therefore would be less effective from an efficiency perspective than subsidizing schooling.

Third, there remains the question of efficiency in the allocation of budgetary resources to the school authority versus other possible uses. Moving to lessen such allocative efficiencies between the school authority under examination and other parts of the economy

may have a high pay-off in terms of efficiency, possibly (or possibly not) a higher pay-off than lessening inefficiencies in the operation of the school authority.

Fourth, if the school authority had perfect knowledge of all the relative incremental social values (prices) of inputs and outputs and of the production technology, it could issue regulations to the schools to produce the socially optimal combination of increments in reading and mathematics. It then could see that the regulations were followed through monitoring and by imposing strong sanctions on errant behaviour. But the real world situation is much more complex and information is quite imperfect. There are many more inputs and many more outputs, and the intensity efforts of some inputs (e.g. students, teachers) reflect behavioural choices. Information is quite imperfect regarding the social values of additional outputs, the nature of the production technology for the outputs of interest, and even the social values of additional inputs, since in some of the relevant markets (e.g. the market for teachers) there may be substantial distortions due either to market failures (such as externalities) or policy distortions (laws and regulations on employment practices). Therefore, there may be an important role for improved information on schooling, as well as for the design of institutions that induce efficient behaviour (section 5D).

Fifth, the discussion so far has been static. But there is nothing inherent in the discussion that precludes dynamic considerations. There is the choice between allocating resources for increasing cognitive achievement this year versus next year, with the same general considerations applicable (though the information problems are likely to be greater for dynamic choices).

Sixth, efficiency justifications for policy changes depend on there being differences between social and private incentives. The pervasiveness of imperfect and often asymmetrical information, together with evidence of substantial behavioural responses to incentives, suggest that there are likely to be gains from policies that increase information and from policies that create incentives for socially efficient behaviour even if information is imperfect (as it is always likely to be). Markets can play important roles in conveying information and in shaping the incentives that individuals and entities face. Market signals, however, do not always convey correctly the social scarcity values of products and activities because of market failures due to information imperfections, externalities, market power of some entities, increasing returns to scale and governmental regulations and subsidies. Therefore, in terms of the important concern about efficiency, there are likely to be gains from policies that make markets more efficient, though there are some market failures that are not likely to be addressed well with market changes alone.

This means that in thinking of possible policy changes from an efficiency perspective, priority should be given to identifying market failures and to considering whether they can be remedied at a reasonable marginal social cost by improving markets or by other means. Note that this policy prescription means that the existence of high returns to human resources does *not* necessarily mean that there is an efficiency reason for policies to subsidize human resources; what is required is evidence that social returns are greater than private returns and that there are high social returns to offsetting (perhaps partially) the difference.

Section 2. Data issues

What we think we know about human resources and development depends on available, mostly quantifiable, data. Such data permit the exploration of at least some important dimensions of analytical frameworks (section 1). If accurate data were available on all of the relevant variables, we could explore very directly with substantial confidence their relevant dimensions for past and current time periods (though there might remain some questions about the applicability of the estimates for future time periods). But there are substantial data problems, including possibly key variables that are not observed and other variables that are observed only with errors, that make the drawing of inferences about behaviour related to human resources in many cases difficult, and point to estimation issues (section 3). Some of these data problems are discussed in this section, in order to point to areas in which better data might be collected and to lay the groundwork for discussing the estimation issues in the next section.

Micro-data used for analysis of human resources and development include household and productive establishment (e.g. firms, farms, schools, health clinics) censuses and surveys and, in a relatively few cases, experimental data. Because of the costs of collecting census data, survey data are more common and probably generally more cost effective. Several problems are widespread.

Selected samples: If samples are selected by some criteria that is systematically related to the relations being investigated, selectivity bias may result. Data collected from enterprise surveys generally constitute neither a random sample of enterprises nor of workers, because small-scale and informal enterprises are less likely to be included than are large, formal sector enterprises. Samples of individuals who use some facility, such as clinics or hospitals or employment services, again are not likely to be random. Even if the sample is random or the data are from a census, for the investigation of certain relations critical information may be available only for a selected subsample (e.g. wage rates only are available for individuals who have wage-paying jobs; choices of medical facilities for curative health care are available only for individuals who perceive that they are sick).

Missing variables: Even if samples are representative so that there is no selectivity bias, inevitably there still are missing variables (e.g. ability, motivations, expected prices and labour market conditions, training and learning-by-doing), which can cause unobserved variable bias if there is not control for such variables on the right side of relations (section 3A), and preclude examination of their determinants if they are dependent variables of interest.

Measurement errors: For the variables that are included in data sets there may be measurement errors (that may cause estimation biases, section 3D) due to systematic reporting errors (e.g. underreporting of income, reporting what the respondent thinks that the interviewer wants to hear rather than what occurred), limited recall capacities, lack of knowledge, or the mechanics of reporting/coding/processing the data. There may be important measurement errors also because analysts use variables that even if error-free are imperfect indicators of desired concepts. A very common example of the latter is the use of

years or grades of schooling to represent schooling investment, with no recognition of the varying costs and the varying qualities of schools.

How can micro-data be improved? *First*, more concern can be given to assuring random samples. For example, if there is to be a sample of enterprises or of schools, the sampling frame can be established on the basis of a household sample so that the appropriate sample weights for workers in the enterprises or students in the school sample will be known and selectivity can be controlled. *Second*, more efforts can be made to measure the critical variables for the analysis of human resources and development. Examples of variables that sometimes are, but often are not, included in data collection efforts, include anthropometric indicators of health, cognitive achievement and ability test scores, wage rates, and community-level prices and facilities. *Third*, more efforts can be made to collect data in a manner that permits the control for unobserved individual, household and community characteristics. For example, adult sibling data permits control for shared childhood background, experimental data with random assignment to treatment versus control groups permits control for unobserved factors, and longitudinal data permits the control for unobserved effects that are fixed over time and for investigation of dynamics. *Fourth*, purposively weighted samples are useful to investigate some phenomena that are important for only a small part of the population, as long as the weights are known and there is a tie-in to a population sample so that selectivity can be controlled.

Analysis with aggregate data has become increasingly common, in part because of the greater availability of such data through international organizations and in part because of increased interest in human resources and aggregate growth issues. However, a general problem is that most of the aggregate data refer to means, not to the distribution of variables. Two countries with identical mean values of variables, such as schooling or life expectancy at birth may have very different distributions of these outcomes, with very different implications for assessment of their development experience. Beyond this general problem with aggregate data, there are possibly major human resource investments for which data across countries are so far from comparable that they have not been used much, if at all, for comparative purposes and there are specific problems with the major aggregate human resource variables that are used widely now that are summarized in Appendix 1.

3. Estimation issues[10]

Data problems mean that obtaining consistent estimates of critical parameters pertaining to relations between human resources and development is difficult indeed, both at the micro- and the macro-levels of aggregation. Therefore, it is difficult to know how to interpret many existing studies. Better data and more attention to the underlying models of behaviour in empirical work would lessen these estimation problems, though often it is difficult to deal with all possible problems at once and remedies for some may exacerbate others (e.g. using fixed effects estimators to control for unobserved fixed effects may exacerbate measurement error bias). Thus, there is some art in empirical work in assessing what are likely to be the

[10] Deaton (1994) provides a more extensive discussion of these and other estimation issues.

major estimation problems, and tests of robustness (including estimates from different samples) are important. Four of these estimation issues are now reviewed.

A. Omitted variable bias

Omitted variable bias occurs when there is a variable(s) that should have been included in the estimation but is not and that is correlated with an included variable. The bias is the greater the more important is the missing variable and the more highly it is correlated with an included variable. Omitted variable bias may occur either because there are not observations on variables that are thought to be important and no way to control for those variables, or because researchers choose empirical specifications that ignore important phenomena. The latter would seem less likely to occur if the empirical specification is tied closely to some plausible theoretical framework.

Possible omitted variable biases are pervasive in the empirical literature on human resources and development, though most of this literature does not attempt to explore such possibilities. For example, a substantial part of this literature purports to estimate the impact of human resources on various outcomes. But an important implication of the framework that is presented in section 1B(i) is that human resource investments are associated with a number of individual, family, community and national characteristics: individual abilities, motivations, inherent robustness, family support, role models, household gender roles, connections, and genetic endowments; community role models, the quality of community health and educational services, the stock of production inputs in the community that are complementary to human resource investments in the individual; labour market segmentation by gender, ethnic and racial groups; preferences regarding material-leisure trade-offs. To identify the impact of human resource investments on a particular outcome, therefore, it is may be important to control for these other characteristics. Some studies of the impact of human resources in developing countries suggest that such controls make a considerable difference (see the surveys in Behrman 1990a,b,c and aggregate estimates in Behrman and Rosenzweig 1993).

How can omitted variable bias be lessened? Better data can help, with greater efforts to include a priori critical variables and to obtain data sets with which unobserved fixed effects can be controlled (e.g. longitudinal data, experimental data, sibling data). But it is also important to tie the empirical specifications more closely to the underlying behavioural models than is often done in order to lessen the probabilities of the inadvertent conceptual omission of critical variables. Of course this is potentially useful only because of the assumption that the behavioural models bear some relation to real determinants of behaviour (perhaps in an "as if" rather than an explicit sense). On a general level, for models such as in section 1B, that assumption seems to be supported, and exploration of the merits of specific forms of such models depends on careful links with empirical work.

B. Simultaneity bias

Most of the studies on human resources and development in the literature do not control for simultaneity. But casual observations, as well as behavioural models (e.g. Part 1, section 1B(i)), suggest that a number of relevant decisions are undertaken simultaneously. For instance, healthier and better nourished individuals may perform better in school and have higher wages and greater productivity, but that does not mean that better health and nutrition cause the better performance in school and in labour markets. Parents who invest more in their children's schooling plausibly may invest more in their children's health and nutrition, so that children who are healthier perform better in school in part because of such parental concern that leads to more investment in both health and schooling, and not only because better health leads to better schooling performance. In this case, control for simultaneity would probably result in a smaller estimated impact of child health and nutrition on schooling success than is suggested without such control for simultaneity. Similar considerations underlie relations that determine productivity and wages; people with greater motivation and relevant ability may be both more schooled and have greater labour market success. If, in such instances, there is no control for simultaneity, biased estimates may result. These biases may be in either direction (depending upon the nature of the underlying behaviour), but the inferences may be misleading, perhaps considerably so, if there is no control for simultaneity.

The most common control for simultaneity is to replace endogenous appearing on the right side of relations with their estimated values, perhaps after specification tests indicate that simultaneity is a problem. However, the choice of variables used for the first-stage estimates often seems cavalier and probably inappropriate. Good variables for the first-stage estimates are (a) associated with the endogenous variable of interest and (b) independent of the disturbance term in the relation in which that endogenous variable appears on the right-hand side. If (b) is not satisfied, the estimates that are obtained are not consistent, so their interpretation is not clear. But obtaining instruments that satisfy (b) is difficult indeed in most contexts. Often prices and community characteristics are used for this purpose for micro-studies. But if there are unobserved choice variables that enter into the relation of interest, such instruments do *not* satisfy (b), so it is hard to know how to interpret the estimates.[11] Once again, careful specification of empirical models in the light of appropriate theoretical frameworks with the possibility of unobserved variables is likely to be helpful.

[11] Behrman and Lavy (1993) provide an example with their estimation of the dependence of child cognitive achievement on child health (and other factors) with Ghanaian data. If community prices and other characteristics are used as first-stage instruments, the health effects appear much larger than in ordinary least squares estimates. But if also there is control for unobserved family and community effects the estimated health impact falls considerably, suggesting that the first-stage instruments for the "simultaneous" estimates are representing in an important part other unobserved factors, and not just child health.

C. Selectivity bias

Many existing studies of human resources and development do not control for sample selectivity determining such decisions as who receives wages, who perceives themselves to be sick, who attends private or vocational schools, who attends different types of medical facilities, who works in different occupations and which countries are included in aggregate data sets. The remedies for dealing with these possible selectivity problems, once again, is a combination of better data (section 2) and modelling of the behaviour that led to the selectivity in the first place (e.g. whether to participate in the wage labour force).

D. Measurement error

Random measurement errors in right-hand side variables, such as schooling in a wage determination relation, cause biases towards zero in the estimated coefficients, and thus underestimates of the effects of human resources. These biases are exacerbated in estimates that control for the effects of unobserved variables by subtracting the observation for one time period from that for another time period. Some recent estimates of the schooling impact on labour market outcomes, for example, suggest that measurement errors can cause considerable downward biases in the estimated effects of schooling on wages in within-sibling estimates (e.g. Ashenfelter and Krueger 1992, Behrman, Rosenzweig and Taubman 1993). Instrumental variables may be used to purge the less reliable variables of their random components. But once again, the set of instruments for the first-stage estimates must be chosen carefully to avoid inconsistent estimates.

But not all measurement errors are random. Some may be systematic, and *may* cause biases in the opposite direction. For example, schooling is usually represented by years or grades of schooling, with no control for school quality, even though school quality appears to vary greatly, and would seem to have an impact on outcomes of interest in addition to that of grades of schooling. If school quality does have an impact and higher school quality is correlated with more schooling, then the failure to control for schooling quality in estimates of the impact of schooling results in upward biased estimates of the effect of extending years of schooling, since in the statistical analysis grades of schooling represents not only the effect of grades of schooling itself, but also of schooling quality (section 4D). The best remedy in such a case would seem to be to improve the data so that they better represent the desired constructs, though estimates that control for unobserved school or community factors by subtracting out the means for the school or the community may be helpful (e.g. Behrman, Ii and Murillo 1993).

Part 2. Selected issues regarding relations between human resources and development

Section 4. Issues regarding the impact of human resources

A. Which human resources are relevant to the development process?

Many commentators on and analysts of the development process effectively equate "human resource investments" with "schooling," in part because accumulation of knowledge is viewed to be so central to the development process and in part because reasonably comparable micro-data and aggregate data are relatively available for schooling.[12] But there are possibly important human resource investments other than those in schooling.

Training is claimed to be a very important form of human resource investment, with advantages in that the gestation lags before productivity is affected are relatively short in comparison with those for basic schooling or child health and nutrition. Though aggregate data are not available with which to summarize the condition of training programmes in the same manner as are data for schooling and health and nutrition, training is widespread and apparently increasing rapidly in parts of the developing world, sometimes as part of formal government-related training programmes. Enrolments in publicly-financed national training systems in Latin America, for example, grew tenfold between 1955 and 1985, and in the late 1980s public spending on training accounted for as much as 0.5 per cent of GNP (Jimenez, Kugler, and Horn 1989). The Brazilian SENAI (Servic Nacional de Aprendizagem Industrial) programme alone, funded primarily by a 1 per cent tax on the payroll of all firms (1.2 per cent for enterprises with more than 500 workers), had an enrolment of about 950,000 in 1991, and a cumulative total enrolment since 1970 of over 9 million.

There has been some micro-analysis of the impact of training, but this analysis has in general not controlled effectively for the selective aspect of training (i.e. that individuals are not trained at random but are selected because of greater motivation, ability and other characteristics). Therefore, it is hard to know how to interpret claims about the relative merits of short versus long training courses or interactions between schooling and training. Aggregate estimates of the impact of human resources typically ignore training because of the absence of a comparable measure of training across countries. Given the fairly large and rapidly growing resources devoted to training in developing countries, the pay-off would seem to be high to collecting more data on training (both micro- and aggregate) and to analysing that data systematically (with care for estimation problems, see section 3) to learn more about the rates of return to different types of training and whether public subsidies for training are justified.

Health and nutrition: There have long been arguments that better health and nutrition can improve productivity through various channels: by freeing resources for current consumption and investment that otherwise would have been used for health care, by increasing child cognitive achievement with a subsequent impact on economic (including household)

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[12] Schooling data limitations (section 2) are often not recognized.

productivity through more and better education, by improving worker productivity (with the last two of these channels though important primarily at low levels of health and nutrition, and thus for relatively poor populations). Conventional wisdom is that health and nutrition may also be affected importantly by schooling, particularly of women.

Micro-studies on the impact of nutrition and health on school and labour productivity in developing country contexts have increased rapidly in number in the past decade and a half, in part because of the increasing availability of more suitable data and in part because of increasing concern for disentangling causalty from association (see the survey in Behrman 1993c). Studies of experimental and socio-economic survey data on the direct productivity effects of health and nutrition indicate growing, though qualified, evidence of positive direct effects of health and nutrition on the labour productivity of at least poorer individuals in developing countries. Qualifications are necessary because of variations in the estimates and because control for simultaneity, unobserved fixed effects and intrahousehold allocations of nutrients is limited in many studies. In some cases these productivity effects appear to be fairly immediate due to current intakes of calories or micronutrients, though in other cases they are medium-run (as reflected in weight) or long-run (as reflected in height). Such productivity effects provide an argument for being concerned with the health and nutrition of the poorer members of society, not only because health and nutrition are of interest in themselves, but also because productivity gains can be made.

In such contexts the studies reviewed have tended to indicate, if anything, greater productivity effects for health and nutrition than for formal schooling, even though the productivity effects of schooling have been much more emphasized in the development literature. With the general tendency to move towards greater dependence on markets in many developing economies, the productivity impact of better health and nutrition for poor people well may increase because of greater incentives towards and rewards for greater productivity. There are some nutrient deficiencies also, for example, infant and child blindness due to vitamin A deficits, for which casual evidence suggests that the economic returns to remedies might be quite high, though more systematic evaluations would be valuable. Studies of experimental and socio-economic survey data on the indirect productivity effects of health and nutrition through cognitive achievement, schooling, and pre-school ability also indicate possible positive productivity effects through these channels, though once again, with variance in the results and with qualifications due to estimation problems.

There are very few aggregate cross-country studies of the impact of health and nutrition on subsequent economic growth, certainly many fewer than there are of the impact of schooling on subsequent economic growth. However, Behrman (1993d) explores such relations and find that initial 1965 health and nutrition - as represented by life expectancies at birth - is a better predictor of per capita economic growth over the subsequent quarter century than is initial 1965 schooling. For this exploration both initial human resources are represented by their actual values minus the values predicted by a cross-country regression on a polynomial in per capita income, in order to control for the initial level of development.

It is desirable to eliminate the effects of the initial level of development for three reasons.[13]

Table 1 reproduces some of the estimates. *First*, a regression with only initial schooling conditions for all 85 countries for which data are available, is consistent with 15 per cent of the variance in the growth rates over the next quarter century. The schooling coefficient is significant at the standard 5 per cent level and indicates higher subsequent real per capita growth of 0.39 per cent per annum for every additional initial year of schooling. This is the total schooling-economic growth association, including all direct productivity effects and any indirect effects, such as those affecting health and nutrition in ways that made people more productive. *Second*, a parallel regression for initial life expectancy for all 96 countries for which data are available is consistent with 18 per cent of the subsequent variance in the growth rates over the next quarter century. The life expectancy coefficient is significant at the standard 5 per cent level and indicates higher subsequent real per capita growth of 0.14 per cent per annum for every additional initial year of life expectancy. This is the total life expectancy-economic growth association, including all direct productivity effects and any indirect effects, such as through saving resources otherwise used in curative health or through increasing education that makes people more productive. Note that initial life expectancy has at least as great an association (in fact a fifth greater) with economic growth over the subsequent quarter century as does initial schooling. *Third*, if both initial life expectancy and initial schooling are included for all 85 countries for which data are available the regression is consistent with 21 per cent of the subsequent variance in the growth rates over the next quarter century. The schooling coefficient is less than two-fifths of that in the first case discussed above and is not significantly non-zero at the 25 per cent level. The life expectancy coefficient is three-quarters as large as in the second case discussed above and still is significantly non-zero at the 5 per cent level (though less precise than in the second case). Thus, the initial conditions with respect to life expectancy have greater predictive power with regard to subsequent per capita income growth and are more robust than those for schooling.

Summary: The evidence is not absolutely conclusive regarding the direct and indirect productivity effects of training and health and nutrition, but neither is the evidence regarding other factors that are widely emphasized such as schooling or tariff structures. Nevertheless, the micro-evidence is suggestive that there are considerable direct and indirect productivity effects of health and nutrition for the poor populations that predominate in many parts of the developing world and that there are important training effects for populations that are somewhat better off. Moreover, the aggregate evidence is that initial life expectancy conditions were better predictors of economic growth in the 1965-1990 quarter century than initial schooling conditions. Further, in many societies considerable resources are devoted to health and nutrition and training, including considerable subsidies. Therefore, whether

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[13] First, there is evidence that health and nutrition and schooling in part respond to the level of per capita income (e.g. Preston 1986, Schultz 1988) so it is desirable to purge the data of this impact so that the estimates do not pick up this reverse causality. Second, the spirit of the "new economic growth" literature and of the observations of many others is that what counts in subsequent economic performance is a country's initial human resource position relative to its level of development. Third, if there are differences across countries in factors such as preferences towards materialism and work effort, such a procedure controls for these differences and probably lessens biases arises from omitted variables.

Table 1. Estimates of the associations of initial 1965 human resources relative to the levels predicted by cross-country regressions on subsequent economic growth for the period 1965-1990[a]

Dependent variable real per capita GDP annual growth 1965-90	Initial schooling	Initial life expectancy	Constant	R^2	F	N
Row 1	0.39 (4.0)		1.8 (9.1)	.15	16.3	85
Row 2		0.14 (4.7)	1.7 (8.2)	.18	23.3	96
Row 3	0.15 (1.1)	0.10 (2.6)	1.7 (8.9)	.21	12.1	85

[a]t statistics are in parentheses to right of point estimates. The initial human resource positions are the actual values minus the values predicted by a cross-country regression on a polynomial in per capita income for 1965. Schooling is the expected schooling for a synthetic cohort. For more details see Behrman (1993d).

attention is limited to productivity concerns or a much broader view is taken of human resources and development, human resources themselves should be viewed more broadly than just the schooling on which attention often is focused.

B. What do we know about the impact of human resources?

There are literally hundreds of micro-studies that purport to investigate the impact of schooling on economic (e.g. wages, agricultural productivity) and non-market (e.g. health and nutrition, fertility) outcomes (see the surveys in Behrman 1990a,b,c). Table 2 reproduces a well-known summary of many of the studies on the economic outcomes. There are fewer, but a growing number of similar studies that purport to investigate the impact of health and nutrition and of training on productivity. Some studies tie together micro-estimates of the impact of human resources with the distribution of income or of earnings (e.g. Blau, Behrman and Wolfe 1988, Lam and Levison 1991, Psacharopoulos et al. 1992). There also is a recent growth industry in the presentation of cross-country regressions that purport to investigate the impact of schooling on economic growth (e.g. Barro 1991, Dollar 1992a,b, Romer 1989).

While these studies are not unanimous in their conclusions, the conventional wisdom based on them is that the evidence is strong that there are high returns to schooling investments, with the social rates of returns higher to basic than to higher schooling, to general rather than to technical/vocational schooling, and perhaps to female than to male schooling. The views are less prominent with regard to training and health and nutrition, but there seems to be some consensus among those working in these areas that the returns to the right types of training (e.g. for workers with a basic education on which to build and that is

tied to employers' needs) are high, and that productivity returns may be high to health and nutrition investments in poor populations.

But this voluminous and growing literature is much less conclusive than many claim because of the data and estimation problems (see sections 2 and 3). Selectivity, simultaneity, and omitted variable biases due to failures to control for such factors as ability, motivation, family background, and community characteristics may cause substantial biases (probably upward) in estimated returns to human resources. Some of these problems and random measurement errors may cause important downward biases. If such factors are important, our knowledge about the impact of human resources is much more shaky than usually recognized. Some seem to maintain that because there are so many studies that report strong positive associations of schooling with various "good" outcomes, those effects indeed must be important. But if it is the case that individuals with better family background and with a greater share of abilities that are rewarded in the labour market and with greater motivations for material gain tend to have both more schooling and to obtain higher wages in most societies, then the fact that there are strong associations in most societies between schooling and wages does *not* demonstrate to what extent more schooling *causes* the higher wages.

Table 2. Average rates of return to schooling in percentages

Region/ country type	Private			Social		
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
Africa	45	26	32	26	17	13
Asia	31	15	18	27	15	13
Latin America	32	23	23	26	18	16
Intermediate	17	13	13	13	10	8
Advanced	--	12	12	--	11	9

Source: Psacharopoulos (1985, Table 1).

Previous surveys of the estimated impact of schooling (Behrman 1990a, b, c) have expressed the view (based on the relatively few studies that attempt to control for the data and estimation problems) that in micro-studies the actual impact of schooling may be much less than usually is claimed -- in some cases half as much or less. It may also be noted that aggregate estimates in Behrman and Rosenzweig (1993) indicate that the association of schooling with per capita income in cross-country estimates are only about half as large if there is control for unobserved country fixed effects (perhaps representing cultural differences in materialism and work ethics) than without such control.

Similar problems may be important also for the evaluation of the impact of other human resources. Even the available studies of the productivity impact of health and nutrition that attempt to control for possible simultaneity of current health and nutritional status tend to

treat longer-run health and nutritional status as predetermined without control for possibly persistent effects, such as that individuals who are inherently more robust may be healthier and more productive. Likewise, none of the studies of the returns to training programmes of which the writer is aware have controlled well for what would have happened to trainees' earnings and occupation without training or, equivalently, for who receives training. Instead they are undertaken as if both formal schooling and training were randomly distributed to members of the population, rather than there being selective choices about how long individuals go to school and for how long, if at all, they receive training. The trainees in most programmes have relatively high schooling and come from families with more educated parents. Quite possibly they also tend to have greater ability and motivation than those who did not enrol in (or were not selected for) training programmes, so a careful evaluation of training programmes needs to control for the selectivity of the trainees. Existing studies provide much less persuasive evidence of the impact of training programmes than their interpreters often claim because of their failure to control effectively for such estimation problems. Thus, there appears to be considerable potential for improving our knowledge of the impact of all human resources through better data and more careful estimation.

C. Can human capital explanations of the impact of human resources be identified from other possibilities, such as screening and signalling?

The literature on the impact of human resources on development is based primarily on the human capital interpretation of such human resources in which human resources are of interest because they increase productivity. There are well-known alternative interpretations in which human resources investments may serve as signalling or screening devices (i.e. they do not add to productivity *per se*, but serve to signal that individuals with higher schooling levels have greater degrees of desired abilities and motivations).

There are private returns to schooling from signalling because schooling signals that one has the desired attributes. The equilibrium investment from this private perspective continues to be one that equates the expected marginal benefits and the expected marginal costs. Why does not everyone obtain high schooling in such a case? The answer, within the screening/signalling framework, is that the costs of going to school vary because the attributes about which signalling is occurring vary across individuals. For example, individuals with more powers of concentration or more persistence effectively have lower costs of going to school than other individuals so they attend school longer. If schooling only is associated with such attributes, standard estimates of the impact of schooling on wage rates would reflect the private returns to schooling through signalling that an individual has such attributes. If schooling is also associated with other characteristics (say, with family background independent of such attributes), omitted variables also lead to biases in standard estimates of the private returns to schooling.

Sometimes it is suggested that schooling is less socially productive within a screening/signalling framework than within a human resource framework. But on *a priori* grounds it is not clear why. If information is imperfect about individual attributes and there are productivity returns to sorting people into different jobs depending on what attributes they

have, then clearly there is a productivity return to such screening/sorting. The only relevant question would seem to be whether there is a socially less costly means of undertaking such sorting equally well. If so, it would be desirable to switch from using schooling for such a purpose to using the alternative sorting mechanism. But the possibility that there are preferable alternative mechanisms for sorting/screening is no different in essence from the possibility that there are more efficient mechanisms to produce cognitive achievement (or whatever schooling is producing). Thus, in a sense, it may not be all that important whether schooling is producing cognitive skills as in the human resource model or sorting people as in the screening model. In either case the relevant questions are whether there are other mechanisms that could perform the same functions with higher rates of return and whether there are differences between the private and the social rates of return.

A number of empirical studies have claimed to identify whether schooling is serving in part screening/credentialism functions by investigating whether the apparent schooling impact on wages is greater for the particular grades of school that pertain to completion of certain school levels (e.g. primary, secondary, or tertiary schooling). If ability or motivation are complementary inputs with schooling in producing productive skills and if schooling costs increase significantly with advancing to a new school level,[14] then it would seem that those who completed each schooling level would include both (i) those for whom that is the appropriate grade of schooling, given their ability and motivation, even if there were no cost problems with continuing on with further studies at a higher level and (ii) those who have greater ability or motivation so that they would continue with further study if there were no such cost problems but find stopping at that level optimal, given the actual costs involved with going to the next level. In this case, standard estimates would indicate higher returns at the margin for individuals who just completed a particular schooling level, because of the relatively greater incremental ability or motivation for that group than for comparisons between two grades within the same school. What is interpreted to credentialism may reflect this phenomenon in part or in whole.

Such a possibility could be tested in at least three ways. *First*, if there is a means of controlling for ability or motivation through direct observations on these characteristics or through fixed effects estimates, a comparison of wage function estimates with and without such controls would reveal whether the estimated final grade level effect drops with such controls.[15] *Second*, would be the estimation of schooling effects on direct productivity outcomes (e.g. self-employment, household production) since credentialism would not seem to be relevant for such activities. *Third*, data could be collected on the predetermined individual attributes and on cognitive achievement and other products of the schooling system, and a system of relations could be estimated in which the importance of

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[14] As would often seem to be the case, particularly if there is no school at the next level available locally or if there are adjustment costs associated with switching schools in addition to those for switching grades.

[15] The fixed effect estimates would be only a first-order approximation to the appropriate functional form in which interaction between schooling and ability/motivation is important. Fixed effect estimates would also require data on pairs of identical twins to control for differences in innate ability/motivation since longitudinal data on individuals will not provide the necessary information as each individual has only one most advanced schooling grade.

predetermined attributes and of schooling characteristics in producing cognitive achievement and other school products, and the impact of those products on subsequent productivity, could be estimated.

D. Are there important quality-quantity trade-offs in the impact of human resources?

Most empirical analysis of the impact of human resources uses quantitative indicators of human resource investments, most commonly years of schooling or of training. Yet casual observation as well as more systematic analysis suggests that there are substantial quality variations across schools and across training programmes. What is the implication of such quality variations in assessing the impact of human resources?

First, for a given level of human resource investments, the expected marginal benefit is a positive function of the service quality; therefore better quality should increase the rate of return to a given period of schooling or training. *Second*, if the marginal cost of funds is not infinite, individuals (or their parents) in equilibrium invest in more years of schooling or training if quality is higher, so there is a positive association between an individual's years of schooling or training and the quality of schooling or training; therefore, if schooling or training quality is important, the failure to include it in standard estimates results in an upward bias in the estimated return to years of schooling or training, since this estimated rate of return incorporates in part the return to the quality of schooling or training.

A set of studies for Brazil suggest four points about the empirical magnitudes of school quality effects in that country (Behrman and Birdsall 1983, Behrman, Birdsall, and Kaplan 1993): (1) school quality should be included in addition to school quantity in analysis of labour market and non-economic outcomes. (2) There is a substantial upward bias (about 80 per cent) in the estimated rate of return to years of schooling if schooling quality is excluded. (3) The social rate of return to schooling quality is as high as or even higher than the social rate of return to years of schooling. (4) Schooling quality and years of schooling interact. Thus there is an equity-productivity trade-off in the sense that there are greater productivity gains for society if years of schooling and schooling quality are concentrated among fewer individuals instead of spread broadly, which contrast with the usual interpretation of estimates such as those in table 2 that productivity and equity goals can be pursued harmoniously through expanding primary schooling of a given quality.

These results raise questions about the efficiency of the current allocation of resources between schooling quality and schooling quantity and about a possible equity-productivity trade-off since the productivity gains may be larger from concentrating schooling resources among fewer individuals rather than spreading them broadly in low-quality schools. The nature of the equity-productivity trade-off, moreover, may have subtleties since some quality improvements may require more household inputs from poor households and others may free such resources for poor households (Barros and de Mendonca 1992). Stokey's (1991) conjecture that there are high quality goods the production of which requires high quality labour, with little or no possibility of producing such goods with low quality labour raises similar questions about the role of quality.

The studies summarized above and related studies have their limitations. They do not control well for other unobserved community level characteristics, so the average local teacher schooling used as a quality indicator may be representing in part unobserved community characteristics such as the general learning environment and the perceived importance of education, which is likely to bias upward the estimated impact of school quality (though not the implication for the estimated impact of years of schooling). On the other hand, the use of the same quality measure may result in a downward bias in the estimated impact of school quality, since it is the average value for a large geographical area (i.e. the rural or urban part of a state), so it approximates the actual quality experience in a neighbourhood school with a significant random measurement error component. Nevertheless, such results suggest the possibility that incorporating quality into the analysis of the impact of human resource investments may change the interpretation of that impact and of the nature of relatively high return investments importantly. So it would be valuable to add to the relatively small number of studies that incorporate quality in a systematic manner in the analysis of the impact of schooling and of other human resources on various outcomes.

E. How does the impact of human resources reflect the context in regard to physical capital investments, technology, macro-economic performance, economic policy for international interactions, and market developments and policies?

Empirically observed returns to human resource investments are for a given macro-economic, market, policy, regulatory and general labour demand environment. If macro-policies have reduced the costs of physical capital investments and reduced the rewards for human resource investments, these factors need to be taken into account in evaluating the prospective future returns from new human resource investments. If labour market discrimination or "glass ceilings" have limited the advancement and thus the financial returns to human resources of groups identified by gender, ethnicity, or race, then possible labour market changes need to be taken into account in assessing future returns to investing in the human resources of such individuals. If an economy has been relatively closed to international economic interactions, possible changes to a more open economy need to be taken into account in such assessments. If limited physical infrastructure has suppressed the returns to human resources in the past, then possible changes again need to be incorporated in predictions of future returns.

There are many, often inconsistent, speculations concerning the probable relations between various dimensions of the context of labour market demands and the returns to human resource investments, these include: relatively highly-regulated and closed economies create relatively high private but low social returns to formal human resource investments, such as school degrees and other forms of credentials. Better human resources, at least above some threshold levels, increase adjustment capacities with private gains and with social gains beyond the private ones (given the social costs of unemployment). High levels of human resources are complementary with physical capital investments and recent technology, but such factors are substitutes for low levels of human resources. More open economies permit

better use of and higher returns to human resources through developing profitable innovations for rapidly changing international markets that have positive external effects due to the information that they provide to others. Labour market regulations and discrimination increase private human resource returns to some at the expense of lower returns to others, with social inefficiency costs in addition to any inequity costs.

A few of these speculations have been explored with micro-data for some countries. There also is some aggregate evidence that more schooling and more open international policy regimes interact to cause higher economic growth (e.g. World Bank 1990a). But careful systematic analysis of these speculations to date is very limited, and there would seem to be potentially important gains from further careful systematic related micro-studies. For example, we might learn from detailed examination of complementarities and substitution related to human resources in different production activities.[16] And we might learn from further investigations of the relations between human resources and adjustment, which some studies suggest has an important non-monotonic aspect.[17] But many of these questions have essential macro-aspects to them, i.e. the interactions of human resources with the degree of openness of an economy, with the extent of market distortions, and with the extent of macro-stability. This means that aggregate data, with its greater pitfalls,[18] must be used to explore them. Nevertheless, it would seem that some progress could be made by investigating the associations between comparable micro-based estimates of returns to human resources (most easily for schooling) and indicators of openness, macro-stability, physical capital, technological change and market distortions. Such descriptions might be quite suggestive, though attempting to untangle causality is likely to be difficult indeed given the underlying behavioural choices underlying many of these indicators, various unobserved factors, simultaneity, and measurement problems.

F. What is the relation of human resources to environmental problems and sustainable growth?

Recently, particularly in the more developed countries and in international agencies, interest has increased in alleviating various environmental problems and in sustainable growth. Human resource investments would seem to have an impact on these issues through several channels. If human resource investments have positive effects on economic growth

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[16] Though the estimation problems in such studies are not trivial since many of the inputs are choice variables and not all of them are observed.

[17] Individuals with more general human resources are able to learn better, and thus the returns to investing in their specific human resources is greater. But with adjustment to another job or firm, specific human capital is lost. Those with little general human resources do not have much specific human capital to lose with adjustment, but acquire new specific human capital relatively costly. The net result may be that those who lose most with adjustment are those with some, but not a lot of, general human capital (since they have some specific human capital to lose but do not acquire new specific human capital easily). Estimates for Brazil are consistent with this pattern, with those who have completed primary schooling losing most from adjustments (Barros, 1992).

[18] These data problems are severe not only for human resources (Appendix 1) and national accounts data, but also for the characterization of the phenomena with which human resources are hypothesized to interact. For example, Harrison (1993) discusses the limited correlations among various indicators of foreign sector openness.

and there are positive income elasticities of demand for production of goods and services that have negative environmental by-products, one basic effect would seem to be negative. This effect probably is attenuated somewhat, however, by a changing composition of products and activities as income and human resources increase so that the unit resource and environmental costs fall. If human resource investments are associated with lessened population growth, as is often claimed (particularly for female schooling), there would be an additional impact through lowering the population growth below what it otherwise would have been. If, in the light of increasing concern about scarce resources and environmental problems, technological change is more likely to be resource and environment saving, and if more human resources (particularly education in various forms) increases the probability of technological change, there may be further reductions in resource and environmental costs per unit.

While there is speculation on these and other possible relations between human resources on the one hand and environmental problems and sustainable growth on the other, most of the basic issues hinge on the magnitude of such effects, and there has been very little (though some, e.g. Birdsall 1993b) effort to quantify these effects. Therefore, there is little basis for judging how important human resource investments may be relative to other means for dealing with these issues. Some careful systematic data collection and analysis would seem to have a potentially high pay-off in this area.

G. Are there important gender, ethnic or other demographic differences in the impact of human resources?

In most societies there are some demographic groups for whom mean wages are lower, even when there is control for observed human resources, such as years of schooling and age. Examples include women, indigenous groups in Latin America and the Caribbean and most minority tribes and low castes where they exist in Asia. Some suggest that, as a result of these lower wages, the rates of return for investing in the human resources of members of such groups on the average are lower than for investing in men, members of the dominant group and of higher castes.

But the leap from low wages to low rates of return does not necessarily follow. Investments in individuals with low wages can have relatively high rates of return. This may be so for human resource investments that take the individual's time, such as schooling and training, since *ceteris paribus* low wages mean that the opportunity cost of time for such investments is relatively low. Also in some societies average wage gaps conditional on schooling appear to narrow with higher schooling, which may reflect a number of factors that change with more schooling, including greater labour force integration, more emphasis on intellectual rather than physical attributes, and lessening discrimination. Moreover, if the proportion of females and minority groups that receives higher levels of schooling and training is relatively low;[19] if the distributions of innate abilities and motivation are the same across demographic groups; and if those individuals who receive such human resource

[19] This term is ised to refer to demographic groups that are thought to be disadvantaged in a population even though in some cases they may constitute a majority of the population (e.g., indigenous people in Bolivia).

investments tend to have relatively high abilities and motivations; the average ability and motivational levels of women or of minority group members with higher levels of schooling and training will exceed the average ability and motivational levels of men or majority group members with the same levels of schooling and training. Further, a greater proportion of the returns to human resource investments in women and some minority groups may be in informal sector, family enterprises, and household production activities that often are not incorporated into rate of return analyses in the same way that are returns in terms of labour market activities.

There have been some efforts to explore whether rates of returns to human resources, particularly schooling, differ among demographic groups. On the basis of micro-data, for example, Behrman and Deolalikar (1993a,b) report that estimated rates of return to schooling in Indonesia are higher for females than for males for schooling above the primary level, Psacharopoulos (1993) reports that estimated rates of return to schooling are lower for schooling for indigenous peoples than for those of European descent in Bolivia and Guatemala, Schultz (1993b) finds little evidence of selectivity differences between males and females in Thailand, Foster and Rosenzweig (1993) investigate the extent of statistical discrimination versus productivity differentials in gender wage gaps in the Philippines, and Birdsall and Sabot (1991) present a series of studies that investigate differences in schooling returns among groups identified by gender, ethnicity, and caste. There are also many studies that report that the impact of women's schooling is large in household production. Some estimates with aggregate data also report similar differences with regard to the impact of aggregate gender gaps in schooling and in health and nutrition; for example, King (1990) reports significant associations between gender gaps in schooling and demographic outcomes (when gender gaps favouring males are smaller, outcomes are better) and Behrman (1993d) finds that initial gender gaps in life expectancies are associated with subsequent inequalities in income distribution (with more equality associated with smaller gender gaps favouring males).

These and other explorations are suggestive, but only suggestive because most of these estimates are not sensitive to the estimation problems that plague the literature on the impact of human resources on various outcomes (sections 2 and 3, section 4B), some of the results seem to reflect in substantial part the *a priori* specification (e.g. many of the studies of the impact of human resources on household production a priori assume that the effect of male human resources is zero so that female human resources effectively represent both their own human resources and the correlated part of their spouses' human resources),[20] and usually "discrimination" is just the unexplained residual (Foster and Rosenzweig 1993 is an important exception).

Thus, there is potential for improving our understanding of whether there are differences in the rates of return to human resource investments and, if so, why? Are there potentials for increasing productivity through policies that reduce barriers to equalizing such returns?

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[20] Behrman and Sussangkarn (1989) provide an example for Thailand. If paternal schooling is included, its coefficient estimate is not significantly different from that of maternal schooling, that for maternal schooling falls substantially from what it is if paternal schooling *a priori* is restricted to have no effect, and there is evidence of significant gross substitution between maternal and paternal schooling.

H. What is the evidence regarding externalities or other market failures?

Externalities to human resource investments have long been emphasized, but with renewed vigour recently because of their centrality in the "new neoclassical growth models" (section 1A). It would seem *a priori* that there might be numerous possibilities for such externalities. If an individual who is more educated contributes to marginal productivity beyond what she or he is paid, there is a positive externality and the social marginal benefit is greater than the private marginal benefit. Or if an individual adjusts rapidly to changing circumstances and by virtue of that adjustment provides information to others about whether or not there are economic rewards to such an adjustment, there is a dynamic externality in the form of information about the changing world. Or if an individual is cured of a contagious disease because someone has received more schooling, not only does that individual benefit, but also others who may have been at risk of contacting the contagious disease from that individual if she or he had not been cured. Or if positive marginal income taxes mean that the private marginal returns to an individual's human resource investments are less than the social marginal returns. Or if an individual contributes to knowledge that is not excludable. Or if more education reduces the marginal costs of information with its public goods characteristics.

With such positive externalities, the private incentives are to underinvest in human resources from a social perspective.[21] Such possibilities are a major part of the efficiency rationale for governmental subsidies of human resource investments (in addition to any possible distributional rationale).

However, it should be noted that this is a partial equilibrium view. In addition, in general equilibrium it must be recognized that the private marginal benefit curve of this individual is also higher if there are positive externalities from the human resource investment of others than it would be without such externalities. More specification of the interactions is required to understand to what extent this effect of others' human resources on this individual's private marginal benefits eliminates the difference between the partial equilibrium private and social marginal benefits of investing in this individual's human resources that originates in positive externalities of such investments.

Although externalities are often emphasized as being important, the empirical support for this position is in most respects very weak. The empirical evidence to which reference is usually made includes: (i) micro- and macro- evidence of the association between women's schooling and various household production outcomes (e.g. fertility, mortality, health and nutrition, child education), (ii) micro evidence that average community schooling in the community in which an individual resides is associated with desirable outcomes, and (iii) aggregate estimates that human resources are associated with economic growth or other desirable outcomes.

But much of the evidence of associations between women's schooling and various household production outcomes does not obviously relate to externalities, and some evidence

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[21] To focus on these externalities on the benefit side this statement assumes that the private marginal costs and the social marginal costs are equal.

that more plausibly may refer to externalities does not obviously imply subsidies for human resource investments. A more-schooled mother, for example, may make the time her children spend studying more effective, but that seems to be no more an externality to the family than is more-schooled factory workers making more productive the time spent working by their co-workers is an externality to the factory. If more-schooled women have fewer children, and therefore place less demands on subsidized schooling and health systems, there would seem to be an externality that is induced by public-sector pricing policies. But the first-best resolution would seem to be to eliminate the policy-induced pricing distortion, rather than to invest more in the schooling of little girls, so that in two or three decades they will have fewer children. If more-schooled women keep their family healthier and that reduces the spread of contagious diseases that would seem to be an externality. But, at least for some contagious diseases (e.g. measles), the first-best solution would seem to be more immediate steps, such as inoculations, rather than schooling young girls.

The micro-evidence regarding the impact of schooling of others in the community on various outcomes also is problematic. The available studies are not persuasive that average community schooling is representing external effects of schooling rather than, say, price of time/wage rates or other unobserved community factors. As Manski (1993) has emphasized in his recent review of this literature, it is very difficult to obtain persuasive estimates of such community effects from the types of socio-economic data that are available. There might be some possibility of advancing further in this regard by focusing on individuals who have changed communities (e.g. Bollinger 1991) or by focusing on intergenerational effects, but these approaches, too, may require some strong assumptions about the lack of correlations of unobserved characteristics with schooling of others in the same community.

Most of the aggregate evidence, though often motivated by aggregate growth models that emphasize externalities, by itself provides possible support only for human resources being important, *not* for there being differences between private and social returns. The aggregate estimates that explicitly claim to find evidence for such externalities are dependent upon strong assumptions regarding functional forms to identify external from internal effects, for which reason considerable qualifications seem necessary (e.g. Lucas 1990).

Given the alleged critical role of externalities of human resources and the very limited persuasive empirical evidence of their importance, there might be high returns to efforts to clarify analytically exactly what is the nature of some of these relations and to estimate systematically their magnitudes. There would seem to be some scope for useful analytical clarification, for example, of the widespread sense that if mothers' schooling increases their children's human resources there is an externality or other reason for public subsidies for female schooling. Is the underlying motivation that human resources are thought collectively to be more important than they appear to be individually? That the social rate of discount is lower than the private rate of discount, so that society should subsidize human resource investments in future generations? If this is the case, why should it be desirable from an equity point of view, to transfer resources from present, relatively poor adults to future, richer adults? If human resource stocks accumulated in the past have externalities in the present and in the future, why should not the transfer be in the other direction, so that earlier generations are induced to invest more in their human resources than they would on the basis

of the private incentives alone? Within the whole tax-subsidy system which way are the net transfers? Is the motivation for public-sector subsidies for investing in children primarily a distributional one, since such children cannot determine the degree of the investment in their own human resources?

The systematic estimation of externalities does not seem to be an easy task with available data, though one can think of conceptual experiments that would help (e.g. randomly changing the schooling composition of communities). Some progress might be made by exploiting the observation that what is an externality at one level of aggregation is internal at another level of aggregation. For example, if carefully estimated micro-private rates of return to schooling and carefully estimated rates of return to schooling based on aggregate data are compared, the differences would seem to reflect that the micro-externalities are internal to the aggregate estimates. There would remain other estimation problems, such as controlling for simultaneity and unobserved factors, but perhaps careful analysis could isolate their effects. However, the standard micro-estimates such as those summarized in table 2 indicate much higher private rates of return to schooling than do aggregate estimates. If there were no estimation problems in either the micro-estimates or the aggregate estimates, this would imply that the externalities are negative, which is contrary to the beliefs of most people who work in this area.

I. What is the nature of interactions among human resources?

It would seem *a priori* that there are important interactions among different types of human resources. If children or young adults have better health and longer expected lives *ceteris paribus* their expected returns from investing in other human resources, such as schooling or training, is greater. Better health and nutrition are likely to make time spent in school or in work more productive. Greater education, in turn, may make one more productive in caring for one's own and others' health, perhaps partially by enabling one to obtain new information about relevant health and nutritional developments at lower cost.

More information about such interactions may be useful, because there may be possibilities of developments or policies that affect directly some dimensions of human resources, and it would be useful both from the point of view of prediction and policy analysis to understand how they might percolate to affect other aspects of human resources. However, the empirical investigation of such effects is difficult, given the usual socio-economic data, because of the problems of assessing the impact of one choice variable on another in the presence of unobserved factors (section 3B). For example, there are claims that the evidence is strong that better health and nutrition improves child school performance (e.g. Pollitt 1990). However, the studies based on socio-economic survey data that underlie this claim do *not* control for the possibility that child schooling performance and child health *both* may reflect behavioural choices[22], so that the simple association between them may

[22] There are some good studies based on experimental data that are more persuasive regarding the impact on schooling performance of certain specific dimensions of child health improvements, such as control of parasitic worms.

either under- or over-estimate the casual impact of child health on schooling performance (see Behrman and Lavy 1993). Thus, our knowledge of the impact of child health and nutrition on child schooling performance is much more imperfect and probably biased than seems to be generally realized. As with other topics discussed above, there are possibilities of improving our understanding of the interactions among human resources by more systematic analysis of better data.

J. Are there important productivity-equity trade-offs in human resource investments?

If human resource investments in basic education and health and nutrition have relatively high rates of return, equity and productivity goals can be pursued in harmony through expanding such investments. Such an interpretation is often given to the patterns of rates of return by schooling levels in the standard estimates such as are summarized in table 2. Since the estimated social rates of return are highest to primary schooling, and children who are not in primary schools tend to be from poor households, expanding primary school attendance is desirable on both productivity and equity grounds. If rates of return are higher for investing in female schooling than in male schooling, as at least some studies suggest there may be equity gains (since females have less control over resources than males) in addition to productivity gains from expanding female schooling relatively at the margin. Health and nutrition improvements are likely to have productivity effects particularly for the poor, which provides another example of possible complementarities in pursuing equity and productivity goals.

But in some of these cases the extent to which equity and productivity goals are in harmony might be questioned. For example, the estimates concerning the role of quality versus quantity of schooling in Brazil imply an interaction between years of schooling and the quality of schooling, so that the highest rates of return may be obtained if there are fewer schools of higher quality rather than spreading resources more thinly to assure widespread access.[23] The true social rates of returns to tertiary schooling may also be higher than those for basic schooling if there are large positive external effects of knowledge creation related to higher education (e.g. Birdsall 1993a).[24] Moreover, it may well be the case that the estimates of the returns to basic schooling and training based on historical data might be overestimates of the rates of return to making such education universal, because there has been selectivity regarding ability and motivation, so that the last individuals brought into the system are likely to be very low in the distributions of abilities and motivation. For such reasons, further and more systematic investigation of the complementarities and trade-offs

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[23] A recent study for rural Pakistan, however, reports that the highest rates of return are to making low-quality primary schools more widely available (which effectively means more available to females given the gender gap in the availabilities of rural, primarily single-sex schools), the next highest to increasing the quality of primary schools, and the lowest to expanding middle schools of a given quality (Alderman, Behrman, Khan, Ross and Sabot 1993).

[24] The "social" rates of return in table 2 include both public and private costs but do not include the effects of externalities.

for different human resource investments would be useful for positive economics and for policy analysis.

Section K. Are there political economy effects of human resources?

In some characterizations of the successful east and south-east Asian development experiences of recent decades, human resources play important roles, not only because of their direct productivity impact, but also because of their political economy effects. For example, it has been suggested that the populations were willing to sacrifice current consumption in part because substantial and relatively equitably distributed human resources assured that the benefits of higher growth would be spread widely. It also has been suggested that some of these governments were more or less as interventionist as the governments in other countries with less satisfactory experiences, but interventions were wiser because of the greater human resources of governmental bureaucrats. These and other political economy possibilities are intriguing and merit reflection regarding how they might be assessed, though it would seem that some critical dimensions of such stories are difficult to assess.

Section 5. Issues regarding the determinants of human resources

A. How important is family background in the determination of human resources?

Family background affects human resource investment in a number of ways. It may affect expected marginal benefits through influencing abilities, motivations, prior human resource investments, and the probabilities of obtaining a relatively attractive position conditional on the human resource investment undertaken. It may affect expected marginal costs through altering the facility for financing human resource investments, in light of poor capital markets for such investments, and the opportunity cost of time for such investments.

The importance of family background in the determination of human resource investment is of interest for at least two, very different, reasons. *First*, the more important is family background in determining human resource investments and the more that such family background characteristics are associated directly with the outcomes of interest, the greater the omitted variable bias in standard estimates of the impact of human resource investments. *Second*, some widely (though far from universally) accepted notions of justice emphasize equality of opportunity. Equality of opportunity may be interpreted to mean equal probability of human resource investments independent of family background, though meritocratic interpretations might add "excepting individual abilities and motivations."

Casual observations and the more systematic evidence available suggest that family background does play an important role in the determination of human resource investments. Intergenerational correlations for observed variables pertaining to schooling and health and nutrition across generations are fairly high, and probably higher in most developing countries than in more developed societies. The relatively few studies that control for unobserved variables find that such controls have large effects, so these studies may have estimation

problems due to measurement errors and unobserved individual characteristics.[25] In many developing countries capital markets have changed substantially in recent decades and governmental programmes have been introduced to lessen the importance of capital market constraints related to family background. These changes would seem, *a priori*, to weaken the influence of family background on human resource investments, but the writer is unaware of systematic empirical investigations of these possible changing effects.

For both of these reasons, more extensive evidence regarding the extent and the nature of the importance of family background would be desirable. For the second, equality-of-opportunity, reason, the details of such relations would be useful to know, since they may determine whether some policy response is warranted and, if so, the nature of that response. If mother's schooling is particularly important in determining human resource investments in children, for example, in the interest of equality of opportunity is it desirable to equalize mother's schooling or to minimize its effects?

B. What are the origins of gender differences in human resource investments?

Gender differences in indicators of human resources are considerable, though with considerable variance across countries. In most developing countries males average more schooling than females, though this gender gap has been reduced in recent decades (Behrman and Schneider 1993, King 1990, 1991). Life expectancies at birth tend to be greater for males than females in parts of Asia and North Africa (Sen 1990), but the gender gap is the opposite in most of the rest of the world. How one interprets these gender gaps may depend importantly on what underlies them.

Inter-household differences may account for some of these gender gaps. If it is important to have a surviving son, and a household has a number of children who are females, it may have more children than it would otherwise have in order to have a son, but also invest less in the human resources of all of its children than it would if it had fewer children, which leads to less investment in daughters since they are more commonly in households with more children, under such assumptions.

But much of the gender differences in human resource investments reflect intra-household allocations in light of preferences, prices and expected returns that may differ by gender. A gender gap favouring boys may occur because: (a) parents simply prefer boys in the sense that they place greater value on an outcome such as command over resources associated with a son than with a daughter, (b) the prices of human resource investments are higher for girls than for boys due to gender roles in the family (e.g. caring for sick siblings) or due to lesser availability of schools (e.g. if single-sex schools predominate), and (c) the rates of return that parents receive on investments in boys are greater, in part due to gender roles in providing old-age support for parents. It would seem to make a difference which of

[25] These studies control for such unobserved family fixed effects through having multiple observations on family behaviour or on adult members of the same childhood family. Examples include Behrman and Wolfe (1984, 1987a,b), Behrman and Deolalikar (1993a,b), Behrman and Lavy (1993), Behrman and Sussangkarn (1993), Pitt and Rosenzweig (1990), Pitt, Rosenzweig and Hassan (1990), Rosenzweig and Schultz (1987), Rosenzweig and Wolpin (1988), and Wolfe and Behrman (1987).

these factors is most important in deciding whether it would be desirable to attempt to lessen a gender gap through policy interventions and, if so, how best to attempt to do so.

If preferences are such that human resource investments are weighted differently depending on whether they are in males or females, from a welfare perspective, the rationale for intervention would seem difficult to justify, except by asserting that one's own preferences ought to override those concerned (a position with which the writer is not comfortable). True, one could try to change the preferences so that they were gender neutral, but that would raise the old conundrum about how to evaluate whether the individuals concerned are better or worse off if their preferences have changed.

If the prices or the expected rates of return to human resource investment differ by gender there probably is some other important gender difference, such as in roles relating to care of siblings or of elderly parents. Efforts to change those gender roles directly might raise the same ambiguous questions that are mentioned in the previous paragraph. But there are alternatives of "levelling the playing field" by, for example, improving health care and child care for infants and young children or by improving capital markets so that parents have better options for saving for their old age.

Presently there are relatively few studies that systematically examine the nature of the underlying behaviour that results in gender differences in human resource investments. Subject to assumptions about functional forms, the writer estimates that in rural south India there are gender preferences that favour the health of sons in the lean season (Behrman 1988). Subject to the assumption that all relevant choice variables in the health production function are observed, Pitt, Rosenzweig and Hassan (1990) find that Bangladeshi intra-household nutrient allocations, that have been claimed often to favour males, do not offset work energy demands, so that in fact adult males are taxed by other household members. Subject to functional form assumptions, Pitt and Rosenzweig (1990) find that a significant share of the lower schooling investment in girls than in boys among Indonesian teenagers is due to girls providing child care for sick younger siblings. Subject to the assumption that the availability of single-sex local schools is independent of individual household demands, Alderman, Behrman, Ross and Sabot (1993) find that much of the gender gap in cognitive achievement favouring boys in rural Pakistan is due to a gender gap in the provision of schools.

These and a few other studies have advanced our knowledge about the origins of gender gaps in some developing contexts and have developed strategies for getting at some important issues, despite the limitations of the available information about what happens within households. But they are few in number, for a few societies, and rest on strong assumptions indicated above. Given the possible importance of gender differences in human resource investments from both productivity and equity perspectives, more such systematic investigations are warranted.

C. How important are the market and the macroeconomic contexts?

Human capital investment responds to actual and expected market and macro-conditions through both the expected marginal benefit and marginal cost. The higher are expected

returns to human resource investments in labour markets or elsewhere (due to the nature of macro-policies, international sector policies and complementary investments) the higher are the marginal benefits. If investors are risk averse and can not procure insurance at a low cost, the effective marginal benefits are higher the greater is the expected macro and market stability. Marginal costs, on the other hand, are lower the lower is the opportunity cost of child labour, the cheaper is credit, and the lower are the private costs of schools (controlling for quality).

Imperfections in the capital market, for example, lead to private marginal costs above social marginal costs. With the same configuration of benefits this results in too little human capital investment. Policies to remove the discrepancy between private and social costs are warranted on efficiency grounds.[26] For example, capital markets are often thought to be imperfect for human resource investments because human capital cannot be used as collateral for private loans in the same sense that physical capital can. Moreover, private lenders cannot easily attach the returns to human capital investments in the form of future earnings, particularly in large, mobile societies in which migration and anonymity are substantial. But from the point of view of the government, income taxes can be used to gain repayment of subsidies,[27] so it may be efficient that governmental interest rates for human resource investments are lower than private rates or that the government initiate a low-cost loan programme for human resource investment.

Empirical knowledge about the roles of these market and macro-determinants and the implications for better policies again are limited, though there are some suggestive studies. Rosenzweig and Schultz (1982), for instance, find that gender differences in mortality in India respond to gender differences in expected labour market opportunities. Alderman, Behrman, Khan, Ross and Sabot (1993) report that the cost of travel to school is particularly important for girls in rural Pakistan. But, again, more such careful studies would be useful.

D. How effectively are human resource-related services provided?

Many human-resource related services are provided by public or publicly-subsidized institutions: schools, clinics, hospitals, extension services, training centres. Much commentary suggests that often such institutions may not provide such services in a very effective manner.

To be concrete, we consider the explicit example of schools though the general approach and many parallel results apply to institutions that provide other human resource-related services. If the school authority had perfect knowledge of all the relative incremental social values (prices) of inputs and outputs and of the production technology and information were free, it simply could issue regulations to the schools and monitor their implementation effectively to produce the socially optimal combination of, for example, increments to

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[26] Abstracting from the distortion and resource costs of such policies, which need to be incorporated to come to a decision about the merits of these policies.

[27] Though such taxes also might shift the private marginal benefits curve downward, depending on their form (e.g., more so if they are progressive).

reading and mathematics ability by purchasing the right combination of material and teachers' services. But the real world is much more complex and information is quite imperfect and costly. Therefore, there may be an important role for studies that attempt to improve the informational basis for choosing schooling policies. Most existing studies that are explicitly concerned with measuring the effectiveness of schooling can be viewed as efforts to estimate school production functions, perhaps with explicit use of such estimates for cost-benefit analysis.

The currently available empirical evidence on school production functions, however, strikingly indicates how little is really known about what specific inputs improve schooling achievement. Among the six variables summarized from 96 studies in table 3, none has statistically significant positive effects in more than two-thirds of the studies and only half of them, facilities, teacher education, and expenditure per student (with the last of these based on relatively few studies), have significantly positive effects in half of the studies. The teacher/pupil ratio that is widely used as an index of the quality of schooling has significant coefficients in half of the studies, but the sign is the opposite of that presumed in half of these significant cases. These and other related results suggest that there are some specific inputs into schooling that appear to have fairly widespread impact, namely instructional materials (which is not included in table 3), teacher education and facilities. For some of these specific inputs, the returns to improvements may be quite high (e.g. Hanushek, Gomes-Neto and Harbison 1992 estimate that improved textbooks and other materials would have a 10-to-1 payback by reducing grade repetition in northeastern Brazil). There is evidence also in several studies that school effects are much larger than the effects of specific identifiable inputs (e.g. for rural Pakistan, Behrman, Ross, Sabot and Tropp 1991; for Brazil, Harbison and Hanushek 1992). That is, some schools are much better at teaching students than others for reasons that are not very clear from the available quantitative studies. This means that there is the potential for increasing substantially the effectiveness of school systems if better practices are adopted widely.

But the lack of much knowledge of exactly what constitutes better practices makes it unlikely that directives or regulations from above will lead to substantial improvements. Better evaluations of schooling practices may help, particularly with improved data and estimation procedures since most existing studies do not address estimation problems very well. But what may be useful also is the creation of incentive systems to induce better practices, that is incentives that reward schools and the teachers and staff that do well by linking rewards to the value added of schooling.[28] There are difficult questions about how to measure teachers' performance without introducing distortions, and how to make schools more responsive to demands, but it appears that the potential gains may be considerable.

One institutional change that *a priori* might make schools more responsive to demands, and thus more effective, would be to increase dependence on private schools. Simple comparisons of outcomes between private and public schools do not provide an empirical test

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[28] The apparent limited effectiveness of teachers' salaries in table 3 is not evidence against such a strategy, since these results are derived from experiences in which teachers' salaries generally have *not* been linked to performance, but to credentials and tenure.

Table 3. Summary of educational production functions for developing countries

	Percentage distribution			Number of studies
	Positive significant effect	Negative significant effect	Insignificant effect	
Teacher/pupil ratio	26	26	48	31
Teacher education	55	3	42	64
Teacher experience	34	4	62	47
Teacher salary	29	14	57	14
Expenditure per pupil	50	0	50	12
Facilities	66	8	26	35

Source: Based on summary of 96 studies in Harbison and Hanushek (1992, table 2.2) updated to include their own results.

of the relative effectiveness of private schools, however, because in most countries students in private schools on the average come from better family backgrounds than students in public schools (even if in a number of cases the very best students go to elite public schools). Recent studies for five developing countries attempt to control for selectivity in who attends private schools. They find that private schools, nevertheless, are much more effective at producing test score improvements and attributes that are rewarded by higher wages, apparently in part because of better access to textbooks and in part by recruiting teachers with lower formal qualifications, giving them more in-service training, and promoting better teaching practices regarding homework, testing and order in the class room (Behrman, Sussangkarn, Hutaserani and Wattanalee 1993). However, such observed school characteristics account for only part of the difference. An important policy implication may be to mimic the incentive structures of the private schools, including decentralization and the introduction of mechanisms (such as vouchers) that encourage schools to be more responsive to the needs of students and parents.

There are a number of methodological questions concerning existing studies of school production relations. *First*, most existing studies are not sensitive to their use of selected samples, such as only students in school or only students in certain types of schools (e.g. private versus public, general versus technical-vocational) or to the importance of unobserved variables (e.g. motivation, ability in many samples). *Second*, to the writer's knowledge none of these studies control for the endogeneity of decisions regarding the distribution of school resources differentially across communities and neighbourhoods. But if public programme resources are distributed in response to community characteristics that cannot be directly observed in the available data (e.g. political power), failure to control for those characteristics can and in fact, in some cases, does result in considerable biases regarding the effectiveness of those resources (e.g. Rosenzweig and Wolpin 1986, Gertler, Molyneaux and Hatmadji 1992 and Pitt, Rosenzweig, and Gibbons 1993).

Third, many existing studies are not very careful about specifying relations to be estimated that appear to be production functions with an output as the dependent variable and

a set of inputs as the right-side variables, but instead include both inputs, such as teacher quality and materials and textbooks, and variables that may determine inputs, but are not directly inputs themselves, such as family income, which makes interpretation difficult. *Fourth*, the data that are used to represent both the outcomes and the inputs are imperfect and some of the desired data are missing, but there is relative little attention to missing variable and measurement problems in most of this literature. *Fifth*, many of the studies that are summarized in table 3 do not present enough information to allow very satisfactory evaluation of the returns from changing various inputs, because they do not translate the production relation estimates into comparable measures, such as cost-benefit ratios or internal rates of return.[29,30] And many of those that do calculate rates of return do so under partial-equilibrium assumptions that the change that is investigated has no effect on the marginal values, or prices, that society places on inputs and outputs so that, in Hoehn and Randall's (1989) words, "too many proposals pass the benefit cost test".

These problems suggest that there may be gains from better school production function studies. But the estimates to date also suggest that there may be important gains from encouraging a range of institutions to provide schooling services by eliminating many of the restrictions and practices that discriminate against innovation and market responsiveness. To obtain distributional objectives and to lessen differentials between private and social incentives due to any positive externalities concurrently, payment systems such as school vouchers and arrangements that depend more on local finance might be implemented.[31] Public subsidies might also be directed at improving information about the value added of different schools, since private markets are not likely to provide sufficient information because of the public good characteristics of information itself. In certain contexts, such as very specialized education or school activities in remote areas, moreover, public policies may be sufficiently important to offset the negative effects of concentration of market power. But a focus on such activities would imply a substantial change in the way in which schools are organized and regulated in developing countries, with much greater emphasis on complementary activities of markets and market-like institutions to induce greater

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[29] There are a few exceptions including cost effectiveness comparisons of alternatives in Hanushek, Gomes-Neto and Harbison (1992) and Jimenez, Lockheed and Paqueo (1991), and rates of return (by linking the cognitive production relations results both to costs and to labour market wage/productivity effects) in Alderman, Behrman, Khan, Ross and Sabot (1993).

[30] Though it is somewhat disconcerting to read in World Bank (1990b, p. 6): "Although strong arguments can be put forward for wider use of rate-of-return analysis in evaluation education projects, these techniques are not much invoked, and acceptance of projects is more often based on other criteria such as meeting manpower targets." This is disconcerting since "meeting manpower targets" is likely to imply criteria that are not necessarily consistent with the efficiency concerns that are emphasized in this essay, as well as being based on very uncertain targets that are likely to be generated under assumptions of much greater rigidities in the economy than actually exist.

[31] Recent studies by Jimenez (1993) for the Philippines and James, King and Suryadi (1993) for Indonesia suggest that, having some local finance is associated with improvements in performance of schools, though only the second of these syudies attempts to separate causality from association.

effectiveness and concentration of governmental policies in areas in which market failures are likely to predominate.

While this section has focused on schools for concreteness, the same set of issues regarding the methodological difficulties in the evaluation of effectiveness, and limited knowledge about what causes effectiveness; how to improve information and how to improve the incentives for effectiveness are important also for other human resource-related service institutions, such as clinics, hospitals, and training organizations.

Conclusions

The development of human resources is increasingly seen as critical in economic development, whether human resource enhancement is seen as the essence of the development process or as a means towards increasing productivity and equity. This increased emphasis originates in part from applied analysis of the roles of human resources in developing countries, and in part from the "new economic growth" literature in which human resources play a critical role in productivity growth, because of externalities and increasing returns to scale to human resources and the learning-by-doing associated with certain products.

This literature and casual observations have spawned a rich range of hypotheses about the determinants of human resources and the impact of human resources in developing countries. There have been a myriad of empirical studies, both using micro-data and aggregate data, that purport to investigate these hypotheses, and such studies are becoming available at increasing rates. As a result, we can be confident about many *associations* between human resources and various background factors, policies, and market and non-market outcomes of interest.

Yet we know surprisingly little about *causality*, both regarding the magnitudes of factors that determine human resources and the magnitudes of the effects of human resources on different outcomes in various contexts. We know so little because so many of the studies are based on inadequate analytical frameworks and data with either no or limited efforts to control for estimation problems, such as omitted variables, simultaneity, selectivity, and measurement errors, that may cause substantial biases in empirical estimates. In a number of cases in which there have been controls for such possible problems, a comparison of the resulting estimates with standard estimates suggest that such controls affect importantly our understanding of human resources and development, both from a positive perspective and in terms of possible policy prescriptions. With regard to policy evaluations and recommendations, moreover, the existing literature also lacks clarity, particularly regarding the efficiency reasons for policy interventions. For example, often it reads as if it were sufficient to show an impact (preferably a large impact) of human resources on desired outcomes to warrant policy support, with little or no attention paid to the need to identify distortions between private and public incentives to justify considering such interventions on efficiency grounds. It is true that there is frequent appeal to externalities, but repeating the mantra "externalities" is not a good substitute for systematic analysis of what constitute externalities, their magnitudes, and what policies are likely to be high in the policy hierarchy.

Looking forward, the limited present knowledge regarding causal relations between human resources and development would seem to have two major implications. *First*, given the present imperfect information, and given that information is *always* likely to be imperfect, asymmetrical and not necessarily timely, in terms of policies it seems desirable to develop and support institutions that are more compatible with incentives. This probably means relying more on markets and improving markets when the social returns of doing so are high, rather than engaging in so much direct production and regulation of human resource-related services and the uses of human resources. But it also means focusing government activities where the government is likely to have a comparative advantage because of distributional concerns or market failures, such as providing and analyzing information; preventing unregulated local monopolies; providing essential infrastructures; supporting experiments regarding the development of human resources and publicizing their results; subsidizing human resource activities where there is good evidence of externalities (e.g. contagious diseases); and supporting human resource investments in the poor through schemes such as vouchers that increase the pressures for efficiency. For many governments such a focus would represent a considerable shift in their approaches to human resources and development.

Second, there is scope for a considerable improvement in the analysis of human resources and development by building on improved analytical frameworks, better data, and better control for estimation problems, as well as by being more systematic about inferring the possible policy implications of such analysis. Given the public good aspect of such knowledge, and particularly of the information required for good analysis, there is a strong argument for public support for this process, both at the national and the international level. As is discussed extensively in this paper, more systematic studies with better data could be enlightening on the whole range of important questions regarding the impact of and the determinants of human resources in developing countries.

Appendix 1. Aggregate Human Resource Data[32]

Schooling investments: The most used data for primary, secondary and tertiary enrolment rates are compiled by UNESCO, primarily from annual reports of ministries of education, which present four principal problems that probably cause systematic overestimation of schooling investments for lower per capita income countries with lower adult literacy, that biases downward the estimated impact of schooling on other outcomes and biases downward the estimated impact of income and other variables that are positively associated with development on schooling investments. *First*, enrolment rates often reflect opening day enrolment rates, not regular attendance, with the difference inversely associated with development. *Second*, for many countries only gross enrolment rates (i.e. enrolments in a school level of individuals of all ages relative to the census-estimated population for the age range thought appropriate for that school level) are available, rather than net enrolment rates in which the age range for the numerator is the same as for the denominator. For countries that have both (these tend to be more developed), the ratios of the two vary considerably, because of considerable differences across countries in age when starting school and in grade repetition. For some research questions net enrolment is the more appropriate concept, but the countries for which such data are available are relatively few (though increasing rapidly recently) and tend to be more developed.

Third, different starting ages for school and different durations of schooling levels further make cross-country comparisons difficult. *Fourth*, enrolment rates address only the quantitative, not the qualitative, dimension of schooling investments. Differential schooling quality across countries at a point in time and changing schooling quality over time would seem to be important, but aggregate data are not readily available with which to make satisfactory comparisons of school quality over time or across countries. Possible quality indicators that UNESCO presents include only student/teacher ratios and central governmental expenditures on schooling. Teacher/student ratios over a broad range do not seem to be strongly related to the value added of schooling systems (Hanushek 1986, Hanushek and Harbison 1992), and the extent of schooling expenditures by other governmental levels and by private individuals varies considerably across countries, and in some cases within countries over time (in addition to the problems of appropriately converting such expenditures into common terms, see Srinivasan 1994).

Schooling stocks: For many purposes, such as investigating the determinants of growth or of health changes, schooling stocks are of interest rather than schooling investments (though a number of studies use enrolment rates in such contexts). There are three basic types of measures available of the stocks of schooling, adult literacy, adult schooling attainment collected directly in censuses or surveys, and adult schooling attainment series constructed from time-series of census or survey-based enrolment data.

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[32] For more details see Ahmad (1994), Behrman and Rosenzweig (1993, 1994), Bouis (1994), Chamie (1994), Heston (1994), and Srinivasan (1994). To explore relations between human resources and development, indicators of development also are needed. The most common indicator, per capita income, also has a number of problems of comparability that are discussed by Ahmad, Heston and Srinivasan.

(a) *Literacy*: UNESCO summarizes literacy data, with which there are at least three problems: *First*, definitions of literacy differ across countries and over time within countries. *Second*, the actual data on which available literacy measures are based often are sparse and dated and are selectively more available for more developed countries. UNESCO (1991, table 1.3), for example, gives for 141 countries and territories the year of the last census or survey for literacy data. The variance is considerable across countries, with the median experience being a census or survey over a decade earlier in 1980 and with 19 countries or territories (18 of which are in Africa) with no such survey in 1970 or later (and with significantly more and earlier literacy measures available for higher per capita GDP countries than for lower per capita countries). Estimates of the relation between literacy and variables, such as per capita GDP, moreover, change substantially if "constructed" literacy data are used instead of only the direct empirically-based literacy data (Behrman and Rosenzweig 1994). *Third*, conceptually literacy represents only one major dimension (i.e. not numeracy, nor more advanced knowledge) of basic schooling with little variance across the more developed economies by conventional measures, even though causal observations and enrolment rates suggest that schooling stocks may vary considerably.

(b) *Direct census- or survey-based schooling attainment*: UNESCO also summarizes the distribution of the population 25 years of age and older by levels of schooling attainment. This measure, however, is limited to the relatively small number of censuses and surveys that are available for a wide variance of years across countries, similar to the problems with the literacy data. UNESCO (1991, table 1.4) also notes additional problems of comparability across countries: for 14 countries the age range differs (usually including younger ages but in two cases excluding older ages), in five cases "not stated" is combined with no schooling, and in nine cases illiteracy is interpreted to be no schooling. Moreover, this indicator has the same problems as the school enrolment data with variations of schooling duration for different schooling levels across countries and over time, with variations in schooling quality, and with the ignoring of non-schooling education.

The data gaps in the available adult schooling data have led researchers to construct schooling data series. Barro and Lee (1992) have constructed quinquennial time series data from 1960 through 1985 for 110 countries using census data. These estimates are based on one or two actual observations for 44 countries and three or fewer actual observations for 82 countries; thus most of these data are estimates.

(c) *Enrolment-based schooling attainment*: A third indicator of schooling stocks that has been developed and used recently is the average stock of schooling for adults calculated by the perpetual inventory method based on time series of schooling investments (enrolment) data. Lau, Jamison and Louat (1991) calculated such a measure for adults aged 15-64 under the assumption that the schooling capital stock was zero in 1900 (which has no important effect on the schooling stock in the post-1960 period in which they are interested); that country-specific primary and secondary school enrolments for the period before 1960 followed the same secular trends as those in the post-1960 period (generally 1960-87) so that estimates of these enrolment rates can be backcast (subject to the constraint that they be non-negative); that there is no depreciation in the stock of schooling; and that mortality and international migration for the 15-64 age range are not dependent on schooling.

Dubey, Swanson and Nehru (1992) have recently revised the Lau et al. annual estimates of the schooling stock for adults aged 15-64 based on longer time series of enrolment rates (back to 1930 for most countries and 1900 for several), estimated repeater and drop-out rates and estimated age-specific mortality rates for 85 countries for the 1960-1987 period. Kyriacou (1991) also has constructed a time series of schooling stocks for adults quinquennially over the period 1965 through 1985 using a similar procedure, although the range of countries varies in each quinquennia from a minimum of 69 to a maximum of 95. These estimates are, of course, subject to the problems with the underlying enrolment data discussed above, which may result in schooling attainment measures being too high and measurement errors that are systematically related to economic growth. Moreover, there is limited information on grade repetition and on mortality rates (the former of which Dubey, Swanson and Nehru suggest is particularly important based on their sensitivity analysis).[33]

Though the simple bivariate correlations among these measures of adult school stocks for common years and countries are all fairly high (above 0.8), country/year coverages differ substantially across the series in ways that are selective regarding economic and demographic developments (Behrman and Rosenzweig 1993). These data differences result in some different coefficient estimates for adult schooling across data series if schooling stocks are used as the right-side variables in estimates of the relationships of schooling with various economic and social variables, such as real per capita GDP, infant mortality rates, total fertility rates, and life expectancies at birth. Thus there has been and is likely to continue to be a pay-off to improving these series since the use of many of them may cause biased inferences.

Mortality, life expectancies, health and nutrition: Data on estimated life expectancies and on infant and child mortality rates have been used regularly for cross-country studies[34], but again have problems of comparability: *First*, definitions differ. Some, primarily poorer, countries require that an infant survive at least 24 hours before being counted as a live birth rather than a late foetal death, which causes a reduction in the reported birth rate and a greater reduction in the reported infant mortality rate in such cases than would occur if the 24-hour restriction were replaced by a zero hour restriction. The result is a less strong estimated inverse relation between per capita income and fertility and between per capital income and mortality than would occur if all countries used status at birth to define births and deaths. *Second*, there are different degrees of completeness of population data collection. For most of the more developed countries, death rates and life expectancies are based on national registered deaths and official population estimates, which are believed to be virtually complete. In the beginning of 1992, by contrast, registered data on deaths and infant deaths

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[33] Recent information collected in a special UNESCO/OREALC survey on repetition rates in Latin America and the Caribbean, for example, suggests that official-reported repetition rates for primary schooling are only about half the survey rates, though with a lot of variations across countries in the discrepancies between the official and the survey rates (Schiefelbein and Woolf 1992).

[34] Data for cross-country comparisons of direct indicators of health and morbidity have not been readily available. World Bank (1993, Appendix B) summarizes new WHO-World Bank estimates of the global and regional burdens of disease based on disability-adjusted life years (DALYs) that seem to represent a definite improvement in this area, but which are not yet widely available to researchers.

are estimated to be complete in approximately 70 per cent of Latin American countries, 18 per cent of African countries, and 21 per cent of Asian countries.

The countries with incomplete, defective or nonexistent vital registration data are countries generally with higher mortality and lower per capita income. These countries use estimation techniques with incomplete vital registration data or with other mortality data collected in censuses or sample surveys. Therefore, most of the values cited in UNDP (1990) or World Bank (1990a) for these countries in the mid-1980s are in fact extrapolations from previous censuses rather than direct observations.

The physical input measures that affect health and nutrition that are readily available for cross-country studies are limited indicators of the availability of health personnel and of calories. The health personnel measures are from censuses and surveys, and thus again the values for particular years often are extrapolations or interpolations. Because these are stocks, however, this is likely to be less of a problem for concerns with broad associations or changes over fairly long periods than it would be for analysis of shorter-run variations. Nevertheless, there are differences across countries and possibly over time within countries in the definitions of such categories such as "physicians" and "nursing persons." The availability of calories is based on FAO balance sheet calculations that have varying errors across countries and over time as a representation of actual caloric inputs, because of their focus on basic calorie sources and because of differences in losses due to waste, insects, and rodents. Another set of available indicators for cross-country comparisons related to health pertain to central governmental expenditures on (i) health and (ii) housing, amenities, social security and welfare as percentages of (i) total central governmental expenditures and (ii) GNP. These measures are subject to limitations parallel to those discussed above for central governmental expenditures on schooling. Central governmental expenditures on health typically are but a part of the total expenditures on health (e.g. World Bank 1991, Table 3.4 suggests an average of 40 per cent for low-income countries for which data are available and 36 per cent for middle-income countries for which data are available).

Such considerations suggest a number of additional problems with aggregate data beyond those for micro-data and that investments in data quality, in the data infrastructure of individual countries, particularly in low-income counties where data are scarce, would have a high pay-off for improving our understanding of the determinants and consequences of human resources in the development process.

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