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CENTER DISCUSSION PAPER NO. 720

EVALUATION OF INTEGRATED HUMAN  
RESOURCE PROGRAMS

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February 1995

**Note:** Center Discussion Papers are preliminary materials circulated to stimulate discussions and critical comments.

This paper was originally prepared for the World Bank as a background to the Human Resource Strategy Paper, "Investing in People," Human Resources Development and Operations Policy.

The author appreciates the comments on a previous draft from G. Psacharopoulos, H. Patrinos, R. Chase, A. Judd, G. Ranis and other participants at Bank workshops.

## **Abstract**

Human resource programs are evaluated by comparing the productivity of individuals who have benefited from a specific program to the productivity of similar individuals who have not had this benefit. To implement such an evaluation may require a model of the demand of households and individuals for several distinct forms of human capital, of how public agencies and private firms work with households to produce these forms of human capital, and of how these investments increase the lifetime productivity of individuals and thereby contribute to economic growth and socio-demographic development. This paper proposes to estimate an integrated wage function that provides the policymaker with a basic tool for simulating the private and social returns to human resource stocks, specifically those in schooling, vocational experience, child nutrition, migration, adult health and nutrition and family planning.

**KEY WORDS:** Human Capital, Program Evaluation, Education, Nutrition, Health

## **I. Individual Productivity Effects of Human Resources**

Human resource programs are evaluated by comparing the productivity of individuals who have benefited from a specific program to the productivity of similar individuals who have not had this benefit. To implement such an evaluation may require a model of the demand of households and individuals for several distinct forms of human capital, of how public agencies and private firms work with households to produce these forms of human capital, and of how these investments increase the lifetime productivity of individuals and thereby contribute to economic growth and socio-demographic development. This paper proposes to estimate an integrated wage function that provides the policy maker with a basic tool for simulating the private and social returns to human resource stocks, specifically those in schooling, vocational experience, child nutrition (proxied by adult height), migration, adult health and nutrition (proxied by adult weight given height), and family planning (proxied by avoided unwanted births). To complete the task of program evaluation, the policy maker must provide information on the value of public sector subsidies and private household resources used to produce the various forms of human capital.

Many studies of education, nutrition, health, labor mobility, and training have sought to measure the contribution of these forms of human capital to the productivity of workers and to modern economic growth. The base of knowledge in this field is growing rapidly but is unavoidably qualified because returns to investments in human capital are only realized over a lifetime. In addition, without true social experiments designed to assess how randomized policy interventions work through the actions of the family and individuals, statistical estimation of causal relationships may be biased or conditional on hypothetical structural models. Microeconomists and other social and biological scientists have examined the economic and physical functioning of individual workers with different characteristics, while macroeconomists have analyzed aggregate output, measures of labor inputs, and the economic growth experience of nation states. A consensus has been forged that recent periods of sustained growth in total

factor productivity are critically dependent on improvements in a population's nutrition, health, education, and mobility.

Analysis of these forms of human capital must now be integrated to measure with greater precision their distinct effects on economic development, because stocks of human capital acquired by individuals may not be independent: they potentially interact with each other in their impact on the productivity of the worker, and they are often subject to diminishing (or increasing) returns. Traditional semi-log-linear approximations for wage functions should, therefore, be extended to more flexible specifications that allow for returns to vary and interactions to exist among several forms of human capital in addition to education.

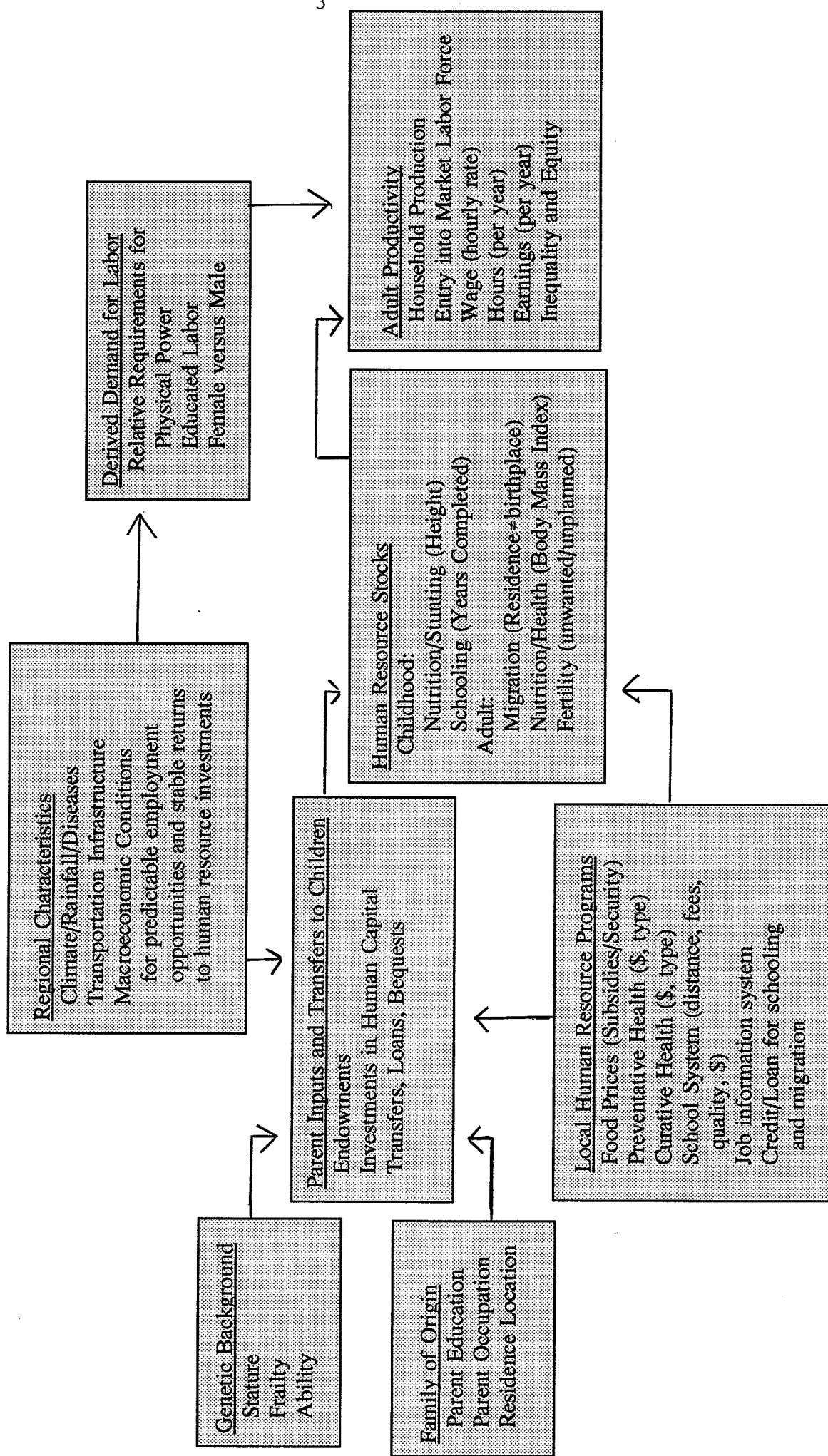
Finally, in considering the effects of human capital on development, we are primarily interested in how state and family investments influence the formation of reproducible human capital and how it in turn impacts on labor earnings and growth. The exogenous skills and genetic endowments of workers that are largely unaffected by state and family actions are less central to our objective, except as they mask or modify measured returns to the reproducible component of human capital.<sup>1</sup>

Figure 1 illustrates the overall system that constrains parents whose resources and preferences govern, for the most part, investments in their children's human resources. These human resource stocks are then expected to influence their children's lifetime productivity, and other outcomes, given the aggregate economy's derived demand for the different types of labor services the children can offer. The objective of the integrated program evaluation approach

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<sup>1</sup>Do the endogenous components of the variation in human capital exert the same "effect" on labor productivity as do the exogenous endowments? If they differ, it is the productive effects of endogenous reproducible human capital that policymakers need to know. Specifically, much of the variation in height, for example, is due to genetics. It is not clear whether differences in this genetic endowment have the same productive effect on workers as do differences caused by variation in childhood health and nutritional investments. Specification tests can be implemented to assess whether different sources of variation in human capital stocks are exogenous or endogenous, and thus whether specific forms of human capital are justifiably treated as exogenous or endogenous variables when estimating extended wage functions (Schultz, 1994).

**Figure 1: Human Resource Programs and Their Consequences on Productivity**



is to measure two connections: (i) the impact of the human resource stocks on adult productivity (i.e., wages); and (ii) the opportunity cost of social resources expended on human resource programs (or perhaps infrastructure) to modify human capital investments. The social policy maker needs to assess the social internal rate of return earned by these human resource programs, or the discount rate that would reduce the present value of the extra wage returns associated with the human resource stocks to the present value of the marginal expansion of public subsidies needed to create these stocks. A number of conceptual and statistical issues arise in jointly estimating without bias these two behavioral and technical linkages in a specific setting.

## II. Individual Productivity Function

Social resources are used to produce stocks of human capital that enhance the productive capacity of the individual over the long run. How individuals allocate their productive capacity -- whether they make further investments in themselves, work in the home, work in the labor market, or engage in leisure activities -- should not necessarily influence how we measure the private or social return to that human capital. Because of the difficulty of assigning a value to the output of labor in self-employment, home production, or leisure, it is a common practice to analyze (following a procedure Heckman (1979) first proposed) the market productivity of persons who work for a wage in the labor market, and then correct for any bias that may arise from analyzing only this selected sample. The critical requirement to correct for sample selection bias is that there is some observed variable known to affect the probability of working for a wage, but not to affect the market-offered wage. The potential correlation across individuals between the errors in the market wage equation and the wage participation equation is responsible for the sample selection bias (Schultz, 1993).

A natural choice for an exclusion restriction that could identify the sample selection procedure is a variable that affects only the individual's marginal productivity in nonwage production, or the individual's utility from

leisure, or both, but is uncorrelated with the market wage. Inherited land, business assets, or wealth raise the individual's productivity in nonwage activities and thereby decrease the probability she or he would work for others as a wage earner. By assumption, these wealth variables have no effect on market productivity or the wage offer, nor should these wealth variables be determined by the market wage, or past labor supply and savings behavior.<sup>2</sup>

Individuals who are observed not to work for wages are assumed to value what they produce with their time more highly than the market wages they could receive. It is common to assume that the variables which are observed to influence market wage opportunities, such as education, also affect nonwage opportunities, roughly in the same proportion. Without more information on the structure of the nonwage production function and the utility function, the market wage function is assumed to determine the marginal productivity effects in wage and nonwage activities of human resource investments.<sup>3</sup> These productive effects are then independent of how time is allocated between wage and nonwage activities. This assumption may be particularly important for evaluating how human resource programs enhance the productivity of women because only a small share of adult women in many low-income countries work for wages. More research

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<sup>2</sup>Actual correlations do not inform us of the validity of an identification restriction. Nonetheless, the expected negative sign of the effect of the identifying wealth variables in the wage participation equation might be reversed (to positive) if the wealth variables were in fact endogenous to the household demand system and reflected the accumulation of wealth from having received a high wage in the past. In my experience, the land and business asset variables usually are negatively associated with wage participation in low-income countries, given the educational attainment and age (i.e., postschooling experience) of the individual (Schultz, 1993). A positive coefficient for the wealth variables in the wage-participation function might suggest that this choice of identifying restriction was invalid.

<sup>3</sup>The productivity of labor in nonwage activities for those who do not participate in wage activities can be inferred only if the functional form of nonwage marginal product function is known, and its identifying argument known and observed. If the underlying nonwage (home) production function is subject to constant returns to scale, as postulated by Becker (1965), the inframarginal producer surplus in nonwage production accruing to labor would be zero, contrary to Gronau's (1977) suggestion. However, some investigations of wage participation find that it increases in education, nutritional/health status, and migration. This could be interpreted as evidence that the marginal productivity of some human resources is greater in wage than in nonwage activities (Schultz, 1989; Schultz and Tansel, 1992; Schultz, 1994).

should assess the adequacy of these methods for inferring the productive gains from human resources.

The wage function is determined by several types of conditioning variables. First, there are initial abilities, which may be thought of as genetically determined or at least not affected by the input of family or public resources.<sup>4</sup> Second, there are several dimensions of human capital, which are produced means of production, formed jointly by family and individual private inputs of time and goods and by public inputs of goods and services, typically provided in the region of residence. The production possibilities to create human resources are constrained by biology, technology, and perhaps, in the short run, by organizational limitations.

The third type of variable entering the human resource production function is age or experience.<sup>5</sup> Experience acquired after completing school is expected to enhance initially labor productivity. Mincer (1974) found a quadratic

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<sup>4</sup>In the initial exploration of variations in the Mincerian wage functions, much effort went into assessing the bias to the schooling coefficient caused by the omission from the wage function of the individual's initial ability, or IQ for short. It is clear that if ability increases the amount of schooling received, and ability increases productivity holding schooling constant, then the omission of ability will tend to bias upward the estimated schooling return (Griliches, 1977). However, subsequent studies have also indicated that using a variety of family variables in an effort to "pick up" ability and family effects can introduce an offsetting downward bias on the estimated schooling return (caused by errors in measurement of the true [quality adjusted] education) which is larger than the omitted variable upward bias (see e.g., Lam and Schoeni, 1993). In the situation being analyzed here, the ability must be exogenous to the family and public human resource investments. It is difficult to imagine how the social statistician can measure ability before it is affected by schooling or by the family's preschool investments in the child's capacities. Because the ideal experiment to isolate the "ability bias" is so difficult to perform, considerable analysis has focused on the study of homozygotic twins, who share initial genetic capacities (e.g., Ashenfelter and Krueger, 1994).

<sup>5</sup>Because education is assumed to be exogenous to the wage function in Mincer's specification, and age is exogenous, this measure of potential postschooling experience is exogenous. The implicit assumption is that all activities engaged in after leaving school contribute equally to later market productivity. When experience is adjusted for period of nonparticipation, as would seem plausible in the case of intermittent female workers, this actual experience variable becomes endogenous because it depends on lagged labor supply. If such an actual market experience variable is added to the wage function, actual experience and such related variables as job tenure must be treated as endogenous, and estimation may then depend on some (lagged) instrumental variables that are independent of the current period wage function error but related to the actual experience variables.

function in years of potential postschooling experience (i.e., age - years of schooling - seven or eight) approximated reasonably well U.S. male earnings data from the 1960 Census. This quadratic specification could be derived from a model in which the value of a worker's time invested in on-the-job training declined linearly with postschooling experience. With sufficient data, higher-order polynomials in potential postschooling experience may also be added to improve the empirical fit of the wage function to wage data.<sup>6</sup> For other human resource accumulation processes, such as gestation, birthweight, height, weight-for-height, but probably not migration, biological age may be more relevant than postschooling experience. When education is treated as endogenous, then postschooling experience also becomes endogenous, and experience may be replaced by an unrestricted polynomial in age.

### III. Types of Human Capital

In this section I propose five forms of human capital that may increase the lifetime productivity of a worker, although the relative returns to different types may vary by income and technological stage of the society, and each type may, after a certain point, be subject to diminishing returns. The first is net childhood nutritional status, which is measured by early physical growth and development, such as height-for-age and weight-for-height. It is believed that height at the fourth birthday is already a good predictor of an individual's final adult height (Martorell and Habicht, 1986). Adult height is, moreover, an important determinant of adult productivity, and reemerges as inversely correlated with chronic health problems among the middle-aged and elderly (Fogel, 1991). Finally, height is inversely related with mortality and consequently length of productive life. In addition to improving adult productivity and

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<sup>6</sup>Murphy and Welch (1990) found that a quartic function was justified in fitting male wage profiles from large Current Population Surveys from the United States in the last two decades. The choice of functional form to summarize wage and earning profiles tends not to be critical, i.e., whether quadratic or cubic. But if postschooling experience is replaced by age, internal rates of return to education can no longer be inferred directly from the wage function coefficient on education, but must be adjusted for different amounts of age for the same individual. Also, experience tends to fit log wage data better than age, when both are expressed in quadratic form.

health, childhood nutritional status may also enhance the performance of children in school and in early training tasks, and thereby affect the return to other human capital investment activities (Behrman, 1993; Moock and Leslie, 1986). Alternatively, the covariation of nutrition and school achievement among children might be caused by unobserved heterogeneity of families and children, as would occur if credit constraints or preferences affected families in their investments in both nutrition and schooling.

Nutritional status in childhood is the sum of several factors, of which nutritional intake is probably the most important. Another is the exposure to infection and disease, which places extra demands on nutritional inputs and reduces the efficiency with which the body can absorb nutrition, such as through the incidence of diarrhea, or develop immunities. The child's work load can also place different demands on diet. Poor nutritional status is revealed in adults who are stunted, or experience a deficit in their mature height. This adult measure of height appears to be relatively stable after maturity from about age 18 to 50.

The second form of human capital is schooling. Children start school at very different ages, from age 5 to 10, and continue for different numbers of years, including repetitions. The length of school terms and the number of hours a day the school provides instruction varies across and within countries. The attendance of "enrolled" pupils during the regular school term is also far from uniform. If there were a consensus on how to measure school quality per hour attended, this would also exhibit substantial variation. Consequently, describing investments in schooling by "years completed" is only a first-approximation that urgently needs to be extended and refined in many directions.

The third form of human capital is migration, which may occur repeatedly over a lifetime and involve return migration. To simplify, I focus here on any movement of adults from their region of birth, which most often occurs in the first few years after completing school. Migration occurs more frequently for more educated individuals (Schultz, 1982), suggesting again two alternative hypotheses. Education and migration may be complementary forms of human capital,

or families that invest more in the education of their children also are more likely to finance their migration, possibly because they face a lower cost of investment funds (Becker, 1967), or because they simply have a stronger taste for child human capital. Much of the return to education for a rural-born individual may be realized only through migration, suggesting a close linkage between these investments (Schultz, 1988a). Returns to a variety of human resource programs may therefore be measured more precisely by joint evaluation. If migration occurs first in order to continue secondary or higher education, because these forms of education are only provided in some urban areas, the chronological and causal order of these two human resource investments may be difficult to disentangle. Migration may not be as closely associated with increasing market-productive opportunities for women as for men because families often move together, and collectively families may assign greater weight in the choice of destination to the earnings opportunities of males rather than females (Mincer, 1978).

The fourth form of human capital is the means to avoid unwanted fertility, which enhances women's market productivity by allowing them to continue their education, to migrate where their skills are most valuable, or to allocate time to their most rewarding work. To the extent that public resources that subsidize family planning and provide associated information about birth control can delay a woman's first birth or reduce the subsequent number of births, a woman's market human capital may increase. Consequently, the impact of family planning subsidies on fertility may be direct and indirect, first helping women avoid unwanted childbearing, and second enhancing the market productivity of women that generally leads them to want lower fertility. It is not surprising that family planning is viewed as a means to "empower" women because it is likely to increase their economic opportunities. Little analytical effort has been directed to measuring family planning as a mechanism for enhancing women's human capital.

The fifth and final form of human capital is an adult's current nutritional status, proxied by weight for height squared (BMI), which affects the current productivity of the individual, particularly at low levels of calories and for

energy-demanding tasks. This indicator of nutritional status among adults must be treated as simultaneously determined with the choice of productive activity, because increased income can also support increased current expenditures on nutrition and the performance of more demanding jobs (Strauss, 1986; Pitt et al., 1990). Unbiased estimates of the one-directional effect of improved adult nutrition on wage productivity requires valid instrumental variables that predict current nutrition or BMI and that are uncorrelated with the error in the wage function. The prices of nutrients in the locality or the cost of health care are possible instruments for this purpose (Strauss, 1986; Deolalikar, 1988; Sahn and Alderman, 1988). Poor adult current nutritional status is known as wasting and is often measured by the BMI (Fogel, 1991). Because BMI and height are often nearly orthogonal, both can be used together to explain variation in individual productivity without the vexing problem of multicollinearity.

Human capital is also accumulated in the form of vocationally relevant experience. The actual amount of a worker's time invested in the acquisition of such skills or even learning-by-doing is difficult to observe and is undoubtedly an endogenous decision of the worker and perhaps firm. Consequently, this form of human capital is imperfectly controlled in the wage function, as discussed earlier, by an exogenous polynomial in years experience after leaving school or age (Mincer, 1974).

#### IV. Problems in Applying the Framework to Program Evaluation

I have focused on only five human capital stocks to simplify exposition, to illustrate the potential for integrating human resource program evaluations, and to offer a concrete specification to guide empirical analysis. There are many limitations to such a scheme. Health is not separately distinguished as a human resource goal, but the indicators of childhood and adult nutrition are selected because of their high correlation with childhood and adult mortality.<sup>7</sup>

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<sup>7</sup>There is some evidence that chronic health problems measured by clinical investigations among the middle aged may be predicted by adult height (Fogel, 1993). Physical limitations on daily activities are also associated with height (Stewart and Ware, 1993). The occurrence of acute illnesses among adults can also be related to anthropometric indicators of health status. Days ill and

Although these nutritional indicators are less well documented as predictors of morbidity, they nonetheless appear to summarize parsimoniously the cumulative repercussions of disease and nutrition on adult well-being and the quality of life (Stewart and Ware, 1993; Broome, 1993). Human resource activities are defined here to encompass explicitly early nutrition/child survival interventions, current nutrition/preventative health measures, education, and family planning programs.

Labor market mobility as a means for realizing the highest possible returns on a population's human capital warrants more explicit study as a significant factor facilitating development. Transportation and communication infrastructure and reduced regulations on job turnover and residential change are rarely considered as factors in low-income countries explaining their differential success in adjusting to short run exogenous shocks due to weather or terms of trade or longer term effects of technical change or sectoral transformation of the economy. Analysis of labor markets, and particularly the determinants of labor force participation, time allocation, and migration should be a high priority for human resource studies within development agencies and governments. To perform timely assessments of human resource programs, periodic household labor force surveys will be needed. These surveys should include human resource stocks and wages and be in a form to merge with community data on human resource and welfare programs that influence households in their investments in human resources.

In estimating a wage function that relates human resource stocks to adult productivity, several econometric specification issues are paramount. First, which forms of human capital are exogenous or endogenous; in other words, are these stocks uncorrelated or correlated with the unobserved wage determinants impounded in the error of the wage function? Characteristics of the region of residence have been used to identify forces that may plausibly influence the

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unable to work in the last month among male wage earners in Côte d'Ivoire and Ghana are associated with lower wage rates when the individual is working and reduced likelihood of entering the wage labor force. These measures of acute illness should be treated with caution, however, because of the subjective nature of these self-response indicators of health status (Schultz and Tansel, 1992).

accumulation of human capital stocks. The simultaneous determination of wages and adult weight (BMI) is noted as an instance where the effect of adult weight on wages could only be estimated by instrumenting weight by local prices of food, availability of health care, or food-for-work programs for unemployed (e.g., Strauss, 1986; Deolalikar, 1988; Deolalikar and Gaiha, 1992). Although fertility and migration are often viewed as choice variables in an economic household production framework (Schultz, 1974; 1992; Sabot, 1982), few studies attempt to endogenize migration and unwanted fertility in a wage function.<sup>8</sup> Education is generally treated as exogenous, but the decision to continue in school is occasionally modeled along with the wage function conditional on that educational choice (Willis and Rosen, 1979). Intergenerational studies of the schooling of children could treat access to schools and their quality as public program inputs that may be expected to influence household investments in human resources but not directly impact on the wages of the children when they are adults.

Programmable policy variations that occur across local areas are thus a promising source of instrumental variables (IV) to explain the human resource stocks that in turn serve as arguments in the wage function. These IV estimates have three advantages and one shortcoming. First, if the human resource stock is measured with classical measurement error, these IV estimates of the wage function eliminate the resulting measurement bias, which tends to bias the productivity effect of human capital to zero (Griliches, 1977). Second, if the human resource stock is endogenous and correlated with the error term in the wage function, these IV estimates are consistent and unbiased in a large sample, whereas the ordinary least squares (OLS) estimates are not.<sup>9</sup> A third standard problem is that of omitted variables, such as exogenous ability or other dimensions of human capital. If these omitted inputs that should be in the wage

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<sup>8</sup>The effect of one unanticipated birth on the wage of Malaysian women is estimated to be a 9.6 percent reduction in her wage rate, whereas in the U.S. an unexpected birth is associated with married women receiving a 9.9 percent lower wage (Schultz, 1992: Table 5.1).

<sup>9</sup>If the explanatory power of the instruments is relatively weak, the IV estimates may not be reliable and specification tests will merely confirm exogeneity due to the poorly identified model (Staiger and Stock, 1994).

equation are uncorrelated with the included inputs, the OLS estimates of the wage function are unbiased for evaluating the effect of measured policy interventions. However, if the omitted variables are correlated with the included variables, a standard misspecification problem may occur and IV estimates should mitigate this problem if they satisfy the usual properties (Griliches, 1977; Lam and Schoeni, 1993). The shortcoming of using local variation in human resource programs to instrument human resource stocks in the wage function is that the local placement of programs may be correlated with omitted variables (e.g., healthiness of environment) or selective migration may occur toward regions with better programs and thereby affect behavioral outcomes across regions. Either selective program placement or migration may bias the IV estimates based on regional programs (Rosenzweig and Schultz, 1983; Rosenzweig and Wolpin, 1986; Pitt et al, 1993).

A central goal of human resource evaluation studies should be to estimate the wage returns to various human capital stocks that can be augmented by existing and readily implemented public programs. Depending on the purpose of the study and the nature of the program intervention, each form of human capital may be treated as exogenous or endogenous. Schooling is conventionally treated as exogenous following Becker (1964) and Mincer (1974). Schooling is formed during childhood when the family of origin exerts considerable control over the investment decision, whereas the school sets some standards for advancement. The years of schooling completed appear to augment the productive capacity of a wide quality-range of students. Other forms of human capital are perhaps jointly determined over an adult's lifetime: such as their allocation of time to market labor supply; on-the-job training; job search and turnover; migration; and fertility (for at least females). These investment-related decisions undertaken as adults are more plausibly viewed as endogenous to the wage determination process than schooling itself.

Childhood nutrition and health conditions are summarized by adult height, whereas adult health and nutrition, are summarized by weight-to-height. Both of the nutrition-health proxies have been implicitly assumed exogenous by economic historians for the purposes of inferring their effect on labor productivity

(Fogel, 1986, 1994; Floud et al., 1990). But development economists have recently considered weight and height as potentially endogenous variables in the labor productivity function (Strauss, 1986; Deolalikar, 1988; Thomas and Strauss, 1993; Schultz, 1994). The challenge is to measure the labor productivity improvements released by short-run and longer run advances in nutritional status, as proxied by such anthropometric indicators as height and weight. Would the reproducible health human capital captured by some of the variation in these indicators of stature have a distinctively different impact on productivity than would the genetically fixed endowment of stature that individuals are given at the time of their conception and then developmentally express? Growing evidence suggests that the ratio of weight to height squared (i.e., BMI) and perhaps also height are appropriately modeled as endogenous human capital stocks, if the goal of the analysis is to evaluate what human resource programs can contribute to economic productivity at current levels of human capital development and technological opportunities. Moreover, if the research goals are to describe the longer term role of public policies on intergenerational economic mobility in a society and to quantify the effects of public policies and programs that affect both childhood and adult investments in human capital, then all forms of human capital formation should be endogenized (if suitable instruments exist) within the model and explained by programs and parent endowments.

Another econometric approach to mitigate bias due to omitted variables is to consider deviations of individuals from the mean of groups that are likely to share many of the conditioning variables that cannot otherwise be observed and controlled. This fixed-effect specification can use panel data for an individual over time allowing for individual fixed-effects, or it can use special samples of twins or siblings for which genetic or family factors are eliminated by a family fixed-effect, or it can use community fixed-effects to remove the bias from any conditions shared by residents in a region that might be correlated with variables included in the wage function. But as community, family, twin or individual fixed-effects are added to a wage function to eliminate omitted variable bias, errors-in-measurement of the human capital stocks becomes a more

serious limitation (Griliches, 1977; Griliches and Hausman, 1986; Lam and Schoeni, 1993). There is no agreement on the optimal approach to dealing with these many estimation issues but the best choice probably depends on many special features of the available data and specific goal of the evaluation study.

Some recent studies of wage functions in the United States have relied on unusual legal provisions surrounding schools in different administrative areas as instrumental variables for explaining a small fraction of the variation in educational attainment of individuals (Angrist and Krueger, 1991). This administratively explained variation is then used to obtain IV estimates for education in the wage function. Although these instrumental variables may not be efficient, with sufficiently large samples from Population Censuses they may imply statistically significant estimates of the private rate of return to education (Angrist and Krueger, 1994). These estimates in several U.S. studies are close to the simple regression (OLS) estimates of the wage function in the form proposed by Mincer that treat education as exogenous, measured without error, and uncorrelated with ability. One conclusion that might be drawn from these recent U.S. wage studies is that the bias due to the omission of ability or family background in estimating wage functions is not as serious as originally believed. Moreover, adding further controls in the wage function for family background can seriously understate the returns to schooling because they exacerbate the problem of measurement error attached to education.

These various econometric sources of bias in estimating wage functions have not yet been adequately appraised for the other forms of human capital emphasized in this paper, such as nutrition and mobility. Based on recent Living Standards Measurement Surveys (LSMS) for Ghana and Côte d'Ivoire, education and migration appear to be exogenous in wage functions, whereas IV estimates appear to be needed to estimate the endogenous effects of height and BMI on wages of men and women (Schultz, 1994). Interaction effects among the human resource variables are also anticipated from the human capital literature, such as between child nutrition and education or between education and migration. Estimation of these interaction effects among endogenous human resource stocks may clarify whether

these stocks are technically complements or substitutes for each other in their effects on labor productivity.

#### V. Critical Aspects of Programs to Evaluate

Three questions need to be answered in setting public sector priorities to help the family invest in human resources and encourage development. A cluster of human resource programs needs to be considered together in conceptually evaluating its benefits for families. Empirically, evaluations can build on standard data from household surveys, matched to data on public resources provided to community schools, health, and family planning programs, etc. The first question is how to get the most benefit from a given expenditure on allied programs. This measure of efficiency should explicitly allow for the likely effects of one program on the outcomes of all other programs, or cross-program effects. The second question is how program benefits are distributed across types of individuals and families, such as the rich and poor, which may inform us about the equity of the program. The third question is how the cost effectiveness of programs would differ if they were in the private or public sectors. In many spheres it is difficult to achieve the same efficiency in the public sector as in the private sector, but the private sector may not be able to reach the same target groups that the public sector can because of their different organizational structures and need to collect fees for services. Benefits from different functionally-oriented programs are difficult to compare, such as health and family planning. Much work remains to be done before it is possible to compare outcome measures, such as a prevented birth, a prevented death, or reduced morbidity, in comparable welfare units. The purpose of this paper is to explore cross evaluation of human resource programs in terms of their comparative impact on a common objective: increasing individual productivity.

A framework within which cross-program effects might be measured is outlined in section 6, and public/private program substitution possibilities can then be explored in section 7. The personal distribution of benefits (or costs) are finally incorporated into this framework in section 8. It is useful to note

at the outset that this general approach has two clear limitations. First, the distribution of benefits across groups can be readily evaluated only when the groups are defined in terms of exogenous variables, i.e., where group membership is not related to choices and allocational decisions made by the observed individual and family. Second, the spatial variation in programs and policies must be assumed random with respect to unobservables, notably the preferences of the population and productivity and healthiness of regional environments.<sup>10</sup>

## VI. Cross-program Effects and Returns to Scale

Many hypotheses are advanced to explain how and why particular programs help a family modify its behavior in a manner that is beneficial to the family and perhaps also to society. Two distinctive program designs with a shared objective may strengthen both programs in achieving their common goal, or one may weaken the independent impact of the other program. The former, complementary effects, are most frequently documented across different types of human capital investment programs. An explanation for this pattern of reinforcement is that one form of human capital enhances the returns to another form. For example, improvements in child nutrition/health permit children to learn more at school (Moock and Leslie, 1986; Gomes-Neto et al., 1992), and healthier children can expect to live a longer, healthier life during which to earn market returns from schooling (Floud et al., 1990). The latter, substitution effects between two social programs, can be expected when the programs are directed to achieving the same end, but through alternative mechanisms or motivations or instruments, such as may be the case when public and private sector programs seek to satisfy the same demands.

These potential synergies between social programs, either positive or negative, may change with the scale of interventions, possibly reinforcing each other at low levels and then substituting for each other at higher levels. For

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<sup>10</sup>To deal with the migration of individuals to regions that provide preferred social programs, or program placement in regions with distinctive populations or welfare problems, raises identification problems that are discussed elsewhere (Rosenzweig and Schultz, 1983; Rosenzweig and Wolpin, 1986; Pitt, Rosenzweig, and Gibbons, 1993).

example, in a family planning program it may be useful to combine doctors and nurses into different types of programs, some stationary in hospitals and clinics, while others are mobile in outreach teams. Both types of program personnel may be motivated to improve health and reduce the number of unwanted births, but they use different mixes of trained manpower and different organizational delivery systems. In some contexts the clinics and outreach programs may reinforce each other, and in other cases they may substitute for each other, reducing the effectiveness of the other program. Thus, these cross-program effects must be empirically assessed to improve estimates of how effective public sector program efforts will be in different circumstances.

One simple way to estimate the sign and magnitude of cross-program effects is to add interaction variables between allied human resource and social welfare programs to models of behavior or output determination, as, for example, in the wage function discussed here. Thus, the wage or fertility of a woman in a region is expected to be a function of her characteristics and the input of program efforts per woman in her residential region. But the program input may be channeled into either family planning clinic or outreach activities. The wage or fertility equation estimated by the program evaluator would then include a separate program input for clinics and outreach, plus an interaction term between the two regional program activities. According to the discussion above, the two segments of the program might be expected to exert positive effects on wages, and the cross-program effect would be negative if the programs were substitutes, and positive if they were complements. The opposite signs would be expected in an equation accounting for fertility. An example of this approach applied to the study of fertility is found in Schultz (1971; 1988b).

Estimates of such program interaction effects are more reliable if quadratic terms are also included for the two program effort variables, in which case the specification can be generally interpreted as a second-order Taylor series approximation for any functional relationship between the program input variables and the measure of program output. With the inclusion of quadratic terms in each program activity, it is also possible to infer how the returns to

each program varies with the scale of program effort, and hence how the marginal returns to program inputs may differ from the average returns. The objective of public policy should be to achieve the same marginal return from equal marginal outlays in various programs, given that both programs have the same objective. It is a common pattern for the marginal return to program inputs to decline after some program scale is reached and the demand for the good or service is gradually satisfied or, in other words, the market is saturated with the relevant skill or service (Schultz, 1971; 1988b; 1992).

In those instances where the primary objectives of allied social welfare programs differ, such as with education, health, and family planning, the task of comparing all returns is not straightforward, but the magnitude of cross-program effects may still be substantial and readily assessed, if not compared in equivalent monetary terms. In the previous section I proposed evaluating human resource programs within a single wage function to facilitate such comparisons. A basic feature of many social welfare programs is that they may influence the costs and benefits of having children (or avoiding unwanted births) while changing the net benefit streams from investments in the education and training of those children (Rosenzweig and Wolpin, 1980; Foster and Roy, 1992). The most direct route by which public policy may influence fertility is through the provision of information and related services for evaluation and use of modern birth control. If these programs help parents avoid more unwanted births, the evidence from a number of studies suggests that parents reallocate some of their gains to investing more in their children's schooling (Schultz, 1992). If the income effects associated with the benefits of these types of social programs were negligible, then household demand theory predicts that the estimated (uncompensated) cross-program effects should be symmetric, or of the same sign and equal in magnitude.

In the earlier discussion of the wage equation, if the two programs were health subsidies and school subsidies, the direct program effects are expected to be positive, and the program interaction effect might be positive as well, if

they are complementary. This would imply that health expenditures had a higher payoff in regions with greater school expenditures, other things being equal.

### VII. Public and Private Program Interactions

Most public human resource programs provide a service that can also be obtained through private markets, although perhaps in a different quality or form. It should be expected that when public subsidies are provided for a good or service that is also available in the private market, some consumers will switch from private to public providers because of the public subsidy, without necessarily changing outcomes or behavior. Consequently, the supply of contraceptives distributed freely by a public program is likely to overstate the added contraceptive protection provided to the population by the program (Schultz, 1971). Some contraceptors will merely shift their source of supply without improving their contraceptive efficiency. This is of course only a special case where parallel programs may exist with approximately the same objective. The only way to assess accurately the effect on contraceptive use of a subsidy to either program is to analyze both programs together to avoid overstating public program effectiveness. Moreover, an analysis should focus on the final outcome of fertility or female wages, rather than the intermediate input of contraceptive behavior (prevalence), if a more precise measure of program effectiveness is sought.

In a study of Thai birth rates in 1976-1981, the fertility effects of government subsidies to the public sector health and family planning program and to the private, nonprofit family planning program are estimated. The study finds that both the private and public sector family planning subsidies are associated with lower levels of fertility, holding constant for the age, education, and household income of women. The larger public sector subsidies are also associated with diminishing returns to program scale within province administrative units. In other words, the marginal returns in terms of preventing births are smaller than the average returns to government expenditures per woman. This form of diminishing returns to scale within provinces was

evident as early as 1969 in the pioneering Taiwanese family planning program (Schultz, 1971; 1988b). In Thailand, the public and private family planning program subsidies are shown to be substitutes for each other, as might have been expected (Schultz 1989; 1992).

#### VIII. Who Benefits from Human Resource Programs

To assess how social program effects are distributed, it is convenient to add additional interaction variables between program treatments and exogenous groups. In the illustrative fertility model, it has been hypothesized that family planning provides information and assistance on how to adopt more effective modern means of birth control. If it is more difficult for the less educated women to assess a new birth control technology, and program inputs are of only little value to the more educated women, public subsidies for local family planning should then have their greatest impact on the fertility and productivity of less educated women. An analogous problem arises where public sector extension activity promotes adoption by farmers of new technological inputs and management practices. These farm-extension activities have been shown to raise the profits of less educated farmers by a greater proportion than the profits of more educated farmers (Evenson, 1986; Birkhauser et al., 1991).

An interaction variable is defined in this case as the product of the local region's program subsidy and the individual's education. It is clearly important also to hold constant for education and the local level of program subsidy in the fertility (or wage determining) equation. If the local input of family planning activity had a greater beneficial effect in helping women with lower levels of education avoid unwanted births, then the estimated coefficient on this interaction variable would be positive (negative), in the fertility (wage) equation, while the direct effects of the program and women's education would both be negative (positive). This pattern is observed for fertility in Colombia in 1973 (e.g., Rosenzweig and Schultz, 1982) and is generally consistent with the larger gaps recorded between desired and actual fertility among the least educated women in Latin America and South East and East Asia in the World

Fertility Surveys (Schultz, 1989). The first phase of the In-Depth Fertility Surveys from three regions of China, collected in 1985, indicate that the partial effect of a local family planning worker in the community on the fertility of older women is larger for less educated women. As in the other studies, both the woman's education and the presence of a local family planning worker contribute to lower levels of fertility, and the family planning worker narrows the fertility differentials by women's education (Schultz and Zeng, 1991). In each of these studies it would be interesting to know if female wages were larger in those groups in which fertility was lower due to program activity, but many of the surveys used to study fertility have not collected information on wages or earnings.

#### IX. Conclusions for Program Evaluation

Household survey data from individuals on fertility, child health, child schooling, adult education, wage rates, and other sources of income, and household expenditures can be merged with regional data for the residential area on public expenditures on human resource programs. These merged data provide a flexible and representative basis for assessing the success of human resource programs to help individuals increase their productivity and families cope with the challenges of economic and demographic change in the low-income world. Putting modern technologies to effective use to control their reproduction, protect their family's health, and educate their children are closely related achievements that do not proceed independently. If public objectives can be achieved by both private and public sector providers of schooling, health, or family planning, the simultaneous analysis of both public and private providers is mandatory. In some parts of the world, the public sector may not be the most cost effective or equitable provider of basic services, even those that are traditionally associated with the public sector, such as health care (Birdsall and James, 1993). The prices and quality of services in the public and private sectors should be analyzed together with the traditional household demand data on expenditures, time allocation, wages, prices, and nonearned income to isolate

the payoff to expanding public sector subsidies.

The personal distribution of the wage gains from social welfare programs is rarely estimated but should become an important ingredient in deciding what goods and services the public sector should provide and to what segments of the population they should be subsidized. Subsidies for some public sector services may benefit predominantly the poor and help them overcome their initial economic disadvantages. These subsidies should be associated with families achieving for themselves greater intergenerational mobility, through their improved control of unwanted births and the increased health, nutrition, and education of their children. Other public sector services, such as urban hospital care and university education, may benefit predominantly urban middle and upper classes,

These public services may appear to be inequitable income transfers from taxpayers to the rich, without notably affecting average wages, mortality, schooling, or fertility. Identifying which public services should become self-financing by fees-for-service may help sustain and expand government assistance for human resource programs where they remain a cost effective and equitable human resource investment to increase individual productivity, alleviate poverty, and accelerate growth.

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