Journal of Economic Perspectives—Volume 13, Number 3—Summer 1999—Pages 67–88

Health and Schooling Investments in Africa

T. Paul Schultz

Health and education are not only beneficial in themselves, but they can be viewed as investments in human capital which lead to a higher future standard of living. The people of Africa experience lower levels of both health and education than prevail in other regions of the world, which reflects the lower level of economic development in Africa, helps to explain that lower level of development, and suggests a set of policies for improving Africa's standard of living.

The expectation of life at birth is the most common indicator of health status, and though it is measured with much error in Africa, it has clearly been lower in Africa than elsewhere. There are some signs of convergence. Since World War II, life expectancy has increased in low-income regions by about four years per decade, while gains in high-income countries have been slower (Preston, 1980). Nonetheless, Africa's life expectancies remain at the bottom, and the mounting epidemic of HIV/AIDS in central and southern Africa threatens to reduce life expectancies in many of these countries in the future (U.S. Bureau of the Census, 1998).

Intercountry differences in life expectancy are dominated by rates of infant and child survival. In turn, these differences as they existed from 1960 to 1985 can be largely accounted for by a few variables: log income per capita, the expected years of schooling women completed ten years earlier (to focus on the age group that is currently having and caring for children), urbanization or agricultural dependence, and a time trend (Schultz, 1994; 1997a, b). But even after holding these variables constant in a regression analysis, African levels of life expectation are still five to six years lower than other countries, and in addition, child survival in rural African areas is relatively lower than in rural areas of comparable countries. Moreover, if these other factors are held constant in a regression analysis, the infant survival rates in Africa tend to decline from 1960 to 1985 (Schultz, 1997b), which

■ *T. Paul Schultz is Malcolm K. Brachman Professor of Economics and Demography, Yale University, New Haven, Connecticut. His e-mail address is ⟨pschultz@pantheon.yale.edu⟩.*

undermines the widely held belief that unmeasured advances in public health technology are continuing to increase Africa's life expectancy (Preston, 1980).

Africa also has some of the lowest levels of school enrollment in the world, and the relative quality of that schooling remains to be assessed. However, adopting the same regression specification used for cross-country comparisons of health—that is, controlling again for income, schooling level of mothers, and urbanization—and adding a variable for schooling level of fathers, it turns out that Africa's educational enrollments are significantly behind other comparable countries at the primary level, but ahead at the more costly secondary and tertiary levels. When enrollments across all three levels of schooling are summed, African educational enrollments are not notably different from other countries (Schultz, 1997b). But given that Africa has very low income levels, low levels of urbanization, and low educational levels for mothers and fathers, absolute levels of education in Africa are low as well.

The trend in Africa's school enrollment rates is not altogether clear. Declines in school enrollment rates are reported in some African countries in the 1990s, like Tanzania (Mason and Khandker, 1997). UNESCO (1998, Table 2.10) summary figures reveal a 4 percent decline in primary enrollment rates from 1980 to 1990, although they do not show declines in the secondary or tertiary enrollment rates. The African region started the 1960s with the widest relative gap between the educational attainments of men and women. However, the advance of women's enrollments relative to men's has been more rapid in Africa than in the other regions where women were traditionally not sent to school, like south and west Asia (Schultz, 1993). This progress in sending girls to school in Africa has important implications for sustaining the future reduction in child mortality and fertility (Benefo and Schultz, 1996; Shapiro, 1996; Schultz, 1997a, b; Sender, this issue).

Many factors have a bearing on why Africa has grown more slowly than other regions since 1960. Low levels of health and education are two salient factors associated with low productivity and contributing to this slow growth. If there is progress in opening African economies to international trade, reducing internal economic distortions, and achieving greater peace in the region, I would expect health and education to become even more critical to economic progress.

This paper first outlines an organizing framework for considering how health and schooling affect labor productivity and growth, and how household and community factors can in turn affect the demand for these human capital investments. Both cross-country growth models and various aspects of microeconomic studies of individual productivity as related to education and health are discussed. The conclusion offers some tentative leads for policy in this area based on existing research, and an agenda for future research.

The Demand for Human Capital and its Effect on Wages

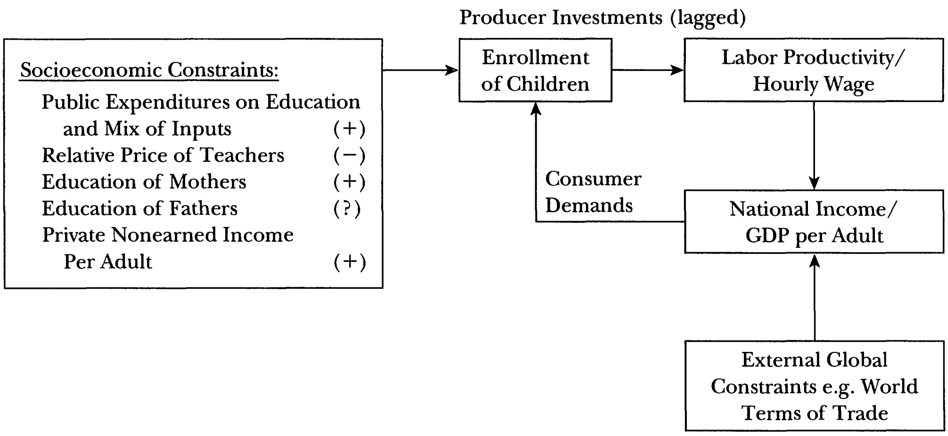
Most studies of human capital in the last half century have interpreted the relationship between the wage rate and schooling, or wage rates and health status, as a measure of the private productive return to the supply of education and health that individuals, families and society create through their investments.

Figures 1 and 2 illustrate in flow diagrams what variables might enter into a simple model for describing the household demands for human capital inputs and their effect on labor productivity or wages. In the case of educational capital in Figure 1, the socioeconomic determinant of household demands for schooling of their children would include the level and composition of public expenditures on education; in low-income countries, about 90 percent of public expenditures on education are teacher salaries. The education of the parents may augment the demand for the schooling of their children, both because more educated parents may value it more highly for their children, and because more educated parents can better help their children learn. Nonearned income or inherited wealth may also facilitate the parents' borrowing to finance the schooling. Consumer income as a determinant of schooling feeds in from the right-hand side of the figure.

Figure 2 presents a parallel flow diagram for health inputs that increase the worker's health status and thereby future productivity. Health status will rise with increased public spending on health services. It will fall with a rise in relative prices of health inputs, which includes salaries of nurses and doctors, the cost of drugs and other medical supplies and services, and the relative prices of nutrients that help to fight off infections and disease. Higher levels of parent education are correlated with lower child mortality, even after holding household income constant. The relationship from parent's education to child health is almost always more steeply sloped for the mother than for the father, which is commonly explained by the mother being more often in charge of child care, more responsible for monitoring the child's health, and in much of Africa she produces the bulk of the food for the family. A year of additional schooling for the mother is often associated in a low-income country with a 5–10 percent reduction in her child's likelihood of dying in the first five years of life (Cochrane et al., 1980; Schultz, 1981). Health status will also be determined by technological factors; these were left out of the analysis for the determinants of schooling because the technology of schooling appears to change quite slowly relative to health technology. There are also some regions where particular diseases remain stubbornly prevalent, with consequences on child and adult health and nutritional status. For example, in some settings, tropical parasitic diseases, such as malaria, schistosomiasis and onchocerciasis, have not been controlled by public health interventions. Diseases and their transmission vectors may also be dependent on climate that make some regions inherently less healthy than others (Bloom and Sachs, 1998).

In Figures 1 and 2, income feeds into enrollment or health from the right-hand side of the picture, as a form of consumption demand. Analytically, the critical distinction is between the socioeconomic and technological factors on the left and the per capita income factor on the right in that the socioeconomic factors modify the efficient investment in human capital, while per capita income may affect consumer demand for education and health, or relax human capital borrowing constraints, or may be a proxy for other generally unmeasured interrelationships between income and productivity. One way to sort out these various effects is to use instrumental variables which are correlated with the conceptualized variable. Often, plausible candidates for such instrumental variables can be found

Figure 1
Determinants and Consequences of Accumulating Educational Human Capital



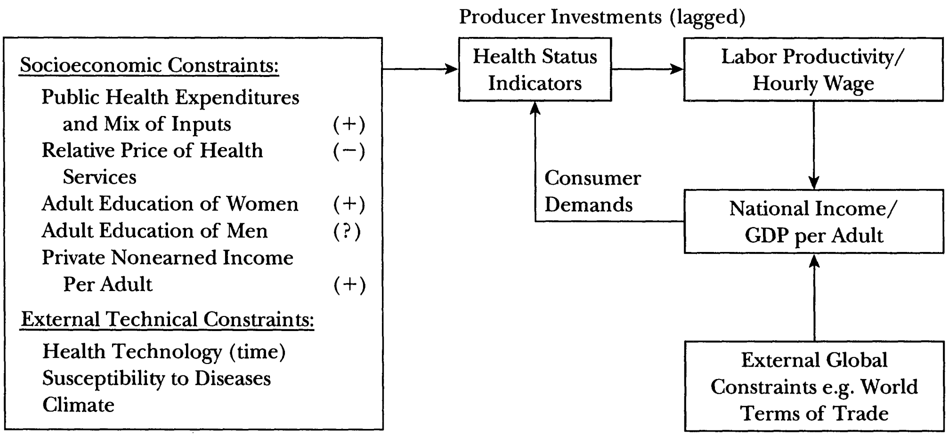
in factors that are external to the household, like commodity prices or program access for socioeconomic factors affecting human capital investments, or on the other hand terms of trade affecting income and consumer demands.

Both Figure 1 and Figure 2 imply a set of variables that might be used in regression framework to estimate determinants of education or health levels. Further, the equations then imply a relationship in which human capital determines productivity and wage levels. In both the case of health and schooling it is important to analyze the hourly wage, for increases in productive potential that raise the workers' wage may also lead the worker to change the number of hours worked, and so looking at total income can be a deceptive measure of productivity (Schultz, 1981; Schultz and Tansel, 1997). In a regression framework, where human capital variables are the independent variables and the wage (or productivity) level is the dependent variable, the coefficient on each human capital variable can be taken as an estimate of how increases in that variable will raise wages. In the case of schooling, for example, certain simplifying assumptions lead to the coefficient on years of schooling being an approximation for the private internal rate of return on the student's opportunity cost of investing a year of time in going to school (Mincer, 1974).

There are several difficulties with discerning causal links between human capital and wages in a regression framework. First, in the case of both health status and schooling, there may be lags during which the formation of human capital occurs before a worker becomes more productive. These potentially long gestation lags add to uncertainties about the precise quantitative payoff to health policy interventions. Their full effect can only be appraised when the policy changes have occurred independently of other health (or schooling) related conditions, and sustained for a decade or two to allow confident extrapolations to changes in adult labor productivity.

Second, there is the difficulty that the relationship between a person's educa-

Figure 2
Determinants and Consequences of Accumulating Health Human Capital



tion or health level as a child and wage as an adult may capture more than a pure human capital productivity effect. Education and health could also be proxying for the effects of other unobserved human capital inputs, for the child's innate ability on productivity, or for how increased family wages and income feed back on the demand for more education or health. As one example of how to approach this problem statistically, Strauss (1986) wanted to estimate only the human capital investment return to increased calorie intakes, while excluding the possible feedback that greater calories could lead to increased family productivity and income and thus to a greater consumer demand for food. He approached this problem by using the local price of nutrients to predict family calorie consumption in Sierra Leone. Then, he used this estimate of family calories per capita to explain family labor productivity, finding that the productivity gains from additional calories were largest among the lowest income households. More broadly, this approach can use the socioeconomic and technology factors identified in Figures 1 and 2 as instrumental variables to estimate wage and productivity effects, in a way which should approximate without bias the private wage return to schooling and health. This approach also corrects for the potential downward bias that would be introduced by random errors in measuring the human capital inputs (Angrist and Krueger, 1991; Schultz, 1995; Card, 1998).

Aggregate Evidence of Human Capital Returns to Growth

Macroeconomic studies of growth often seek to explain differences in economic growth rates across countries in terms of levels and changes in education and health human capital, among other variables. However, these estimates are plagued by measurement error and specification problems.

The educational attainment of adults has been estimated only recently for most African countries, and the shortcomings of these time series on education are only starting to emerge clearly. Information on the distribution of schooling in a population comes from two basic sources: surveys of individuals and reports from schools. In the first instance, respondents might misreport their education because they misunderstand the question, prefer to report it inaccurately, or make an error. In addition, the coded response categories, such as incomplete secondary schooling, may not map precisely into years of education *completed* (Barro and Lee, 1993). In data from schools, as published by UNESCO in its *Yearbooks*, teachers and educational administrators may have a financial incentive to overstate the number of their students, and bias upward these enrollment estimates. Using country estimates of completed years of education that are measured with substantial error will add noise to growth regressions, and bias the coefficients on the education variable toward zero (Krueger and Lindahl, 1998). The problem will be especially difficult when measuring changes over short periods of time and for the more heterogeneous secondary and higher levels of education. Much work is needed to develop estimates that are more accurate and reliable by combining both types of information.

The available evidence does tend to show that higher initial levels of education tend to be associated with more rapid subsequent growth. However, a number of difficult issues and questions remain. A growth accounting framework also leads to the expectation that *changes* in education should contribute to growth, but the empirical evidence of this is weak and fragile (Benhabib and Spiegel, 1994; Barro, 1997; Pritchett, 1997). When changes in male and female education are included separately in the growth regression, male education at the secondary level tends to be positively related to growth, while female education is *negatively* related to growth (Barro and Sala-i-Martin, 1995; Pritchett, 1997). Barro (1997) concludes from this evidence that only male education at the secondary and higher level is the key factor for understanding economic growth. However, the estimated coefficients on even the initial levels of male and female education are particularly sensitive to the choice of data series, and the functional form of the education variable (Topel, 1998; Krueger and Lindahl, 1998; Schultz, 1998).

A number of studies have found an association between initial education and subsequent growth, based on data from cross-country estimates based about 1960 to 1990, that seems too large; that is, it is several times larger than can be explained by the estimated size of private wage returns based on analyses of individual wages and schooling within countries (Heckman and Klenow, 1997; Krueger and Lindahl, 1998; Topel, 1998). Topel (1998) notes that the magnitude of the coefficient reported in the growth literature, for example by Barro and Sala-i-Martin (1995), on male secondary education implies also an implausibly large return to schooling. One is left without confidence that the cross-country growth models have yet shed much light on the magnitude of the growth returns to schooling.

The treatment of health and demography in the aggregate growth models is even less satisfactory than that of education. As noted earlier, one key health statistic is infant and child mortality rates, which in turn has a considerable influence on cross-country differences in life expectancy. The education of a mother is the best single predictor found for the survival rate of a mother's children. This result is plausible enough, given that a mother generally has the most immediate control over her child's diet and medical care, so that even in a patriarchal society, her education should better predict her child's health outcomes than the education of the child's father (Schultz, 1981, 1994, 1997a). But now the effects of education and health on productivity become entangled. Growth regressions sometimes try to deal with this problem by controlling for fertility and mortality while estimating the effect of education on wages and productivity. But if fertility and mortality are themselves affected by female (and male) education, as seems very likely (Schultz, 1994, 1997a, b), then this approach will not work well. Indeed, this problem may explain the finding that female education, holding fertility and mortality constant (!), does not seem to positively affect growth (Barro, 1997, p. 21; Barro and Sala-i-Martin, 1995; Pritchett, 1997).

Other specification issues arise, as well. There is always a question of what other variables to add to these regressions. It is common, for example, to add a variable for the initial level of income, which is expected to contribute to convergence in incomes per capita across countries over time (Barro and Sala-i-Martin, 1995; Levine and Renelt, 1992), but this presumed connection is controversial in itself, and adds further difficulty. In addition, many of the macroeconomic growth models assume that human capital exhibits constant returns across countries (Krueger and Lindahl, 1998; Topel, 1998). It is plausible that some broad patterns for education and health hold across countries; for example, returns to health should be subject to diminishing returns with development (Strauss and Thomas, 1995), and returns to education are probably affected by the supply of educated workers, as well as the composition of economic production, and its regulation by governments. But in microeconomic studies, the actual estimated returns to schooling vary widely across countries, as do the productivity effects of nutrition and public health. Thus, generalizations as to returns to education and health for the African region as a whole are at a minimum premature, if they will ever be warranted.

Measurement errors in the existing aggregate educational and health data appear more serious in African data than in any other continent. Specification problems in thinking about using levels or changes, and how education and health are interrelated, what other variables to include, and how much cross-country variation to allow, all add additional difficulty. Fortunately, analyses of the relationship between the quantity and quality of schooling and labor productivity are rapidly improving in many low-income countries, including several in Africa which I consider in the next three sections. Given the current state of the macroeconomic growth models, I believe that the microeconomic evidence offers more revealing and reliable insights about the returns to human capital in Africa.

Private Returns to Different Dimensions of Human Capital

Economists of the stature of Kuznets (1966) and Fogel (1994) have found it useful to study human capital as a multidimensional input to economic growth.

Four factors might be distinguished—education, child nutrition (proxied by adult height), adult health-nutrition (proxied by the ratio of weight-to-height-squared or what is known as the Body Mass Index), and labor mobility—which can then be used as independent variables in a regression analysis with wages as the dependent variable. Of course, such regressions are not ironclad. These human capital factors may also be valued as a consumer good as portrayed in the previous figures, not just for their capacity as human capital to raise wages, so a regression will understate their full value. Moreover, individuals who acquire higher levels of human capital may also be innately more able and productive workers, and possibly come from richer families that provide their offspring with greater economic opportunities, which could lead regressions to overstate the true productive effects of human capital on wages. Indicators of nutrition and health status, such as height and Body Mass Index, education, and mobility tend to all be positively correlated with each other across individuals. Omission of any one or more of these auxiliary forms of human capital from the wage function would then lead to an upward bias in the effect of those forms of human capital that are included in the wage estimated function, such as schooling. If the human capital inputs are themselves measured with substantial error, as we expect in African survey data, this measurement error would tend to bias estimates of the human capital-input effects on wages downward, or toward zero.

A large literature has concluded that the upward biases from omitted variables and heterogeneity, such as those due to ability and family status, are roughly offset by the downward biases due to errors in measurement, although these empirical issues need to be addressed in each new environment (Griliches, 1977; Card, 1998). One way to deal with these sources of bias in estimating the wage equation is to use instrumental variables, ideally with instruments that proxy the local price of obtaining the human capital, like some of the socioeconomic variables given in Figures 1 and 2.

With these concerns out in the open, Table 1 presents coefficients for these four human capital inputs in a wage function for Côte d'Ivoire and Ghana, based on data from Living Standard Measurement Surveys in the late 1980s which are designed to be nationally representative (Schultz, 1996; Grosh and Glewwe, 1998). The regression analysis also controlled for ten regions of birth, eight to ten ethnic groups, five age dummies, and the season in which the data was collected (to capture seasonal cycles in agricultural wages). The first, third, fifth, and seventh rows of the table present estimates of how these four human capital factors affect wages for men and women in the two countries, based on ordinary least squares regressions. The estimates of all four human capital inputs tend to be positive and statistically significant. Moreover, the coefficients on years of education do decrease with the inclusion of the other three human capital input variables, but only modestly (not reported here), often by less than one-tenth, which suggests that education is picking up a different kind of productive variation than the other three factors (Schultz, 1995).

However, in all four gender/country samples the four human capital input fail a Hausman (1978) specification test that they are all (jointly) exogenous, which

Table 1
Alternative Estimates of Human Capital Wage Returns for Schooling, Mobility and Nutrition-Health: Côte d'Ivoire and Ghana, 1985–1989[a]

Country, Sample, Year, Sex Estimator (Sample Size)	*Years of Education*	*Migration from Birthplace*	*Height in meters*	*Weight to Height Squared (BMI)*
Côte d'Ivoire (LSMS: 1985–1987)				
Males (1692)				
OLS: Wage Effects	.109	.715	.862	.0451
	(16.4)	(8.73)	(2.00)	(4.55)
IV: Wage Effects	.107	.691	−1.05	.159
	(3.88)	(3.09)	(.56)	(3.00)
Females (1180)				
OLS: Wage Effects	.0730	.891	.416	.0613
	(7.18)	(8.26)	(.62)	(6.88)
IV: Wage Effects	.0731	.961	−4.35	.0950
	(3.58)	(4.80)	(1.78)	(2.50)
Ghana (LSMS: 1987–1989)				
Males (3414)				
OLS: Wage Effects	.0437	.348	1.48	.0530
	(9.86)	(6.75)	(5.02)	(6.80)
IV: Wage Effects	.0445	.218	5.69	.0793
	(2.46)	(2.26)	(3.45)	(1.95)
Females (3400)				
OLS: Wage Effects	.0375	.531	1.29	.0420
	(7.26)	(8.46)	(3.63)	(7.63)
IV: Wage Effects	.0356	.361	7.48	.0981
	(2.69)	(2.98)	(3.44)	(4.11)

[a] The coefficients reported are those on the four human capital inputs in a logarithmic hourly wage function, which include age dummies, regions of birth, ethnic/language group, and season. Beneath OLS coefficients are reported in parentheses t statistics, and beneath IV (instrumental variable) estimates are asympototic t statistics.
Source: Schultz (1996, Tables 1 and 2).

suggests that instrumental variable estimates are useful. My approach here—similar to the Strauss (1986) approach described earlier—is to use the local relative prices of foods, the distance to local schools and medical facilities, the community infrastructure in health and sanitation, and the education of the individual's parents, and whether they worked in agriculture to predict the individual-level data for each of the four human capital factors in the table columns: education, migration, height, and Body Mass Index. If individuals reside in a different region from their birth place, then the average local characteristics of that region of birth are assumed those that are relevant to their childhood investments in human capital among migrants. Different combinations of these instrumental variables are considered and they suggest that the instrumental variable wage equation estimates are reasonably robust, or pass overidentification tests (Schultz, 1996). Then, the predicted levels of individual years of schooling, migration, height, and Body Mass Index taken from the instrumental variable analysis are used as the independent variables in a wage regression, with the results for men and women in the two countries presented in rows two, four, six, and eight of Table 1.

The instrumental variable estimates are expected to be consistent. However, the precision of the estimates decreases (increases in standard errors contribute to smaller t-statistics). When the ordinary least squares and instrumental variable estimates are compared, it turns out to make little difference which estimates are consulted for education and migration, since the coefficients are quite similar under either procedure, whereas the wage effects of health and nutrition are sensitive to the choice. The discussion below will refer to the instrumental variable estimates, unless explicitly noted otherwise.

The wage returns to education and mobility appear to be larger in Côte d'Ivoire than in Ghana, while the anthropometric measures of child health and nutrition are associated with larger increases in wages in Ghana than in Côte d'Ivoire. The finding that wage effects associated with an average additional year of schooling are larger in Côte d'Ivoire than in Ghana is consistent with other studies (Glewwe, 1990; Schultz, 1993; Vijverberg, 1993; Tansel, 1997). The underlying reason may be attributed to the greater supply of educated workers in Ghana, or to the greater growth in the derived demand for educated workers in Côte d'Ivoire. The greater benefits to migration in Côte d'Ivoire may reflect greater cultural-political barriers to movement across tribal regions than in Ghana; moreover, the high-wage opportunities in Côte d'Ivoire are concentrated in one region (Abidjan), which makes gains for migrants to the capital especially large.

However, the association between wages and height is stronger in Ghana than in Côte d'Ivoire, suggesting malnutrition among children is more often a binding constraint on adult height in Ghana. Indeed, 36 percent of the children under age five were malnourished in Ghana in 1990, whereas only 12 percent were in Côte d'Ivoire (World Bank, 1991). In Ghana, men age 20-29 report an average height of 1.70 meters (5 ft. 7 inches), or an increase of 2 centimeters (0.8 inches) over Ghanaian men age 50-65, whereas in Côte d'Ivoire young men in these surveys have a height 1.71 meters versus 1.67 in the older ages, implying a significantly faster rate of growth in height occurred in Côte d'Ivoire than in Ghana in these three decades. For women in Ghana, the advance has also been slower between the same two age groups than in Côte d'Ivoire. These improvements in height are consistent with larger declines in child and adult mortality in Côte d'Ivoire than in Ghana over recent decades (Benefo and Schultz, 1996), and are of the same order of magnitude per decade as those observed in France from 1705 to 1975 (Fogel, 1994).

The fact that different types of human capital have different returns in the two countries has several implications. It means that human capital investments priorities in these neighboring countries might reasonably differ. These findings also illustrate the need for periodic evaluations of the actual returns to a variety of forms of human capital, to assess their economic value in a particular economy in a particular time period. In the three decades before these surveys were collected, real GNP per capita increased about 70 percent in Ghana and 316 percent in Côte d'Ivoire (World Bank, 1991). Perhaps wage returns to education have subsequently increased in Ghana as its economy revived, and returns may have conversely declined in Côte d'Ivoire as that economy during the 1990s was buffeted by currency devaluations, retrenchment of the public sector, and structural adjustment. Only updated research can answer these questions.

Private Returns to Years of Education

Returns to years of education in different countries will be heavily influenced by the supply of workers with different amounts of education, and the level of derived demand for such skills in the economy. In turn, the supply of workers with different levels of education will be influenced by government policy choices, and the demand for workers with different skill levels will be influenced by sectoral shifts in the economy, including those caused by increased openness to foreign trade. In many instances, increasing the relative supply of educated workers at the national level has been associated with a narrowing of wage inequality with development, as in Korea in the 1980s and Brazil and Colombia since the 1970s. Trade liberalization has been linked to the increasing returns to higher education in some low-income countries in the 1980s and 1990s, such as Chile and Mexico (Robbins, 1994). It seems likely that demand for skilled labor can shift more quickly than supply, because the education of a generation takes years to complete. As a consequence, returns to middle and higher education levels can be for a time driven to high levels, especially in times of rapid growth. This appears to have occurred in Brazil in the 1960s, Korea in the early 1970s, and Thailand, the United States and a number of advanced economies in the 1980s, to cite only a few examples (Schultz, 1988). Of course, any changes in the return to skills that can't be explained by measurable shifts in supply and demand can always be attributed to the catch-all cause of technical change (Topel, 1997).

In Africa, few countries have sufficient data over a long period of time on wage structures, educational returns, and supplies of educated workers on which to analyze trends as to the returns to human capital. However, the distinctive educational policies followed by Kenya and Tanzania in east Africa provide one instructive example. The two countries started from about the same educational level in the 1950s at independence. In both countries, primary schools were expanded, but in Kenya secondary schools also grew rapidly and private secondary schools were allowed to expand to absorb the excess demand for education. School fees became an important means of financing the expansion in secondary schools in Kenya. In Tanzania, the state concentrated on primary schools and restricted the growth of secondary schools, while allocating the scarce entrance places to the secondary and higher levels of education by competitive exams without school fees. Partly as a result of these policies, Kenya enjoyed more rapid economic growth (until recently), while the increased supply of secondary school graduates in Kenya drove down the returns to secondary school in comparison with Tanzania and promoted thereby greater equality in the Kenyan wage structure (Knight and Sabot, 1981, 1990).

For Ghana and Côte d'Ivoire, the two west African countries examined earlier,

Table 2 reports the percentage increase in wages per average year of schooling completed at each of three levels of schooling. As in Table 1, the first, third, fifth, and seventh rows provide estimates based on an ordinary least squares regression, where the dependent variable is the log of hourly wages, and the explanatory variables are number of years of school completed at each of the three levels, along with a measure of experience, and several dummy variables for different regions.

In carrying out such a regression, however, an uncomfortable fact emerges: a relatively small proportion of those surveyed work for hourly wages. Just 4 percent of the women in Côte d'Ivoire and 7 percent of the women in Ghana work for wages; of course, many women in these countries are not in the paid labor force at all. But even of the men, just 19 percent work for hourly wages in Côte d'Ivoire and 26 percent of the men in Ghana. The great majority of men and women in these two countries work on their own account, often as self-employed farmers. However, comparing wage-earners to the self-employed is problematic, both since errors in reporting self-employment income and hours worked are probably greater, and because self-employment income includes realized returns to business capital and risk (Vijverberg, 1991). A concern arises that estimates based only on wage-earners—a distinct minority of the population—might not accurately reflect the productive payoff to the average person attending school.

One statistical approach to this problem is to build a model of the decision to engage in wage labor vs. nonwage work or leisure. In particular, the probability of participation as a wage worker is assumed to be affected by ownership of land or financial and business assets. The critical assumption that permits the estimation of this model is that observed household assets raise the reservation wage of the worker in nonwage work or leisure, but do not affect market wage offers. Given these restrictions and the normality of the error in the model determining who is a wage earner, we can then estimate with maximum likelihood methods a joint model of both participation as a wage worker, and conditional on that choice, the dependence of wages on education.[1] The results of these two methods are not fundamentally different in Table 2, which gives one some confidence as to the robustness of the estimate.

In Côte d'Ivoire and Ghana, returns to education for men and women are of roughly the same magnitude, with the exception of secondary education in Ghana, where returns to women are nearly double those of men. In west Africa—as well as east and central Africa—women received substantially less education than men in the past. Twenty years ago, women might have obtained half the number of years of education as men. The gender gap is wider in Côte d'Ivoire than in Ghana, but is closing rapidly in both countries. However, the differences between the education of men and women are much smaller, and sometimes even reversed, in portions of southern Africa. It is notable that the education gender gap in Africa is

[1] For details of the calculations behind Table 2, see Schultz (1993). For a complete reporting of parallel maximum likelihood estimations with the inclusion of adult health disability variables, see Schultz and Tansel (1997). For further discussion of the Living Standards Measurement Survey on which these estimates are based, see Grosh and Glewwe (1998).

Table 2

Estimates of Private Wage Return to Years of Schooling in Côte d'Ivoire and Ghana by Sex, Without and With Statistical Correction for Sample-Selection Bias[a]

Country, Year, Sex and Estimator (Sample Size)	*Primary*	*Secondary*	*Higher*
Côte d'Ivoire (LSMS: 1985–87)			
Males			
OLS: Wage Effects	.140	.274	.224
(1,452)	(11.5)	(15.3)	(18.0)
ML: Selection Corrected Wage Effects	.116	.241	.200
(7,832)	(7.03)	(10.3)	(11.5)
Females			
OLS: Wage Effects	.109	.243	.224
(376)	(4.08)	(7.45)	(9.95)
ML: Selection Corrected Wage Effects	.078	.209	.202
(9,099)	(1.26)	(2.71)	(4.22)
Ghana (LSMS: 1987–1989)			
Males			
OLS: Wage Effects	−.013	.070	.118
(1,471)	(.72)	(3.15)	(15.1)
ML: Selection Corrected Wage Effects	−.013	.079	.123
(5,605)	(.78)	(2.73)	(9.23)
Females			
OLS: Wage Effects	−.010	.145	.104
(454)	(.34)	(3.95)	(8.30)
ML: Selection Corrected Wage Effects	−.012	.142	.101
(6,067)	(.31)	(2.97)	(2.07)

[a] The coefficients reported are those on the variable years of education completed at each school level, in a logarithmic hourly wage function, which also includes experience (age-schooling-7), experience squared, and several regional dummy variables (capital city, north, central, south, and other urban). The estimation sample is restricted to wage and salary earners between the ages of 15 and 65. The ordinary least squares (OLS) estimates of the education coefficients are reported first, follow by the maximum likelihood (ML) estimates of the joint probit model for participation as a wage or salary worker (not reported) and the conditional log wage function. See text for discussion of identification restrictions, and Schultz and Tansel (1997) for a review of the data and report of paralled ML estimations with the inclusion of adult health disability. Beneath the OLS estimates in parentheses are t ratios and beneath the ML estimates are asymptotic t ratios.
Source: Schultz (1996).

closing more rapidly than it is in south and west Asia (Schultz, 1993; Sender, this issue). One explanation for the rapid catching up of African women in terms of schooling is that they work extensively outside of their family, and returns to women's schooling in agriculture and trading occupations are substantial. In comparison, in south and west Asia women are less frequently participating in the labor force outside of their family, particularly in the rural sector (King and Hill, 1993; Schultz, 1993).

Returns to primary schooling in Ghana are not significantly different from zero, but returns are 8 and 14 percent for men and women at the secondary level, and 12 and 10 percent for higher education, respectively. In Côte d'Ivoire, returns to education start at 8 and 11 percent for women and men at the primary level, and then rise to about 20 percent for both sexes at both the secondary and higher education levels. These findings imply that there is little scarcity of primary educated workers in Ghana to justify families sending their children to primary schools, except to gain the option of their continuing into secondary and higher education where the returns are more competitive.

The decisions of individuals concerning migration and what type of economic activity to pursue will depend in part on their educational attainment, and conversely, returns to education are partially realized through flexible labor markets that facilitate geographic and sectoral reallocations of labor (Schultz, 1988). The returns to education are often observed to be somewhat larger among wage earners than estimated for the self-employed, and larger in urban than in rural wage labor markets, which explains why better educated workers are more likely to migrate, particularly from rural to urban labor markets (Schultz, 1988). In Côte d'Ivoire, Vijverberg (1993) analyzed the range of employment opportunities faced by an educated worker, including whether to migrate to the urban sector, and whether to work as self-employed or in wage employment. He is able to decompose the returns to education for men and for women into that portion that accrues due to each of these reallocations.

Another intersectoral allocation of labor occurs between the private and public sectors. In Guinea, Glick and Sahn (1997) conclude that public sector jobs provide a larger wage premium for educated workers, particularly for women. In Côte d'Ivoire, however, Van der Gaag and Vijverberg (1988) also report substantial wage differentials between public and private sector wages, but after they control for education and other worker characteristics in a framework that corrects for the self-selection of the worker into the sector where they are most productive, the public-private wage gap is eliminated.

If the goal is to decompose that total gain from education or another form of human capital into that which arises from migration and from gaining access to particular sectors of employment, then a more complete structural model of the sectoral allocation of labor is required. But estimates of this structural decomposition depend critically on assumptions about how to specify the problem. Moreover, estimating a "reduced form" that does not attempt to separate choice of job and migration, as in the ordinary least squares estimates of Table 2, can nonetheless provide a useful estimate of the *total* returns to human resources such as education, health and nutrition. It is therefore quite reasonable for policymakers seeking guidance on human resource priorities to rely initially on the "reduced form" wage effects of schooling, health, and nutrition that are not conditioned on worker choices regarding where to work.

Exogenous Supply of Education in South Africa

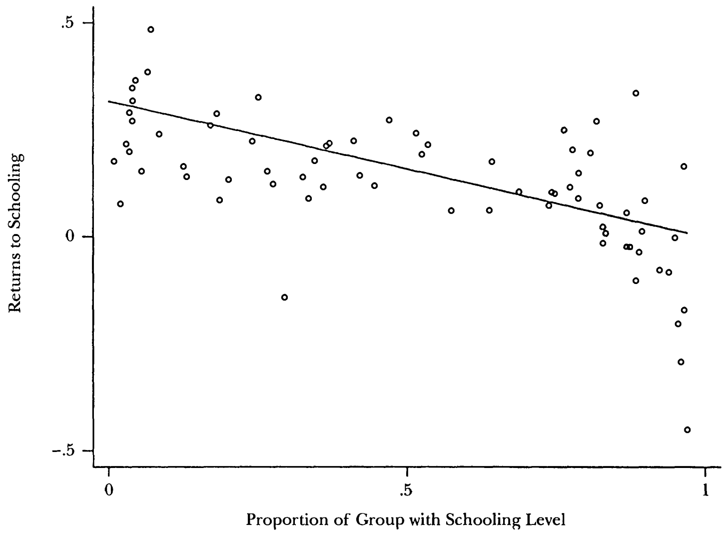
The quantity of human capital supplied reacts to shifts in demand; for example, a shift toward greater demand for skilled labor encourages higher school enrollment. Thus, if one wishes to estimate only how the relative supply of skilled labor affects relative wages (or returns to education), one must either make appropriate econometric adjustments, or search for a situation in which supply of education was varied independently of demand. This was the case with apartheid in South Africa, where the government rationed access to the public school system for political purposes, relatively independently of labor market demands, providing many times the educational resources per white youth as per black youth, with intermediate levels of support given the "colored" (or mixed race) and Asian groups.

A South African Living Standard Measurement Survey was collected in 1993, shortly before the black majority government was established in 1994. The private wage return to a year of primary, secondary, and higher education for men and for women can be estimated separately for the four main racial groups: black (75 percent of the labor force aged population), white (14 percent), mixed race or colored (8 percent), and Asian (3 percent). Because the public expenditures per student were many times larger for white schools than African schools, it might be expected that comparing the returns to an additional year of education would favor whites, because of the higher quality of the education they were receiving (Moll, 1992). Instead, returns are higher at each level of education for blacks than whites (Mwabu and Schultz, 1995). The returns to a year of education can be calculated in the familiar regression framework, where the dependent variable is the log of wages, and the explanatory variables are years completed of three levels of schooling, stratified by gender, the four races, and three different age groups to look at changes that may have occurred over time.[2] Returns to an additional year of primary education are 6. 2 percent and 8.4 percent for African women and men of all ages, whereas they are −3.4 percent and −1.2 percent for whites, respectively; at the secondary school level, returns to an additional year of education, are 25 percent and 16 percent for black women and men, whereas they are 5.2 percent and 8.4 percent for whites; and at the higher education level, the returns for black women and men are 40 percent and 29 percent per year of additional schooling, in contrast with the 13.9 percent and 15.1 percent returns received by white women and men, respectively.

The horizontal axis of Figure 3 plots the relative supply of each of the education-race-sex-groups, where the supply of education is the proportion of the group that has received at least that level of education, specifically the average of those who began and completed each level of schooling. For example, 42 percent

[2] Findings in this regression framework can also be used to approximate the elasticity of substitution by employers between different groups of workers. The coefficient on the relative supply variable in a regression explaining the relative wage between two groups of labor can be interpreted as the inverse of the elasticity of substitution between the two groups of labor in the economy (Topel, 1997). But to estimate the elasticity of substitution from such a regression, it must be assumed that the supply variation is exogenous to other factors that might affect the relative demands for these labor groups. It is also commonly assumed that the aggregate production function is subject to constant returns, and that there are no other factors of production that might have different degrees of substitution or complementarity with the two labor groups, such as physical capital, natural resources and land, or other forms of labor.

Figure 3
Effect of Rationed Supply on Returns: South Africa



Source: Mwabu and Schultz (1995).

of the white males age 30 to 44 received higher education, whereas only 4 percent of the African males in this age group received higher education. For white women the fraction with higher education is 28 percent, whereas for African women it is 7 percent. The Asian and colored groups have intermediate levels of schooling, and their rates of return are between those of the whites and Africans (Mwabu and Schultz, 1995). The vertical axis of the figure plots the returns to an additional year of education for each group.

The downward-sloping solid line represents a weighted regression of the returns against relative supplies for the 71 defined groups (the survey included no mixed-race women wage earners age 44 to 65), where the weight for each observation is the inverse of the standard error of the return estimate for that cell in the sample. The regression line has a slope of −.32.[3] The economic argument for South Africa to provide greater educational opportunities to nonwhites is clear. According to the regression, if the proportion of black men who received higher education could be increased from the current 4 percent in the age group 16–29 to 8 percent (without changing the quality of that education), their returns would decline only from 31.7 to 30.4 percent. Expansion of secondary and higher education for blacks in South Africa has the attraction of both increasing labor incomes

[3] The slope of the regression is robust to various alterations. For example, the coefficient remains largely unchanged if the intercept is allowed to shift between school levels. The high wage returns to African schooling are not significantly affected when potential selection bias due to analyzing only the wage-earning sample is corrected as in Table 2. Nor do quantile regressions confirm any tendency for returns to higher education to decrease among Africans with below average wage residuals (Mwabu and Schultz, 1996).

and growth, while also reducing the overall racial inequality of income by investing in the less affluent racial groups. As racial barriers diminish in education and in the labor market, it seems likely that inequality of earnings among blacks in South Africa will rise, but the inequality between blacks and whites as groups will narrow.

The Trade-off Between Quantity and Quality of Education

In principle, improvements in both quantity and quality can be used to improve educational performance. But there are relatively few analyses of how quality improvements in education have paid off. As one example, the effects of teacher-pupil ratios in South Africa are examined by Case and Deaton (1996) as a measure of local school quality. They find that the teacher-pupil ratio is an important determinant of enrollments, years of schooling completed for the student's age (a proxy for school starting age), and test scores, even after controlling for parent education and incomes. They also note that expenditures in the student's household on education are greater in communities with a higher teacher-pupil ratio. They interpret this pattern to suggest that local school quality encourages a greater private allocation of resources to the educational process in the home.

Quality improvements in education also have potential distributional implications. Improvements in quality may benefit particular groups. Quantitative extensions in basic schooling tend to favor the poor and rural segments in the population who are generally the last to be drawn into the educational system. However, the distribution of qualitative improvements in the educational system may favor the politically more powerful and well-off segments of the population. Indeed, public support of higher education in Africa is primarily a transfer to the children of the upper class and the rich, who can secure entry for their children by sending them to good urban preparatory schools (Psacharopoulos and Woodhall, 1985).

Kenya offers some evidence of the pattern that improvements in quantity of education favor the poor while improvements in quality favor the rich. Expansions in school facilities in Kenya in 1994 had the effect of increasing the enrollment of children in the poorest quintiles of the family distribution of income, but not surprisingly, had no impact on the enrollments of children in the top quintile, who tend to be already attending primary school (Deolalikar, 1997). On the other hand, improvements in teacher-pupil ratios, which can serve as a proxy for increased quality of schooling, had the reverse effect of increasing enrollment rates of children in the top quintile and actually reducing the enrollment of children in the bottom quintiles.

But the evidence on the quality/quantity nexus between rich and poor is not without ambiguity. In Tanzania, Mason and Khandker (1997) do not find that a shortage of primary school facilities in the region or a longer distance to the local school is an important deterrent to early enrollment in primary schools; instead, they find that the parental income and education factors discussed earlier are the key determinants. In Côte d'Ivoire and Ghana, on the other hand, Tansel (1997) finds that the distance to local schools has a substantial effect on enrollments and attainment, even after controlling for parental education and income.

Many of the difficulties with evaluating quality improvements in education are documented by Kremer et al. (1997) in assessing the consequences when a randomly selected group of Kenyan schools were provided with a set of improvements, including added textbooks and free uniforms. The early evidence from this social experiment suggests that schools receiving the added quality increased their enrollments significantly, mostly by attracting enrollments from neighboring schools, not by attracting new students into schools. As a result, class size increased sharply. Average test scores of the students at the higher "quality" schools consequently *declined* slightly. However, the drop in test scores was less than would have been expected on the basis of the inverse relationship between class size and test performance, so perhaps the "quality" schools increased their efficiency. Conversely, perhaps the schools that lost students may have lost their better and more-motivated students, or may have decreased their efficiency. If the experimental schools maintain their larger enrollments for a few years, local teachers will surely seek the assignment of more teachers to their school, who will be paid for by the Kenyan Ministry of Education. It isn't obvious what lessons to draw from a mixed experience like this one. More such social experiments in local education and health programs are likely to repay their expense in improved policy strategies in Africa and elsewhere.

Thus, while studies in Africa have suggested that improvements in school quality, proxied by smaller classes, can increase enrollments, these studies have limitations. Investigating quality changes is difficult, because measuring all the dimensions of quality is complicated, and because these dimensions often co-vary with other factors in the political economy of education. Observed variation in the local quality of schooling is itself often a response to local parent demand for quality, which implies more parental involvement in education. If the quality of schooling is varied without changing the private cost of schooling, then this improvement in quality will tend to increase the quantity of education demanded, which in turn will either dilute the quality or make it necessary to impose a quota. We need to build a more fully articulated model of household demand for schooling that incorporates the various dimensions of quality of education, quantity, and related variables like parental engagement in a way that clarifies the tradeoffs.

Concluding Observations

Most policy research on human capital in Africa has focused on education, as has the discussion here. It seems reasonably clear that social and private investments in basic primary and secondary schooling have competitive returns in many African settings. But each country and each level of schooling requires separate appraisal. Moreover, there is some reason to believe that on grounds of efficiency and distribution, Africa overemphasizes higher education. The estimates on returns to higher education given in this paper focus on private returns to schooling, not social costs. In post-secondary schooling, public expenditures per student are many times those at the primary or secondary level, and thus the social returns to *higher* education may be substantially lower than the private wage returns reported here (Psacharopoulos and Woodhall, 1985). On distributional grounds, public expenditures on higher education benefit today mainly the upper income classes in Africa. Changing to means-tested aid for higher education in Africa would reduce costs, while a growing reliance on tuition would begin to provide universities with more fiscal autonomy from the government and stronger incentives to offer programs for which private demands of student are strongest.

The basic information and analytical methodologies required to evaluate the productive returns to investments in public health are only beginning to be assembled. There are strong indications that health limitations are a costly burden on the productive potential of adults in Africa (Schultz and Tansel, 1997); indeed, if one were to single out the human capital constraint that has slowed development in Africa in recent decades, it would appear to be the low levels of health. As an historical parallel, a third or more of the gains in labor productivity achieved in the last 200 years in western Europe are linked to improvements in health, nutrition, and resulting gains in adult height (Fogel, 1994). Scattered surveys indicate that advances in nutrition are reflected in gains in adult height in Africa, as they were in the previous period in Europe, and indeed life expectancy has risen more rapidly in Africa until 1990 than it has in earlier periods in developed countries. But this region remains a laggard in the indicators of health and mortality.

It seems highly likely that certain intervention strategies could deliver cost-effective gains for Africa. Given the competitive private wage returns to schooling, the economic case for additional investments in basic primary and secondary education is unambiguous. The case for such education is further strengthened by the social externality associated with female schooling and child health gains and reductions in fertility (Schultz, 1993). The balance of benefits over costs for public health programs focused on child nutrition, child survival, and adult morbidity in Africa appears promising, but the evidence of cost-effective programs is scant and the specific program designs require further study.

The role of geographic mobility of labor in Africa deserves more systematic consideration than it has received. There may be large payoffs to interregional migration, but there are also distributional consequences. Powerful urban middle class groups often oppose measures to facilitate rural-urban migration, for migration imposes social costs of congestion on urban residents and increases the cost of public services in already crowded metropolitan areas. This was also the predominant position of elites in Latin America in the 1960s when rural-urban migration reached a peak. With the many local languages and cultures across Africa, reducing the barriers to the movement of people within and across countries must represent as much a political as an economic commitment (Easterly, 1995). The cultural heterogeneity of Africa may explain in part why mass education, which forges a common means of communication and competition in the labor market, is associated with such large percentage gains in labor productivity. Yet even when schooling and health are held constant, wage gains associated with migration are substantial for both sexes (as shown in Table 1). What remains largely unexplored is how public policies might both increase migration and assure that the gains that accrue to the society from labor mobility are equitably distributed.

Creating the information base required to allocate public resources among human capital resource development programs in Africa is a daunting task that begins with the collection of representative household surveys. Describing the policy environment and socioeconomic resources of families that lead them to demand human resources for their members is the first step. The second step is to measure how these human resources increase the productive capacity of those family members over their adult lives. A third required step is to know how much policies cost to modify the environment of the family to foster the desired change in human resource investments. A final step is to weigh the distributional consequences of returns or benefits among families. Only when we combine an understanding of who demands human capital, how much it affects the productivity of workers, what it costs in terms of social subsidies, and who benefits, can we begin to set human resource priorities for Africa on a firm foundation.

■ *I appreciate the comments on an earlier version of this paper from Alan Krueger and Timothy Taylor.*

References

Angrist, Josh and Alan B. Krueger. 1991. "Does Compulsory School Attendance Affect Schooling and Earnings." *Quarterly Journal of Economics.* 106:4, pp. 979–1014.

Barro, Robert J. 1997. *Determinants of Economic Growth: A Cross Country Empirical Study.* Cambridge, MA: MIT Press.

Barro, Robert J. and Jong Wha Lee. 1993. "International Comparisons of Educational Attainment." *Journal of Monetary Economics.* 32, pp. 363–94.

Barro, Robert and Xavier Sala-i-Martin. 1995. *Economic Growth.* New York: McGraw Hill.

Benefo, Kofi and T. Paul Schultz. 1996. "Fertility and Child Mortality in Côte d'Ivoire and Ghana." *World Bank Economic Review.* 10:1, pp. 123–58.

Benhabib, Jess and Mark M. Spiegel. 1994. "The Role of Human Capital in Economic Development: Evidence from Aggregate Cross Country Data." *Journal of Monetary Economics.* 34, pp. 143–74.

Bloom, David E. and Jeffrey D. Sachs. 1998. "Geography, Demography, and Economic Growth in Africa." *Brookings Papers in Economic Activity.* 2.

Boissiere, M., John B. Knight and Richard H. Sabot. 1985. "Earnings, Schooling, Ability and Cognitive Skills." *American Economic Review.* 75:6, pp. 1016–1030.

Card, David. 1998. "The Causal Effect of Education on Earnings." Center for Labor Economics Working Paper No. 2, Berkeley, CA. Forthcoming in *Handbook of Labor Economics,* Vol. 3. Ashenfelter, O. and D. Card, eds. Amsterdam: North Holland.

Case, Ann and Angus Deaton. 1996. "School Quality and Educational Outcomes in South Africa." Princeton University, Princeton, NJ.

Cochrane, Susan H., Joanne Leslie and Donald J. O'Hara. 1980. "The Effects of Education on Health." World Bank Staff Working Paper No. 405, Washington, DC.

Deolalikar, Anil. 1997. "Determinants of

School Enrollment and School Expenditures in Kenya." University of Washington, Seattle, WA.

Easterly, William. 1995. "The African Growth Tragedy." Working paper, The World Bank, Washington, DC.

Fogel, Robert W. 1994. "Economic Growth, Population Theory and Physiology." *American Economic Review.* 84:3.

Glewwe, Paul. 1990. "Schooling Skills and the Returns to Education." Living Standard Measurement Survey Working Paper No. 84, The World Bank, Washington, DC.

Glick, Peter and David Sahn. 1997. "Gender and Education Impacts on Employment and Earnings in West Africa." *Economic Development and Cultural Change.* 45:4, pp. 793–82.

Griliches, Zvi. 1977. "Estimating the Returns to Schooling: Some Econometric Problems." *Econometrica.* 45:1, pp. 1–22.

Grosh, Margaret and Paul Glewwe. 1998. "The World Bank's Living Standards Measurement Study Household Surveys." *Journal of Economic Perspectives.* 12:1, pp. 187–96.

Hasman, Jerry A. 1978. "Specification Tests in Econometrics." *Econometrica.* 46:6.

Heckman, James J. 1979. "Sample Selection Bias as a Specification Error." *Econometrica.* 47:1, pp. 153–61.

Heckman, James J. and Peter J. Klenow. 1997. "Human Capital Policy." Processed, University of Chicago, Chicago, IL.

King, Elizabeth M. and M. Ann Hill, eds. 1993. *Women's Education in Developing Countries.* World Bank, Baltimore, MD: Johns Hopkins University Press.

Knight, John B. and Richard H. Sabot. 1981. "The Returns to Education: Increasing with Experience and Decreasing in Expansion." *Oxford Bulletin of Economics and Statistics.* 43:1, pp. 51–71.

Knight, John B. and Richard H. Sabot. 1990. *Education, Skills and Inequality: The East African Natural Experiment.* New York: Oxford University Press.

Kremer, Michael et al. 1997. "Textbooks, Class Size, and Test Scores: Evidence from a Prospective Evaluation in Kenya." Labor and Population Workshop, Yale University, New Haven, CT.

Krueger, Alan B. and Mikael Lindahl. 1998. "Education for Growth in Sweden and the World." Processed, Princeton University, Princeton, NJ.

Kuznets, Simon. 1966. *Modern Economic Growth: Rate, Structure and Spread.* New Haven, CT: Yale University Press.

Levine, Ross and David Renelt. 1992. "A Sensitivity Analysis of Cross-Country Growth Regressions." *American Economic Review.* 82:4, pp. 942–63.

Mason, Andrew D. and Shahidur R. Khandker. 1997. "Household Schooling Decisions in Tanzania." The World Bank, Washington, DC.

Mincer, Jacob. 1974. *Schooling, Experience and Earnings.* New York, NY: Columbia University Press.

Moll, Peter. 1992. "Quality of Education and the Rise in Returns to Schooling in South Africa, 1975–1985." *Economics of Education Review.* 11:1, pp. 1–10.

Mwabu, Germano and T. Paul Schultz. 1995. "Wage Premia for Education and Location, by Gender and Race in South Africa." Processed, Economic Growth Center, Yale University, New Haven, CT. Forthcoming, *Economic Development and Cultural Change.*

Mwabu, Germano and T. Paul Schultz. 1996. "Education Returns Across Quantiles of the Wage Function." *American Economic Review.* 86:2, pp. 335–39.

Preston, Samuel H. 1980. "Causes and Consequences of the Mortality Decline in Less Developed Countries during the Twentieth Century," in *Population and Economic Change in Developing Countries.* Easterlin, R. A., ed. Chicago, IL: University of Chicago Press.

Pritchett, Lant. 1997. "Where Has All the Education Gone?" Policy Research Working Paper 1581, Policy Research Department, The World Bank, Washington, DC.

Psacharopoulos, George and Maureen Woodhall. 1985. *Education for Development.* New York: Oxford University Press.

Robbins, Donald J. 1994. "Worsening Relative Wage Dispersion in Chile During Trade Liberalization." Harvard University, Cambridge, MA.

Schultz, T. Paul. 1981. *Economics of Population.* Reading, MA: Addison-Wesley Pub. Co.

Schultz, T. Paul. 1987. "School Expenditures and Enrollments, 1960–1980," in *Population Growth and Economic Development.* Johnson, D. G. and R. Lee, eds. National Academy of Sciences Background Papers, Madison, WI: University of Wisconsin Press.

Schultz, T. Paul. 1988. "Education Investment and Returns," in *Handbook of Development Economics.* Vol. 1. Chenery, H. and T. N. Srinivasan, eds. Amsterdam: North Holland Pub. Co.

Schultz, T. Paul. 1993. "Investments in Schooling and Health of Women and Men." *Journal of Human Resources.* 28:4, pp. 694–734.

Schultz, T. Paul. 1994. "Human Capital, Family Planning and Their Effect on Population Growth." *American Economic Review.* 84:2, pp. 255–60.

Schultz, T. Paul. 1995. "Human Capital and Development," in *Agricultural Competitiveness.* Peters, G. H. et al. eds. Aldershot, England: Dartmouth Pub. Co.

Schultz, T. Paul. 1996. "Wage Rentals for Reproducible Human Capital in West Africa." Yale University, New Haven, CT.

Schultz, T. Paul. 1997a. "Demand for Children in Low Income Countries," in *Handbook of Population and Family Economics.* Rosenzweig, M. R. and O. Stark, eds. Amsterdam: North Holland Pub. Co.

Schultz, T. Paul. 1997b. "The Formation of Human Capital and Economic Development of Africa: Returns to Health and Schooling Investments." Working paper African Development Bank, Abidjan, Côte d'Ivoire.

Schultz, T. Paul. 1998. "Inequality in the Distribution of Personal Income in the World." *Journal of Population Economics.* 11, pp. 307–44.

Schultz, T. Paul and Aysit Tansel. 1997. "Wage and Labor Supply Effects of Illness in Cote d'Ivoire and Ghana: Instrumental Variable Estimates for Days Disabled." *Journal of Development Economics.* 53:2, pp. 251–86.

Shapiro, David. 1996. "Fertility Decline in Kinshasa." *Population Studies.* 50:1, pp. 89–103.

Strauss, John. 1986. "Does Better Nutrition Raise Farm Productivity?" *Journal of Political Economy.* 94:2, pp. 297–320.

Strauss, John and Duncan Thomas. 1995. "Human Resources: Empirical Modeling of Household and Family Decisions," in *Handbook of Development Economics.* Vol. IIIA. Behrman, J. R. and T. N. Srinivasan, eds. Amsterdam: North-Holland Pub. Co., Chap. 34.

Tansel, Aysit. 1997. "Schooling Attainment, Parental Education, and Gender in Côte d'Ivoire and Ghana." *Economic Development and Cultural Change.* 45:4, pp. 825–56.

Topel, Robert. 1997. "Factor Proportions and Relative Wages: The Supply Side Determinants of Wage Inequality." *Journal of Economic Perspectives.* Spring, 11:2, pp. 55–74.

Topel, Robert. 1998. "Labor Markets and Economic Growth." Draft for *Handbook of Labor Economics.* Vol. III. Heckman, James J. and D. Card, eds. Amsterdam: Elsevier Publishers.

United Nations Educational Scientific and Cultural Organization (UNESCO). Various years. *UNESCO Statistical Yearbook.* Paris.

United States Bureau of the Census. 1998. *HIV/AIDS Surveillance Data Base.* International Programs Center, Washington, DC.

Van der Gaag, Jacque and Wim Vijverberg. 1988. "A Switching Regression Model of Wage Determinants in Public and Private Sectors of a Developing Country." *Review of Economics and Statistics.* 70:2, pp. 244–52.

Vijverberg, Wim P. M. 1991. "Profits from Self Employment: The Case of Côte d'Ivoire." *World Development.* 19:6, pp. 683–96.

Vijverberg, Wim P. M. 1993. "Educational Investments and Returns for Women and Men in Côte d'Ivoire." *Journal of Human Resources.* 28:4, pp. 933–74.

World Bank Staff. 1991. *Social Indicators of Development 1990.* Baltimore, MD: The John Hopkins University Press.