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CENTER DISCUSSION PAPER NO. 702

INVESTMENTS IN THE SCHOOLING AND HEALTH OF WOMEN AND MEN: QUANTITIES AND RETURNS

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Abstract

Women's years of school enrollment and health, measured by longevity, have increased by a greater amount than men's in this century in most countries. Private and social returns to schooling and health are reviewed to explain these trends in women's human capital. Sample selection bias caused by analyses of only wage earners does not appear to lower women's private returns to schooling relative to men's. Social returns to education, moreover, favor greater public investment in women than men, particularly in South and West Asia and Africa where school investments in women are much less than in men.

KEY WORDS: Human Capital, Women, Development

I. Introduction

This paper surveys the evidence on recent trends in the growth of human capital investments in women. The fraction of national income allocated to human capital formation in both high- and low-income countries has grown decisively in this century, and if height is interpreted as an indicator of health investments in reduced disease and improved nutrition, increases in height can be traced back several centuries in portions of Western Europe (Fogel 1990). The share of these human capital investments that raise women's productivity has risen in this century in most countries, but the forces behind this widespread development are poorly understood. The consequences of this fundamental redirection of social resources are only beginning to emerge from the disparate lines of research reflected in this symposium.

One economic explanation for this development is that the private rates of return to investments in women's human capital have increased relative to the private returns on alternative investments, including those in men's human capital. Societies may also want more investments in women, because of the greater social returns (external benefits) accruing from women's human capital compared to men's. Independent of these private and social economic returns, as parents become wealthier, they may attach greater value to equalizing their investments in their daughters and sons. Some evidence for the "relative returns" and "personal income" hypotheses is discussed below.

In order to test the relative returns hypothesis with regard to human capital, the private and social productive returns to education, health, etc. must be estimated for all women and men, some of whom cannot report the monetary equivalent to their labor productivity. The majority of the world's population

does not work for a wage; their labor productivity is therefore difficult to measure apart from factor payments due other family workers and nonlabor inputs, such as land (Schultz 1990). In the 1960s, when Becker first sought to estimate how college education enhanced the productivity of persons, he implicitly assumed that these returns to college accrued to individuals only to the extent that they worked in the market labor force (Becker 1964). Yet because time in school is treated as a full-time investment cost valued at the market wage rate, application of Becker's methodology biases downward educational returns calculated for women and other groups who do not participate full-time in the labor force after completing their education. Many studies in the last three decades have shown that education also increases the productivity of individuals in nonmarket activities (Michael 1982; Haveman and Wolfe 1984). The direction of the bias in calculating women's returns is clear, but no satisfactory approach has been developed for aggregating the variety of often nontraded home outputs and nonwage production, along with wage production, to shed light on an average economic returns to schooling for the entire population, regardless of how they allocate their productive time (see Jorgenson et al. 1987).

The challenge is to estimate a single rate of return parameter that will summarize the economic pay off to one form of human capital investment for the entire population, when labor productivity is confidently observed for only wage earners. This problem is related to that posed by Heckman (1979) for dealing with sample selection bias. The assumptions underlying Heckman's formulation of the sample selection model are currently being refined, reevaluated, and in some cases, relaxed, as in the case of nonparametric methods. Alternative plausible specifications of these models will need to be considered, and confidence in the empirical results from these models will hinge on their robustness to apparently

minor variations in specification. The critical economic issue here is the choice of a defensible exclusion restriction to identify the role of sample selection in the joint estimation of the private return to human capital. A simple basis for identification will be proposed and implemented on several national population samples at the conclusion to this paper. This statistical approach is gaining widespread acceptance, but deserves a critical evaluation, and even when based on persuasive identification restrictions, it may or may not affect comparisons of female and male returns from country to country and from one time period to the next.

The health and nutritional investments received by males and females are more difficult to assess than are educational investments. Sex differentials in mortality and causes of death may be modified by changing occupational risks and health investments, broadly conceived. Adult height and weight indicate the net nutritional balance of individuals, given their exposure to disease, access to health care, and self-selected forms of activity. Because males and females may biologically differ in their vulnerability to certain of these health conditions, sex differences in health outcomes may reflect both sex-specific genetic endowments and intra- and inter-family allocations of nutrition, health care, and work. Changes in reproduction and breastfeeding practices may also relieve women of certain health risks and expose them to new ones, as responses to environmental changes.

This paper is organized as follows. Section II presents patterns in school investments in men and women across regions and across birth cohorts within countries. Section III reviews gender differences in mortality and nutritional status. Section IV describes how market failure could be responsible for families investing less than the socially efficient amount in girls than boys,

while Section V sets forth the problems of measuring without bias these private and social returns. Section VI illustrates the social externalities associated with educating men and women. Empirical patterns across countries in estimated returns to schooling are then summarized in Section VII. Sample-selection corrected private returns to schooling are estimated in Sections VIII and IX. A concluding section poses questions for further research.

II. Measures of the Investment in Schooling of Women and Men

The average number of years of schooling completed by men and women in various age groups can be derived from some population censuses, but these estimates of stocks of education in the population are available from only a few low-income countries over time. School enrollment rates by sex are published in the UNESCO Statistical Yearbook for most countries annually over the last several decades. A single measure of the flow of investment in education for a cohort is the "expected years of school enrollment" (Schultz 1987). It is constructed by multiplying the gross enrollment rates at each school level (or age) by the number of years of study at that level (or age bracket), and summing over levels. There are, of course, many limitations to this single synthetic measure of educational investment in a cohort: (1) it ignores repetition of grades and partial attendance; (2) it is not adjusted for length of school hours and school year; (3) it neglects quality of the schooling which might be related to school resources per student; and (4) it combines different levels of education indiscriminately, whereas each year of schooling increases the value of the child's time in the next level of education as does the child's aging itself. All of these factors may contribute to overstating the value of education acquired at earlier years compared to later years and to overstating the value

of the same level of education in lower compared to higher income countries. This crude physical measure of expected years of enrollment will be subsequently refined with data on public expenditures per student year by school level.[1]

Expected years of school enrollment are converging between low- and high-income countries, as evident from Figure 1 where the gap is shown to have closed from about seven years in 1950 to five years in 1985. Figure 2 shows that women today are receiving nearly as many years of "enrollment" as men in industrially advanced, high-income countries. Latin America and, to a lesser extent, South East and East Asia are relatively similar to the high-income countries. At the other extreme are most of the countries of South and West Asia and North and sub-Saharan Africa in which women receive about two-fifths to three-fourths the number of years of schooling as men do. This pattern for Latin America, Africa and high-income countries is based on UNESCO regional estimates representing all countries of these regions. I have computed my own estimates separately for the subregions of Asia from individual country enrollment figures because of the noted differences in levels and trends between the subregions of Asia. In every region distinguished in Figure 2, however, the ratio of female to male expected years of enrollment increases from 1950 to 1985.

From the alternative source of data on educational attainment, population censuses, years of schooling completed are shown in Figure 3 by age for seven selected countries. The ratio of female-to-male educational attainment is then plotted in Figure 4. At older ages (that is, earlier birth cohorts), the relative gap between men and women in educational attainment is substantially larger, with the exception of the United States (see Goldin 1992). School attainment and enrollment data, which typically come from independent statistical sources, imply similar estimates of years of educational investment for recent

Fig. 1: Expected Years of Enrollment, by Region, 1950 to 1985

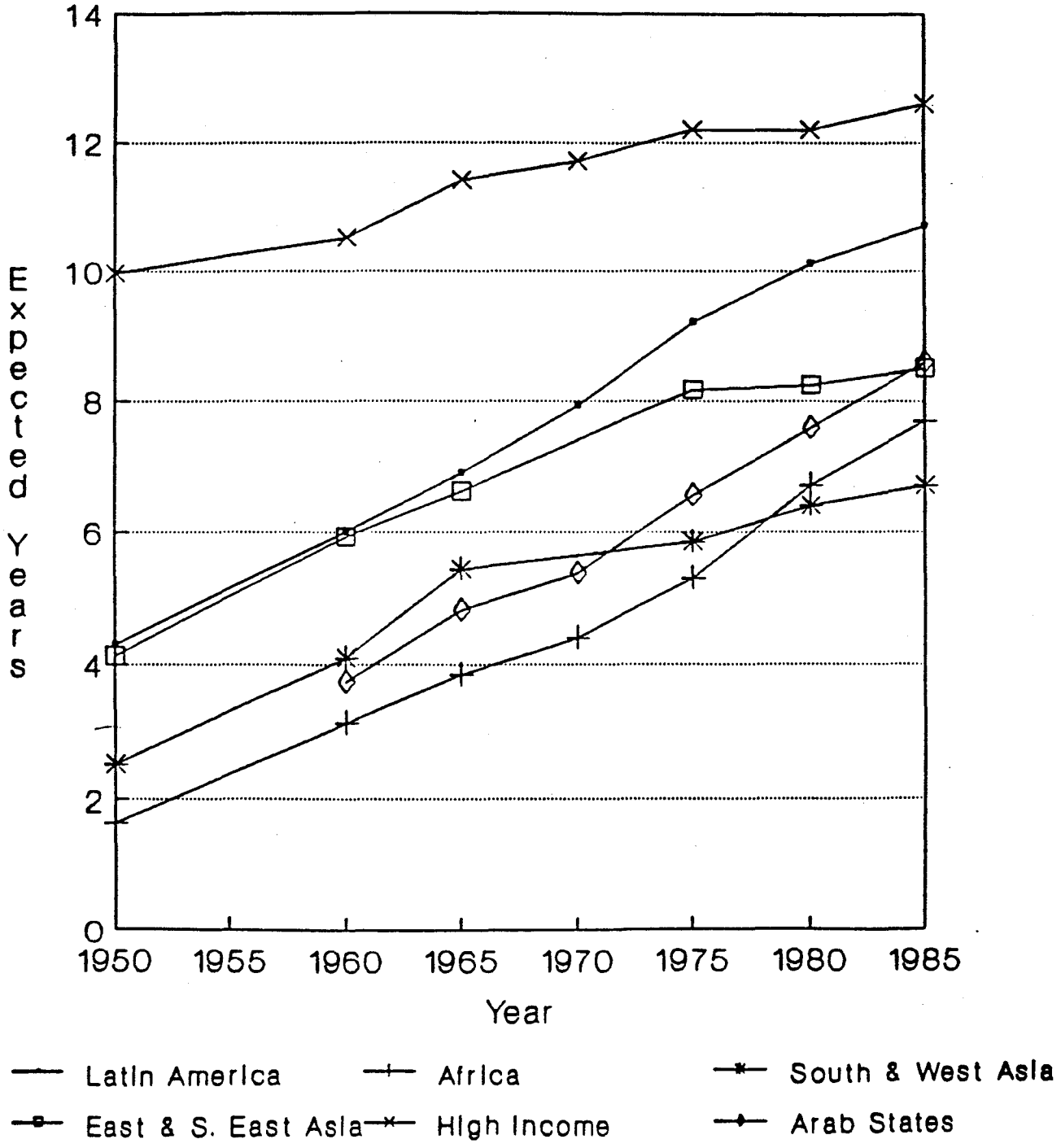
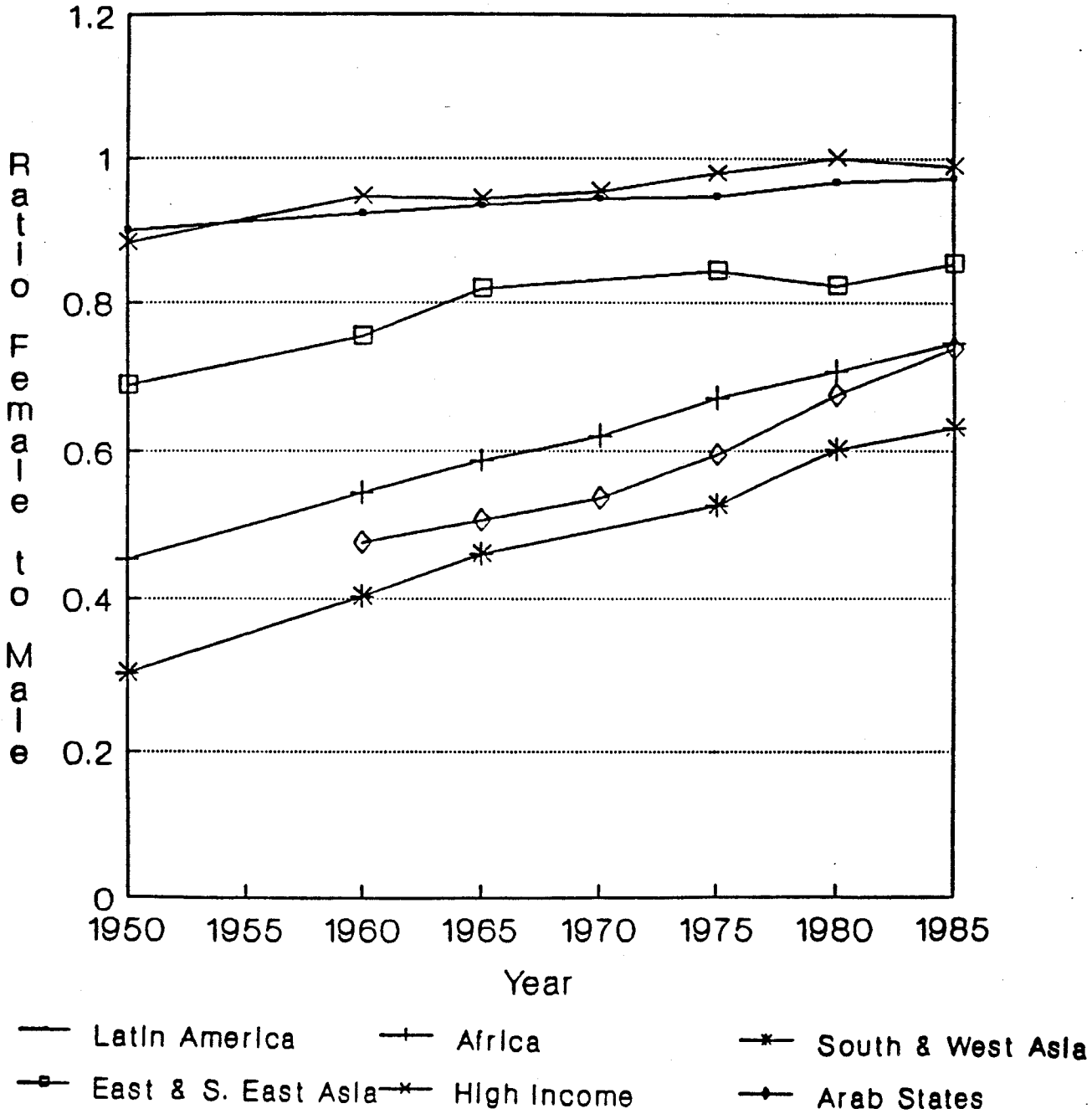


Fig. 2: Female to Male Expected Years of Enrollment by Region, 1950 to 1985



Data notes on figures 1 and 2:

The expected years of enrollment are based on the gross enrollment rates for three age (or school level) groups multiplied by the number of years in the age (school level) group. For example in the 1984 Statistical Yearbook of UNESCO, Table 2.11 provides the age specific enrollment rates for designated regions. In this case the three age specific enrollment rates are each for six year brackets (age 6-11, 12-17 and 18-23), and thus are each multiplied by six and summed for a measure of "expected years of enrollment". To obtain disaggregated estimates for South and West Asia For Asia and East and South-East Asia, enrollment rates for individual countries were aggregated, by school level, and weighted by the population in the age groups conventionally attending that school level. Table 3.2 provides the primary, secondary and tertiary enrollment rates, whereas the conventional duration of each nation's school system's levels is reported in Table 3.1 in the UNESCO Yearbook. In the earlier years, some countries do not report enrollment rates in Asia, such as North Korea and Afghanistan. These countries do not represent a significant share of the Asian regions reported here, and for simplicity enrollment rates are assumed not to have changed in these countries from 1950 to the first year for which figures are reported, usually 1960, whereas UN population estimates by age are available for all countries to weight the enrollment rates. The figures for China are more unstable, and probably are subject to more error, despite the fact that they are derived from time series on enrollments that are consolidated into standard Chinese yearbooks on education. But these estimates for China are not necessarily the same as those implicitly used by UNESCO.

Fig. 3: Years of Schooling Completed, by Age, for Selected Countries

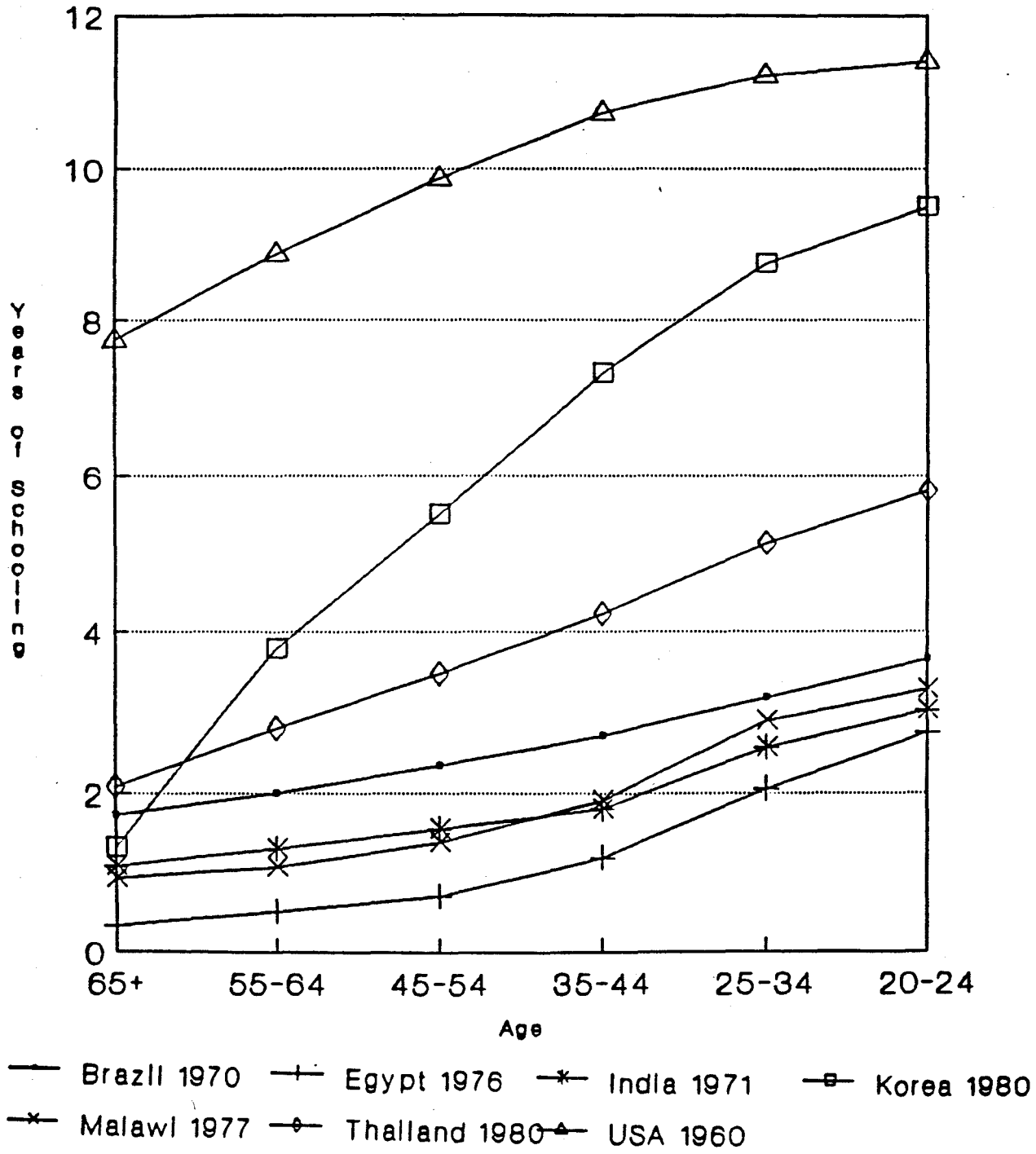
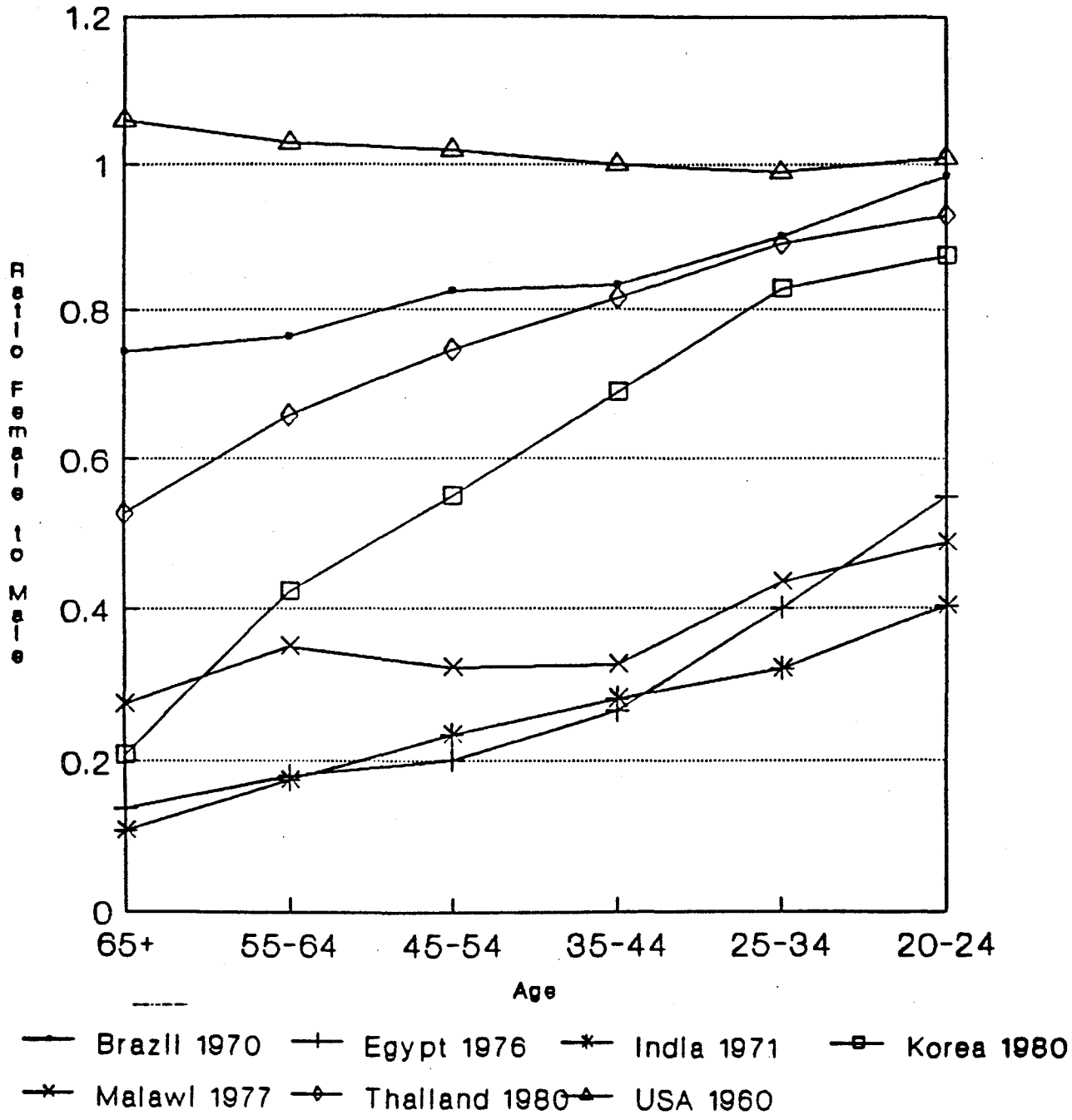


Fig. 4: Female to Male Years of Schooling Completed by Age, from Selected Countries



birth cohorts within this group of countries. The more widely available school system data on enrollments, thus, do not appear to be a misleading indicator of the years of the education that cohorts eventually complete who are currently matriculating in the system. But enrollment rates describe only current investment flows and do not describe directly the stocks of human capital available to the economy or labor force at any particular point in time. It is often difficult to estimate low-income countries' enrollment rates before about 1960. For this reason, estimation of educational attainment among older cohorts from historic enrollment trends is uncertain but probably not too misleading for the entire labor force because of its youthfulness (World Bank 1992). From both sources of data, women's years of schooling are more nearly equal to those of men in countries with higher per capita income, and over time within countries women are making relative gains in those countries that achieved more rapid economic growth in the period 1960-80 (Schultz 1989b).[2]

Public expenditures on education are reported for at least five years in 47 countries in real local currency units. These expenditures are converted according to 1969-71 foreign exchange rates into 1970 dollars. Averages of these expenditures per student in these countries are reported in Table 1 for 140 country-year observations, included at five-year intervals. These estimates should be treated with caution because this small sample of countries may not be representative of the regions I have grouped them into or of the world as a whole.

Expenditures per student increase across regions with increasing income, with the exception of South and West Asia which spend more per student than do Latin America and South East and East Asia. This anomaly can be traced to the higher relative cost of teachers in the South and West Asian region (Schultz

Table 1

Expected Years of School Enrollment and Annual Public Expenditures Per School-Aged Child, 1960s and 1970s: Averages for a Sample of Countries Reporting Time Series on Schooling Expenditures by Level

Region (Number of Countries Observed[a])	Expected Enrollment per Child[b] (Years) (1)	Annual Public Expenditure per Child[c] (1970 $) (2)	Ratio of Female to Male: Years Enrolled (3)	Ratio of Female to Male: Public Expenditures (4)
World: (47)	8.9	2878.	0.91	0.76
Africa (13)	5.7	455.	0.73	0.50
Latin America (8)	8.0	801.	1.03	0.83
East & Southeast Asia (6)	9.4	913.	1.00	0.86
West & South Asia (5)	7.3	1234.	0.59	0.52
High Income Countries (15)	12.0	6854.	1.02	0.93

[a]A country is included if UNESCO Statistical Yearbooks report for at least five years the required data on enrollments by sex, and public expenditures by three levels of schooling. Countries included in sample (and span of years included) are as follows: Malawi (1965-1980), Mauritius (1965-1975), Rwanda (1970-1980), Tanzania (1965-1975), Zambia (1970-1980), Congo Rep. (1970-1975), Algeria (1970-1980), Morocco (1965-1975), Tunisia (1975-1980), Ghana (1965-1980), Niger (1975-1980), Senegal (1970-1980), Burkino Faso (1975-1980), Trinidad/Tobago (1965-1980), Guatemala (1965-1975), Honduras (1965-1980), Mexico (1965-1975), Panama (1960-1980), Colombia (1965-1980), Paraguay (1960-1970), Venezuela (1965-1970), Japan (1965-1975), Hong Kong (1970-1980), South Korea (1960-1965), Malaysia (1975-1980), Philippines (1970-1980), Singapore (1970-1980), Thailand (1960-1975), Afghanistan (1970-1975), Iran (1970-1975), Iraq (1965-1970), Kuwait (1975-1980), Syria (1970-1980), Israel (1965-1980), Finland (1960-1975), Ireland (1960-1980), Norway (1960-1970), Sweden (1975-1980), United Kingdom (1970-1980), Greece (1970-1975), Italy (1960-1970), Portugal (1975-1980), Spain (1965-1975), Yugoslavia (1960-1970), France (1970-1980), West Germany (1960-1980), Netherlands (1960-1965).

Table 1 (cont.)

[b]Expected enrollments are derived by summing the weighted gross enrollment rates for the three school levels, where the weight is the reported duration of the school level in years.

[c]Public expenditures for each school level includes the current expenditures and a share of capital expenditures. Capital expenditures are smoothed by a five year moving average, and interpolated in a few cases. Because capital expenditures are not allocated by level, they are divided among levels in the same proportion as that level's current expenditures are to all current school expenditures. Female and male students are assumed to receive the same expenditures on their education within the same school level.

1987). In each country, however, public expenditures per student increase markedly at the secondary and higher educational levels compared to those at the primary level, particularly in low-income countries, and especially in Africa and South Asia (Psacharopoulos and Woodhall 1985).

Although public expenditures on education cannot be disaggregated into those spent on educating boys and girls, the expected years of enrollment, which are available by sex, can be weighted in these 47 countries for differences in average (boys and girls combined) public expenditure per student at the three levels of schooling. This adjustment incorporates the tendency for the fraction of female students to decline at higher levels in the school system, and for public subsidies per student to increase at these higher levels. Any differences in expenditures on male and female students within a given schooling level are neglected by this procedure, and, particularly at higher levels of education, such differences may be important (for example, differences between teacher colleges for women and technical universities for men). No data could be found for most countries on the costs of educational subsystems and their sex composition.

In most countries, relatively few youth attend school beyond the secondary level. Nonetheless, the inclusion of the higher level of education increases by 26 percent the total public outlays on education in this sample. Because women receive an especially small fraction of these opportunities for higher education in many countries, the ratio of female to male public expenditures on education is .76 for the full sample (that is, for the world), although women receive 91 percent as many years of education as do men. In Africa, the female to male ratio of years of enrollment is .73, while the ratio of public school expenditures is only .50. Even in Latin America, East Asia and the high income

countries, where the ratio of enrollments approaches parity, the ratio of expenditure on women relative to men declines to .83, .86, and .93, respectively. In the South and West Asia region the ratio of female to male enrollments starts at .59 and declines further in terms of public expenditures to .52. In sum, there is today a noted division in the developing world between those countries that are approaching parity in educational expenditures on women and men (>.83) and those that are not (<.52). Are these regional divisions closing over time and are women's human capital investments catching up to men's in terms of education?

Rates of growth over time in the level and gender composition of school enrollments and public expenditures on education can also be calculated for the same sample of 47 countries. These annual percentage growth rates are reported in Table 2. Expenditures have increased twice as rapidly as enrollments in the world. The exception to this pattern is Africa where enrollments increased nearly as rapidly as expenditures. African school systems have reduced their costs per enrolled student. This has been accomplished through a reduction in the relative cost of teachers associated in part with replacing expatriates with natives, and reducing the relative wages of teachers as the available native supply of potential teachers increased (Schultz 1987). Salaries of teachers accounted for 90 percent of public expenditures on education in low-income countries in 1981--as they did in the last half of the nineteenth century in the United States (World Bank 1981; Fuchs 1968).

The educational system has the capacity to reduce the equilibrium wage of teachers by expanding the supply of persons capable of holding such jobs, for example, graduates of secondary or normal schools. Because teachers are the dominant input to the educational system as well as an output, a more rapid

Table 2

Annual Growth Rates in Percent of Expected Years of School Enrollments and Public Expenditures per School Aged Child, from 1960s and 1970s: Averages for a Sample of Countries

Region (Number of Countries Observed[a])	Expected Enrollment per Child[b] (Years) (1)	Public Expenditure per Child[c] (1970 $) (2)	Ratio of Female to Male Years Enrolled (3)	Ratio of Female to Male Public Expenditures (4)
World: (47)	2.0	5.4	0.74	0.85
Africa (13)	3.3	3.7	1.6	0.70
Latin America (8)	2.3	5.2	0.07	1.2
East & Southeast Asia (6)	1.1	3.3	0.81	1.8
West and South Asia (5)	2.8	7.7	1.5	0.45
High Income Countries (15)	0.95	7.2	0.10	0.52

Notes: See Table 1.

expansion of secondary school output can contribute to lowering the unit cost of basic education and helping enrollments expand more rapidly than public educational expenditures. The compression of the ratio of wages of secondary school graduates to primary school graduates, which is a rough measure of long-run private returns to secondary education, is then empirically related to the widespread expansion of basic education in a society, other things being equal. (Knight and Sabot 1987; Lam and Levison 1992; Almeida and Barros 1991; Londoño 1990).

Every region in Table 2 shows a tendency for the ratio of female-to-male enrollments and the ratio of female-to-male school expenditures to increase. The increase varies substantially across regions, however, as does the gap to be closed between human capital investments in men and women. The slowest rate of increase of female-to-male expenditures on schooling is in South and West Asia, .45 percent per year, and this slow advance is based on the initially low level of the female-male expenditure ratio of .52 (Table 1).[3] Thus, the low-income region that currently invests the least in the education of women compared to men is closing this gap in expenditures more slowly than other regions, or falling further behind. Why are these regional differences so substantial and persistent?

There are two plausible reasons parents in low-income countries do not investment more in the schooling of their children: the low returns on schooling and their own low income. Parents may see the expected private rate of return to schooling of their children as low relative to their alternative investment opportunities. Even when expected returns are competitive, parents may not invest an efficient amount in the education of their children because of their aversion to the associated risks or because of credit constraints that limit

their ability to borrow funds to invest in the future productivity of their children. Both risk aversion and credit constraints are likely to be more important among the poor who have fewer opportunities to diversify such risks in their portfolio or offer other collateral for borrowing to finance investment in education.

Education can also be viewed by parents partly as a normal consumption good for which their demand increases with their income, holding constant the return (or inverse of the net price) of education. Parents may be called "altruistic" if they derive utility from increasing their children's future consumption by educating them. From either perspective, parent income moderates the effect of risk aversion and credit constraints on the demand for the investment good, or parent income increases the demand for education as a consumption good. Clearly, it is difficult to distinguish between these alternative explanations for there being a relationship between parent income and child education. From either viewpoint, parent demand for schooling is expected to increase with their income and decrease with the price, even though schooling is considered mainly as an investment good, at least by economists.

Based on cross-country comparisons from 1950 to 1980, school enrollment rates increase with national income per adult and decrease with the relative cost of teacher salaries. The estimated positive income and negative price elasticities of school enrollments are both larger in absolute value for female enrollment rates than for male enrollment rates (Schultz 1987). Larger responses of female than male enrollment rates to income and prices are also observed within countries over time during the 1960s and 1970s (Schultz 1989b). Per capita income increases and the relative price of teachers decreases with economic development, and, according to these estimates, both changes reduce the

relative and absolute gap between enrollments of women and men. Family-level studies have also found that the household income elasticity of the school enrollment rate of daughters exceeds that of sons, and distance from residence to school is a greater deterrent to enrollment for girls than boys (Lavy 1992; Tansel 1993; Deolalikar 1993).

Public expenditures on education are not commonly disaggregated by sex of student. It is not possible, therefore, to estimate how public sector expenditures on female and male schooling respond independently to income and prices, but the income elasticity of total public expenditures on schooling clearly exceeds one, and not surprisingly. The income elasticity is higher at higher levels of education, when estimated from cross-sectional or time series variation at the national level (Schultz 1987, 1989b).

A question that has not been pursued, to my knowledge, is whether gender differences in educational investments across countries and within countries over time are a response to gender differences in private returns or social returns to schooling in those countries. If enrollments do not respond positively to returns, then are we to conclude that the distribution of schooling is misallocated as an investment? Does the allocation of human capital between the sexes affect the differentials in returns to schooling and lead men and women with comparable skills to perform different tasks in the economy? This set of issues is clearly difficult to pursue and not attempted here.

III. Women's and Men's Health and Nutritional Status

Much less is known about nutritional inputs and health-related care that are invested in men and women than about the gender allocation of educational investments. Biological relationships are postulated between human nutritional

inputs, physical growth, metabolic requirements for body maintenance, and finally an energy "excess" that can be allocated to productive and leisure activities. The efficiency of this energy conversion system, however, is affected by exposure to disease, and the immune system itself makes requirements on nutrition inputs to fight infections and parasites. Given the complexity of these processes and the long lags between inputs and outcomes, research on nutrition has sought indicators of the net (or final) outcome (for example, height) rather than trying to quantify all of the inputs and production functions that underlie human growth and health status. Moreover, as long as health and nutrition inputs are themselves allocated within families and societies in response to unobserved (by researcher) healthiness of individuals, direct estimates of health technology, or the effects of inputs on health outcomes, can be quite misleading. This heterogeneity bias will be present even if all inputs are accounted for and functional forms of the health production process are known (Rosenzweig and Schultz 1983).

Most analyses of health technology have focused on the least ambiguous (and most final) outcome, mortality. Anthropometric indicators of health, such as birthweight, height for age, body-mass-index (defined as weight divided by height squared), and skinfold thickness, are justified as readily measured proxies of cumulative health status by the strength of their correlations with age-specific mortality (Fogel 1990). There is, however, a view that too much emphasis has been given to mortality, and conversely that measures of morbidity, such as limitations on physical functioning, should be consulted to assess the health of the living. For this view to carry weight, different health investments and behavior must be effective in modifying morbidity compared with mortality, and gender differences, in particular, in these two measures of health are certainly not always congruent (see Strauss et al. 1993).

Under the conditions prevailing today, females appear to live longer than males, given apparently equivalent diet and medical care. In the industrially advanced countries of Europe, European settlements and Japan, females at birth are today expected to live four to eight years longer than do males (United Nations 1982). The mortality advantage of women seems to be a recent development, however. Before the twentieth century, male mortality appears to have been infrequently higher than female mortality, and sometimes lower (Preston 1976; Fogel 1986; Pope 1992). Some countries in South and West Asia continue to report more males than females in their population, such as India, Pakistan, Bangladesh or Nepal, and this can be attributed to the higher mortality rate among females than males from birth until at least the end of childbearing or age 45 (see, for example, Visaria 1971). In general, where the overall level of mortality is lower and life expectancy at birth is longer, the relative mortality advantage of women compared to men is larger (Stolnitz 1956; Preston 1976).

Three hypotheses for this change in sex differences in mortality are that (1) the causes of death have changed, probably due to the introduction of medical treatments for infectious and parasitic diseases, or (2) the diet and/or medical care of females compared to males improved, or (3) differences in occupations have changed and the health risks associated with these roles differ, with the new outcome favoring women. Data on cause of death are not particularly reliable historically and are often of uncertain quality even today in many low income countries. Most cause-of-death rates by sex indicate more frequent male than female deaths within most cause-specific categories, with a few notable exceptions. However, the shift in the cause of death composition of deaths with rising incomes does not, according to Preston (1976), explain the increasing female advantage in survival over males in the twentieth century. Only a small

part of this change, for example, can be explained by the decline in fertility and reduced risk of immediate maternal mortality.

Confronted by this puzzle, Preston disaggregated age-standardized death differentials between males and females into 13 causes of death. He finds that the increase in male relative to female mortality associated across countries with rising average income is explained mostly by cardiovascular disease, neoplasms, TB, and influenza/pneumonia/bronchitis. Family and social allocations of health investments may play some role in some of these sex differences in mortality by cause, but the evolving exposure of men and women through occupational roles determined by technological change and urbanization, as well as possible biological differences in their vulnerability to specific diseases, cannot be ruled out as the originating factor for these patterns. For example, diarrheal diseases and other infectious and parasitic diseases that are a major cause of high mortality at low-income levels, and which might be expected to respond noticeably to intrahousehold resource allocations of food and care, are not quantitatively important in the changes in the gender balance of mortality that occur with development (Preston 1976).

If the decomposition of death rates by cause does not generate any salient hypotheses for why female mortality declines more than male mortality in this century and with development, several characteristics of the environment of the individual do. Problems of multicollinearity among explanatory variables at the national unit of observation limit the confidence we can attach to such estimated relationships, but they are a useful source of hypotheses that may be refined at the micro level. Agricultural populations have higher female relative to male mortality and higher overall death rates. Cardiovascular and neoplasm deaths and

those related to respiratory diseases become relatively more important in urban areas and take a disproportionate toll of males (Preston 1976).

Preston then considers another variable that is more difficult to interpret, because it is a product of two functionally dissimilar variables: the grams of animal protein consumed per capita and the female-male ratio of primary school enrollments. This hybrid variable, holding constant for metropolitanization and agricultural employment share, is associated with greater male relative to female mortality through its correlation with deaths due to cardiovascular disease, to violence other than automobiles, and, because of declining fertility, to maternal mortality. Other than this single study by Preston (1976) and Preston and Weed (1976), there are few multivariate explanations for the recent marked changes or variation in the sex balance of mortality. All that is known, then, is that with metropolitanization and a shift of employment out of agriculture, mortality declines more rapidly for females than for males.[3] It is possible that this is related to increasing returns to health investments in women in urban areas where women have increased their schooling and entered the labor force as their wage opportunities have improved relative to those of men. Alternatively, other changes in the rural/urban composition of endemic diseases and the greater availability of public and private health services in urban locations may have favored the health of urban women independently of their economic productivity.

Adequacy of diet contributes to adult height and the age pattern of growth and timing of sexual maturation, but is presumably also affected by diseases and behavior (Falkner and Tanner 1986, vol. 3). Historical analyses of the level and change in height in Western European populations in recent centuries has documented substantial growth in stature in "man" (Tanner 1981; Fogel 1986), but

relatively little attention has been paid to measuring male-female differences in height or analyzing the origins of changes in these sex differences, if any.[4] Some have argued that females, compared to males, "are more readily thrown off their growth pathway by environmental adversities, such as malnutrition and disease, and that they respond more dramatically to environmental improvement" (Bielicki 1986, p. 298), but the evidence is weak. Sexual dimorphism in regard to human growth may not, however, all be biological (in other words, genetic) in origin, but rather it could be a response to cultural and economic factors filtered through household allocations (van Wieringen 1986; Waldron 1983, 1986). How surpluses and shortfalls in food supplies are shared in the family and society is affected by the roles men and women undertake and the physical claims that these work activities place on their dietary intakes (see Pitt et al. 1990).

Few studies separately assess how the height of men and women varies with economic conditions and how their height affects mortality, morbidity or economic functioning.[5] There is little evidence that adult height has increased relatively more for females than for males in the nineteenth and twentieth centuries in West European populations, although the adolescent spurt of growth may have shifted to a younger age by a greater amount for girls than boys (Bielicki 1986).[6] There is also evidence that height increased more rapidly in urban than in surrounding rural areas in several European populations, but sex differentials in these gains or how they contributed to improved adult health or economic functioning are not discussed.

In sum, there has been a dramatic, but largely unexplained, advance in female longevity relative to male in the twentieth century that is evident in most countries, with the exception of certain countries in South Asia. This development is associated with the shift of populations from dependence on

agriculture to working in urban areas. Height, due to dietary gains and control of disease, has been increasing for as long as two hundred years in some Western European populations. New studies are needed to assess the conditions under which gains in stature differ for women and men with distinct consequences for their economic functioning and welfare. Have health inputs for women increased relative to men from families or from society at large? The gains in longevity and stature have not yet been analyzed in conjunction with women's schooling and labor force participation, inside and outside of the family, to assess whether these factors account for the increasing productivity of females relative to males. These changes are a major source of decreasing inequality within and between countries in this century (Rosenzweig and Schultz 1982; Schultz 1990).

IV. Individual and Social Returns to Education: Conceptual Distinctions

Returns to education are calculated from information on the benefits and costs and can be reckoned from three perspectives: that of the individual student, the student's parents, or the society. The private individual's future after-tax gains in productivity associated with schooling are offset by private opportunity (time) costs lost to the family and direct private costs. Individuals are assumed to maximize their lifetime wealth by investing first in forms of human and physical capital that earn them the highest internal private rates of return.

In reckoning education's costs from the perspective of the society, public sector subsidies to education are included with the private costs of education. In addition, there may be social benefits from the educated individual's increased future productivity and altered behavior that are not captured by the individual.[7] More educated workers may also modify their labor supply to

taxable activities. Taxable labor supply tends to increase with the education of women, but the wives of more educated men supply fewer hours of labor in taxed activities. Moreover, men's market or wage labor supply tends to be relatively unresponsive to increases in their education (Schultz 1981).

Education of women influences their health, longevity, and welfare and that of their children, and perhaps other members of their family (for example, see Cochrane et al. 1980; Schultz and Tansel 1992; Strauss et al. 1993). It also influences family size as well. If these effects embody social as well as private benefits, they are externalities of women's education that should be taken into account in setting public sector priorities. Indeed, public subsidies are already provided to improve child health, nutrition, and schooling, and through family planning programs, to help couples avoid unwanted births. In the literature on educational returns, however, social externalities are in practice neglected, because their quantification is controversial and there is no agreement on how to value them equivalently to the opportunity costs and market production gains of education. Most estimates of social returns to education, therefore, simply adjust the private individual returns downward by adding into the computation the public subsidies for education (Psacharopoulos and Woodhall 1985). Despite the measurement difficulties, the difference between social and private returns is the relevant criterion for allocating public resources (including education) among competing programs to maximize social welfare. If private resources were initially allocated efficiently to activities generating the highest individual returns, social subsidies should supplement private resources only in those activities where social returns exceed private returns.

Between the individual and the society there exists a fuzzier intermediate level of aggregation, the family, or more specifically, parents who have some

interests in and responsibility for their children. Educational decisions for children are undoubtedly influenced by the willingness of parents to sacrifice their current consumption for the schooling of their offspring. How are the motivations of parents to be characterized? One view of the family is that it provides a context for people to transfer resources over time.[8] The inability to internalize in the family all of the individual-private returns to human capital investments in children because credit markets facing parents are imperfect could explain the common practice of public subsidies for education, as well as special interventions to help investors in human capital, such as need-based scholarships and student loans.

In their investments in and transfers to children, parents need not treat all of their children as equal. The private returns to schooling for different children may differ. The family must then consider whether to be guided only by efficiency, in other words maximizing total private returns, or whether to also assign a value to equality in consumption opportunities among offspring.[9]

With these distinctions in mind, the educational investments in men and women can now be considered as a potential instance of market failure. Three factors might motivate parents to invest systematically more in the health or education of boys than of girls (Gertler and Alderman 1989). First, private individual returns to education for women may be lower than for men, possibly because the technologically derived demands for female labor do not assign as large a relative premium to educated female labor as to educated male labor. This line of reasoning presumes that the labor of males and females is technically different in the sense that they are imperfect substitutes for each other in some activities. These female and male market returns to more educated

workers are estimated later in this paper to assess whether they commonly diverge from equality.

Second, remittances to parents may be smaller from daughters than sons. Third, for reasons unrelated to the individual private returns or to rates of remittances, parents may derive more satisfaction from the economic success of their sons than of their daughters. If the second and third sources of intrafamily gender differences in human capital investment are important, parental allocations of these human capital investments will not be productively efficient. Subsidized loans for female education could, under these conditions, promote a socially more efficient pattern of investment that would maximize economic growth. Social external returns to women's schooling provide a further rationale to subsidize female education more than male education.

V. Measurement of Returns to Schooling and Health: Model Specification

There are three limitations in our capacity to measure the economic returns to education. Comparative studies of worker productivity cannot, in most cases, be based on experimentally controlled variation in human capital investment across people. Thus, those who acquire more education than others may differ in many ways that could influence their productivity, whether or not they are educated (Griliches 1977). Controls for ability and other characteristics of the worker may reduce omitted variable bias in estimates of the returns to education, but the introduction of these controls into the wage function also increase errors in the measurement of schooling with the consequence of adding a downward bias to the estimated returns to education (Griliches 1977; Lam and Schoeni 1991). Evidence that additional controls for ability alter appreciably male-

female comparisons of the private individual's returns to education has not been advanced, and I expect whatever bias is present will be similar for both sexes.

Second, labor productivity of the individual is inferred readily only if the worker is paid wages; it is substantially more complex to measure the product of an individual who is self-employed or works without a wage in a family enterprise. Moreover, studies of self-employed men and women in a variety of countries, including Thailand, Colombia, and Israel, have not detected major differences in the monetary returns to schooling associated with working in wage and nonwage sectors (Chiswick 1979; Fields and Schultz 1982; Ben Porath 1986) and Thomas and Strauss (1992) report similar evidence for urban Brazil. Again, this problem is difficult to resolve entirely, but whatever biases it may exert on estimates of the returns to education, they have not yet been shown to differ systematically for men and women.

Third, many individuals at the time of a survey are not in the labor force. Rates of return to education can typically only be estimated for those who are "self-selected" into the labor force, and often only for those in the wage labor force. Are these estimates applicable to the average or representative person for whom schooling investment decisions are intended to be applicable? This statistical problem of "sample-selection" is common to much of nonexperimental social science (Heckman 1979, 1987); statistical methods are required to explain first the reason some people are "selected" into the wage labor force and this information is then used to eliminate potential bias in the estimation of the private returns to schooling arising from unobserved factors that affect the marginal productivity of labor (in other words, wage rate) and also affect the probability that the person is a wage earner.[10] Because the proportion of women working in the labor force is substantially smaller than the proportion of men

in most countries (Schultz 1990), this source of sample selection could be a more serious source of bias in estimating educational returns for women than for men. Estimates of selection corrected returns may be sensitive to the choice of assumptions underlying the statistical approach. There is, however, some theoretical basis for the statistical identification of the sample selection model subsequently proposed for estimating wage functions.

Productive benefits from health and nutrition can be estimated by including health characteristics of the worker in the wage function, just as currently schooling and post-school experience are included (Mincer 1974). If earnings are used partly to improve health or nutrition, then the impact of nutrition and health on wage rates must be estimated by simultaneous equation methods to disentangle only one direction in the causal system. Parameter bias due to errors in the measurement of health and nutritional status may be an even more serious problem than in the case of schooling, biasing down the directly estimated (in other words, OLS) effects of health and nutrition on productivity. To estimate the effect of health or nutrition on wages without bias from errors in measurement and simultaneity requires generally the specification of a valid instrumental variable or an exclusion restriction. Food prices and health programs are candidates for exclusion from the wage functions, and these variables are then assumed to influence the household's demand for nutrition and health inputs and consequent labor productivity. Prices and programs thereby affect labor productivity only through their predicted impact on nutritional status and health, but do not shift community labor supply which would affect wage levels. The wage is measured in real terms, deflated for the local price level, but this requires that the relative prices of food items do not affect labor supply. This approach was proposed by Strauss (1986) in a study of family

farm labor productivity as a function of predicted caloric availability in Sierra Leone, and employed to analyze height and weight by Deolalikar (1988) in India, Sahn and Alderman (1988) in Sri Lanka, Bouis and Haddad (1990) in the Philippines, and used to analyze adult disability days by Schultz and Tansel (1992) in Côte d'Ivoire and Ghana. These estimates of the benefits of calories, height, and a reduction in morbidity have not yet been combined with the costs of investments required to improve these nutritional and health statuses, as will eventually be necessary to derive private or social rates of return to investments in health that are commensurable to those for schooling. There is insufficient evidence as yet to assess whether private productive returns to health and nutrition differ for men and women. A study of the intra-household allocation of nutrition, time, and productivity in Bangladesh provides a broader family context in which to analyze these interdependent decisions (Pitt et al. 1990).[11]

VI. Productivity in the Home and Social Externalities

Because of the difficulty of measuring and valuing nonmarket production, economists focus on the marketable component of income of families and individuals. In principle, personal and national income should include the market value of home-produced and -consumed goods, such as the production and preparation of food and fuel, the fetching of water, and maintenance of housing, for which there are sometimes market-priced equivalents. However, in practice, the complexity of imputing a value to goods one produces and then consumes leads to their frequent omission. Moreover, untradable home-production activities, such as child-rearing, are ignored entirely, although they are economically valued outputs of society. By omitting these nonmarket components of personal

income, economists understate sources of income that are of relatively greater importance to poor families. Within families these conventions of economic measurement understate women's economic contribution relative to men's.

The distinctive role of women in managing consumption of and investment in children within the family is a major reason for social intervention to increase women's capabilities and control over resources. Improving the productivity of women through investments in their human capital directly advances economic development and the growth of measured output. Human and nonhuman capital controlled by women appears to channel associated new streams of income and resources toward particular ends: consumption and investment in food, medical care, and schooling of children (Schultz 1989a; Thomas 1991).[12]

The effects of male and female human capital on fertility have been frequently studied (Schultz 1992). In most societies, fertility is lower among women who are better educated and can therefore expect to be offered a higher wage. Education thus increases a woman's potential income, but also increases what she must give up in order to bear and rear an additional child. The latter "price effect" on fertility invariably outweighs the former "income effect" in empirical studies, and fertility tends to decline as women's market wage opportunities rise. Increases in the labor productivity and wage rates of men, on the other hand, do not appear deter larger families and are often associated with higher levels of fertility, consistently so in low-income agricultural societies. As a consequence, a redistribution in the balance of education from men to women, if the number of places in school were fixed, should have the unambiguous effect of reducing fertility and slowing population growth.

Although male education is not held constant, the tabulation of fertility in Table 3 by woman's education in the 38 countries where the World Fertility

Table 3

Children Ever Born, Recent Total Fertility Rate and Desired Fertility: Averages for Countries with World Fertility Surveys in 1970s, by Region and Education of Women

Regions (Number of Countries Observed)	Children Ever Born[a]	Total Fertility Rate[b]	Desired Family Size[c]
Years of Schooling Completed by Women:	(1)	(2)	(3)
Africa (8 to 10)			
0 years	6.4	7.0	6.9
1-3	6.5	7.2	6.4
4-6	6.1	6.2	5.9
7 or more	4.8	5.0	5.0
Difference (0-7+)	-1.6	-2.0	-1.9
Latin America (13)			
0 years	7.1	6.8	4.8
1-3	6.8	6.2	4.7
4-6	6.0	4.8	4.2
7 or more	4.2	3.2	3.7
Difference (0-7+)	-2.9	-3.6	-1.1
Asia and Oceania (9 to 13)			
0 years	6.7	7.0	5.4
1-3	6.7	6.4	4.3
4-6	6.4	5.8	4.2
7 or more	4.9	3.9	4.0
Difference (0-7+)	-1.8	-3.1	-1.4

[a]Women aged 40-49 years.

[b]The average number of children that would be born alive to a woman during her lifetime, if during her childbearing years she were to bear children at each age in accord with the estimated age-specific birth rates in the five years before in the survey.

[c]Means are adjusted for the effects of age differences between educational groups. National age composition used to compare means.

Source: Summary of data collected in 38 World Fertility Surveys around 1975. United Nations (1987), Tables 112 and 115.

Surveys (WFS) were conducted during the 1970s illustrates the widely observed pattern. In all of the regions distinguished, women at age 40-49 with seven or more years of schooling have 1.6 to 2.9 fewer births over their lifetime, on average, than women with no schooling (Column 1). The measure of recent total fertility rates, based on reproductive rates in the five years before the survey, report a larger educational differential, 2.0 to 3.6 fewer births for this more educated group of women (Column 2). The difference between children ever born at age 40 to 49 (Column 1) and "desired" fertility (Column 3) (across all ages) is a rough indicator of the recent change in the latent demand for birth control among women in the childbearing ages. This measure of latent demand for greater birth control than was used in the past by women aged 40-49 is concentrated in Asia and Latin America within the least educated strata of women. Education of women is thus associated with a reduction in fertility and in a reduction in unwanted fertility.[13]

VII. The Levels of Returns to Investment in Schooling: Stylized Facts

As noted earlier, estimates of the returns to human capital have their limitations, but the accumulating evidence from studies in many countries, based on a wide variety of working assumptions and sources of data, implies that private and social returns to primary and secondary education are substantial, ranging between 5 and 40 percent per year. One survey of empirical studies in African, Asian, and Latin American countries concluded that the average social returns to investment in primary, secondary and higher education were 27, 16 and 13 percent per year, respectively (Psacharopoulos and Woodhall 1985, p. 58). The returns to education within a level of schooling tend to be lower in high-income countries than in low-income countries, but the relationship is not always

monotonic. Middle-income countries often appear to have higher returns to secondary and higher education than do the lowest income countries (Jain 1991).

In a growing number of countries it is possible to follow over time wage differentials by education, and thereby estimate a time series on the returns to education in a particular country. The majority of such studies confirm that private returns tend to decrease over time, although perturbed from a smooth path by business and trade cycles (Schultz 1988; Psacharopoulos 1989; Jain 1991). The slope of the education-earnings profile associated with the private returns to schooling is decreasing over the long run and is an important factor reducing income inequality in some Latin American countries, Kenya, and Korea in the 1980s (Almeida and Barros 1991; Londoño 1990; Knight and Sabot 1987; Choi 1991). Secondary schooling has become a bottleneck in some countries where enrollments have not kept pace with labor market demands, and private returns are consequently substantially higher at the secondary level than at the primary level (Schultz 1988). Within countries, the general rule is for the social rate of return to decline at higher levels of education, noticeably at the university level, where public subsidies are often relatively large. This is particularly evident in Africa (Psacharopoulus and Woodhall 1985).

As already noted, the majority of studies of returns to education are limited to wage earners. To estimate the returns to education among self-employed workers more data and different analytical methods are required. In agriculture, the education of the family (male) head is associated with significantly higher farm profit, but returns to the education of other family workers, such as women, are generally ignored in these studies (for example, see Jamison and Lau 1982).

Analogous private returns on physical capital investments in factories, equipment, inventories, and infrastructure are generally lower than estimates of the private returns to primary and secondary education. The marked increase in investment in education in low-income countries in the last 50 years can be interpreted, on the basis of these micro-economic studies, as a monetarily justified investment of individuals and governments compared to the returns on alternative nonhuman forms of private and social investment (Schultz 1988).

VIII. Gender Differences in Returns to Schooling and Measurement Bias

The primary problem emphasized here with extending the empirical analysis to gender differences in returns to schooling is the need to incorporate the nonmarket returns to education for women. Because nonmarket output cannot be comprehensively evaluated in monetary terms, it is unavoidable that quantitative analyses deal only with the wage rates of wage earners. There is no a priori reason to expect the sample selection bias in this case to understate or overstate the true return to education evident in accepted market wage offers for all women or all men, or to affect differentially this bias between women and men. The direction and origins of such a bias is an open issue in need of more empirical research. The composition of output and employment (Fuchs 1968), the capital intensity of production (Griliches 1969), the rate of technical change (Schultz 1975), and perhaps measures of sex segregation in employment by industry and occupation (Boserup 1970) might all plausibly modify which males and females are selected to be wage earners and thus bias estimates of schooling returns.[14]

It may be useful to consider several hypothetical sources of sample selection that illustrate how bias in estimating returns to schooling might arise. In the first case, assume that virtually all women with higher education

work for wages, but that only half of those who have only a secondary education work for wages. Suppose further that the half of the secondary-educated persons who work for wages are not a representative sample of this population, but for some unobserved reason they are more (less) productive workers. The difference between the wages received by wage earners with only a secondary education and those with a higher education will, in this case, understate (overstate) the productivity gain an average person could expect to receive by studying to obtain a higher education.

To correct for sample selection bias in estimating the returns to education, some specific variable must be known that affects the probability that a person works for wages, but this variable cannot affect the worker's productivity as a wage earner or her market wage offer.[15] I will assume that this identifying variable is the individual's ownership of land and other assets that yield nonearned income; this asset or income steam is expected to raise the individual's shadow value of time in nonwage activities, and thereby reduce the likelihood that the individual will be a wage earner. But this asset or nonearned income variable is assumed not to influence what an employer would offer her as a market wage.[16]

A second source of selection bias might arise in a modern welfare state that could be most pronounced among the least educated. Suppose, for example, that persons in this low education group who decide not to engage in wage employment are the least productive workers. This alternative pattern of selection could be reinforced either by public assistance programs that provide workers with welfare support if they do not accept a wage job or by minimum-wage legislation that discourages employers from hiring workers whose productivity is below the minimum wage floor. This form of sample selection bias might become important

when unemployment, welfare, and disability insurance benefits are set at relatively generous levels, or where legislation sets the minimum wage high enough to reduce the number of job offers for less productive workers (Schultz 1990). In this case, the wage earner sample of the lowest education group is only the most productive members of the group. The estimation sample of wage earners becomes more representative of the entire population as a group's level of education increases. According to this second hypothetical source of sample selection bias, standard estimates of private wage returns to relatively low levels of education would be biased downward. Identification of the selection equation might be possible in this case, if welfare legislation or its implementation differed randomly across regions of the sample and induced variations in the wage labor force participation rate.

Some recent studies of wage structures of males in the United States are consistent with this second hypothesized source of sample selection bias, but they have not been extended to a comparison of the wages of men and women. At the lowest tail of the distribution of educational attainment in the United States, in each birth-cohort by state of birth, there is a threshold below which the returns to education for men appear to fall off markedly, to approximately zero. Card and Krueger (1992) estimate this threshold as occurring at the two percentile level, whereas other empirical studies often omit the lowest educational group, with less than eight years of education, to smooth patterns in the tails of the population distribution (Murphy and Welch 1990). If the minimum wage floors applied to male and female workers are the same and welfare support programs are more generous for women relative to the distribution of their wage opportunities than for men, one might expect the downward bias in estimated returns to schooling caused by this source of sample selection to

extend further up the distribution of educational attainments for women than for men.

IX. Selection-Corrected Private Wage Returns to Schooling

Several empirical examples are presented in this section to illustrate how private returns to schooling at the primary, secondary, and higher education levels can vary for women and men. These returns are first calculated as conventionally reported by ordinary least squares (OLS) for wage earners. Then these estimates are corrected for sample selection bias where property income and assets, such as land ownership, are used to identify the selection correction procedure. Notes to each table describe other included variables and estimation methods.

Thailand has grown rapidly for the last several decades. Women have historically played a major role in the market economy, both in traditional agricultural pursuits and in more modern labor force activities. Thailand instituted universal primary education in the 1930s, and by the 1970s nearly all boys and girls completed primary school. The difference in education received by men and women remains substantial at the secondary school level, but has narrowed recently at the university level. Private returns to schooling are estimated in Table 4 from the two most recent rounds of the Socio Economic Survey (SES) collected in 1985-86 and 1988-89. Estimates of returns to schooling based on similar assumptions from earlier rounds of this survey in 1975-76 and 1980-81 are reported elsewhere (Schultz 1989a). By 1988-89 the selection-corrected returns to schooling in Thailand do not differ substantially from the direct OLS estimates for either women or men. By comparison, in 1985-86 (and in earlier surveys) primary schooling returns are higher when sample selection is taken into

Table 4

Estimates of Private Wage Return to Schooling
in Thailand, in 1985 and 1988, by Sex,
Without and With Statistical Correction for Sample Selection Bias[a]

Year--Unit of Earnings (Sample of Wage Earners/ Population)	Without Correction (OLS) By School Level			With Correction (ML) By School Level		
	Primary	Secondary	Higher	Primary	Secondary	Higher
1985-86 - Monthly Earnings						
Female (2709/8606)	8.2 (4.75)[b]	31.0 (18.7)	9.5 (4.31)	13.0 (7.00)[c]	25.0 (9.84)	18.0 (5.45)
Male (4199/7685)	14.0 (9.40)	18.0 (14.4)	12.0 (6.81)	17.0 (11.3)	6.8 (5.34)	7.8 (4.61)
1988-89 - Monthly Earnings						
Female (2222/8924)	13.5 (8.53)	20.8 (16.5)	9.0 (5.79)	13.8 (9.24)	19.8 (10.2)	8.2 (3.14)
Male (3362/7733)	15.6 (13.8)	12.9 (15.2)	11.8 (10.4)	15.5 (14.3)	12.4 (12.7)	11.3 (7.31)

[a]The coefficients reported are those on the variable years of education completed at each school level, in a logarithmic monthly wage function, which also includes experience (for example, age-schooling-7), experience squared, and several regional dummy variables (Bangkok, municipal, sanitary district (in other words, suburban), and Northeast region). The estimation sample is restricted to wage and salary earners between the ages of 25 and 54. The Ordinary Least Squares (OLS) estimates of the education coefficients are reported in the first three columns, whereas the second set of three columns report the Maximum Likelihood (ML) estimates of joint probit model for participation as a wage or salary worker and the log wage function. The probability of participation as a wage or salary earner is assumed to be affected by hectares of irrigated and dry land owned and nonearned income. These identifying variables are assumed to be exogenous to the wage function, and thus do not affect the wage offered to the individual. See Schultz 1989a for a further discussion of model specification and full ML estimates and parallel estimates for 1980-81 and 1975-76 based on the same Socio Economic Survey in these earlier years.

[b]The absolute value of the t statistic is reported in parentheses beneath each OLS regression coefficient on years of education.

[c]The absolute value of the asymptotic t statistic is reported in parentheses beneath each ML coefficient estimate on years of education.

account, whereas secondary schooling returns are lower, again for both men and women. After secondary school, the correction for sample selection increases the returns for women and decreases them for men until the most recent survey in 1988/89. Corrected returns are generally highest from women at the secondary level, whereas they peak at the primary level for males. At the primary school level men have slightly higher returns than do women, 17 versus 13 percent, whereas women receive higher corrected returns at the secondary school level, 25 versus seven percent in 1985-86 and still markedly higher returns than men in 1988-89, 20 versus 12 percent.

Wage ratios associated with each year of primary schooling, corrected for sample selection, have been of a similar magnitude for men and women in Thailand as have enrollment rates. But where women have received only two-thirds of the years of secondary education compared with men, their wage returns have been consistently higher than men, though falling gradually in recent years, from 31 percent in 1975-76 to 20 percent in 1988-89. Only about one tenth of the Thai survey population has any higher education, but by 1988-89 the SES reports women with 85 percent as many years of higher education as men, whereas in 1975 they had only about half as many years. Women's returns to higher education greatly exceeded men's returns until 1988-89, when this pattern reversed. Under conditions of rapid economic growth in Thailand, returns to schooling for men and women appear to be of a similar magnitude, with the exception of secondary school where the supply of educated Thai females relative to male is lowest and returns to women have greatly exceeded men's for the last 15 years.

Table 5 reports estimates from the Living Standards Measurement Surveys of private returns to schooling from Côte d'Ivoire in 1985, 1986, and 1987 and Ghana in 1987-88 and 1988-89 (Ainsworth and Munoz 1986). Economic growth until the

Table 5

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

Country, Year and Sample (Sample of Wage Earners/ Population)	Without Correction (OLS) By School Level			With Correction (ML) By School Level		
	Primary	Middle	Secondary	Primary	Middle	Secondary
Côte d'Ivoire 1985-87						
Female (376/9099)	10.9	24.3	22.4	7.8	20.9	20.2
	(4.08)	(7.45)	(9.95)	(1.26)	(2.71)	(4.22)
Male (1452/7832)	14.0	27.4	22.4	11.6	24.1	20.0
	(11.5)	(15.3)	(18.0)	(7.03)	(10.3)	(11.5)
Ghana 1987-88, 1988-89						
Female (454/6067)	-1.0	14.5	10.4	-1.2	14.2	10.1
	(.34)	(3.95)	(8.30)	(.31)	(2.97)	(2.07)
Male (1471/5605)	-1.3	7.0	11.8	-1.3	7.9	12.3
	(.72)	(3.15)	(15.1)	(.78)	(2.73)	(9.27)

[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 estimates of the education coefficients are reported in the first three columns, whereas the second set of three columns report the Maximum Likelihood (ML) estimates of the joint probit model for participation as a wage or salary worker and the log wage function. The probability of participation as a wage or salary worker is assumed to be affected by various forms of financial and business assets including land. These identifying variables are assumed to be exogenous to the wage function, and thus do not affect the wage rate offered to the individual. See Schultz and Tansel 1992 for further discussion of the Living Standards Measurement Surveys on which these estimates are based and a complete reporting of parallel ML estimations with the inclusion of adult health disability variables.

[b]The absolute value of the t statistic is reported in parentheses beneath each OLS regression coefficient on years of education.

[c]The absolute value of the asymptotic t statistic is reported in parentheses beneath each ML coefficient estimate on years of education.

late 1970s was sustained and rapid in Côte d'Ivoire, whereas economic output per capita declined in Ghana over the 1970s. Over the previous 25 years, national income per capita grew by 70 percent in Ghana, whereas it more than quadrupled in Côte d'Ivoire (World Bank 1991).

Private returns are uniformly higher for Côte d'Ivoire than for Ghana. The correction for sample selection in Côte d'Ivoire, where only 18 percent of men and 5 percent of the women age 15 to 65 are wage earners, lowers marginally the estimated private returns to schooling. Although women have obtained only half as many years of schooling as men, the private returns are similar for men and women. In Thailand, the labor of more educated men and women does not appear to be a perfect substitute for each other, and the gender balance of labor supplies by education level seems to have influenced returns at the secondary level. The evidence from Côte d'Ivoire, on the other hand, is consistent with the interpretation that male and female educated labor are reasonable substitutes for each other in this economy. Other investigations of wage determinants in Côte d'Ivoire also find few indications of gender differentials between observationally similar workers (Van der Gaag and Vijverberg 1987, Vijverberg 1993).

Ghana began the 1960s with more widespread education than Côte d'Ivoire, but Ghanaian women also receive only half the number of years of education as do men. There are relatively few students who exit the school system before completing nine years, but for those few who do, there have no private returns to show for the first six years of primary schooling in Ghana, for either sex. At the middle level, where women have obtained 61 percent as many years of schooling as men, the relative wage gain for more educated women is almost twice as large as for men, 14 versus 8 percent, respectively. These higher private

returns for women than for men are not evident at the secondary school level and beyond, where women have obtained only 40 percent as many years of schooling as men. Many college graduates in Ghana migrated abroad during the 1970s and 1980s in search of jobs, and may make the observed sample that stayed at home unrepresentative of all those who received educations at the secondary and higher levels.

The United States is examined in Table 6 as an example of a high-income country where wage earners are a large fraction of the labor force, and education is more equally distributed between men and women (Schultz 1992). The state-level duration of unemployment benefits and the value of AFDC benefits in cash and food stamps for a mother and child are added to the individual's property income as identifiers of the wage earner sample selection model. Not surprisingly, the sample selection procedure indicates that the nonrandom selection of wage earners is a less important source of parameter bias in the United States than in Thailand or Ghana. But there is, nonetheless, a tendency, when sample selection bias is corrected, for women's private returns to increase more than do male returns, and they exceed male returns both among blacks and whites. Only at the higher education level do U.S. women have a smaller number of years of schooling than men. One interpretation of this pattern is that the derived demand of firms for workers with a college education in the U.S. economy treats men and women as imperfect substitutes. Contrary to our hypothetical example, correcting for sample selection bias does not raise the low returns to the lowest levels of schooling in the U.S. labor market, although the unemployment and welfare benefits have the theoretically expected effect of reducing wage participation, as does nonearned income, assets and land in the previously reported three studies.

Table 6

Estimates of Private Wage Returns to Schooling in the United States in 1980, by Sex, without and with Statistical Correction for Sample-Selection Bias[a]

Sex (Sample of Wage Earners/ Population)	Without Correction (OLS)			With Correction (ML)		
	By School Level			By School Level		
	Primary	Middle	Secondary	Primary	Middle	Secondary
White Females (5909/9752)	.18 (.11)[b]	5.1 (5.72)	10.4 (21.5)	.11 (.09)[c]	5.6 (1.66)	10.6 (13.9)
White Males (7430/9334)	3.3 (2.66)	7.1 (9.13)	7.0 (17.2)	3.3 (3.02)	7.6 (5.22)	7.0 (16.8)
Black Females (5213/9075)	-2.2 (1.20)	9.6 (8.71)	9.8 (12.9)	-2.4 (1.35)	11.2 (4.46)	10.6 (7.47)
Black Males (5334/7762)	1.5 (1.10)	7.4 (7.15)	7.0 (8.56)	1.3 (1.02)	7.9 (2.63)	7.2 (6.21)

[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, urban (that is, SMSA) resident dummy, and hispanic origin. The estimation sample is restricted to wage and salary earners between the ages of 15 and 64, reporting weeks worked and usual hours worked per week in 1979, so that an hourly wage could be defined as annual earnings divided by the product of weeks worked and usual hours worked last year. The sample includes all blacks and one in ten white persons from the 1 in 1000 public use sample A of the U.S. Census of Population. The Ordinary Least Squares (OLS) estimates of the education coefficients are reported in the first three columns, whereas the second set of three columns report the Maximum Likelihood (ML) estimates of the joint probit model for participation as a wage or salary worker and the log wage function. The probability of participation as a wage or salary worker is assumed to be affected by individual's receipt of income in 1979 from dividends, interest, and rentals (in linear and quadratic form), and the duration of unemployment benefits in the state of residence, and the maximum AFDC cash and food stamp benefit level paid to a single mother and one child in the state of residence. These identifying variables are assumed to be exogenous to the wage function and thus do not affect the wage an individual is offered. See Schultz 1991 for a more extensive discussion of the specification of the model and the full ML estimates.

Table 6 (cont.)

[b]The absolute value of the t statistic is reported in parentheses beneath each OLS regression coefficient on years of education.

[c]The absolute value of the asymptotic t statistic is reported in parentheses beneath each ML coefficient estimate on years of education.

There are relatively few studies of the returns to schooling for men and women that have corrected estimates for sample selection, but the number is growing rapidly. The findings from several other studies are summarized in Table 7 and others are presented in papers at this conference (for example, Deolalikar 1993; Vijverberg 1993; Thomas and Strauss 1992). Because men and women in Latin America receive similar levels of education (Figure 1), I do not expect gender differences in returns to schooling would be particularly sensitive to sample selection bias in this low-income region. The 1985 estimates of male and female returns to schooling for Peru, for example, were not greatly affected by sample selection correction based on land and wealth variables, although women's returns at the secondary level exceed noticeably those to men (Khandker 1989). The first six studies in Table 7 for Latin American countries are reported, therefore, with the expectation that they are not seriously distorted by their neglect of the sample selection problem. No evidence emerges from these studies that individual private rates of return to schooling among wage earners are systematically lower for women than for men in Latin America. Indeed, they tend to be somewhat higher, on average.

Estimates of the returns to women's schooling are more difficult to infer in regions where women have not yet received more than a primary level of schooling and where women are an especially small part of the wage labor force. These conditions hold in most of rural South and West Asia and much of rural Africa. Analysis in these regions could be particularly valuable for understanding why parents in these regions tend to invest more in the schooling of their sons than their daughters.

To estimate with more confidence the returns to schooling, it is necessary that our models account for the individual's allocation of time, particularly to

Table 7

Estimates of Private Wage Return to Schooling
of Women and Men from Selected Studies in 1970s and 1980s

Country, City, or Regional Coverage and School Level	Year	Women	Men
Argentina Buenos Aires	1980	6.6%	9.3%
Bolivia La Paz	1980	11.0	9.8
Brazil Sao Paulo	1971	6.3	5.4
Colombia National	1973	18.0	18.0
Paraguay Asuncion	1979	8.0	11.0
Peru National	1974	14.0	14.0
India Madras	1981	14.9 *	15.8 *
Thailand National	1980/81	20.1 *	11.3 *
Côte d'Ivoire Urban Secondary School	1985	28.7 *	17.0 *
Peru National Secondary School	1985	14.6 *	8.8 *
Indonesia National General High School	1986	9.6 +	6.2 +

* Sample Selection corrected based on land or nonearned income included in the selection equation but not in the wage function.

Table 7 (cont.)

+ Fixed effect for family included which, however, does not correct for problems associated with only selected families having both a male and female earning wages.

[a]The coefficients reported are those on the variable years of education completed (on school level if indicated), in a logarithmic wage function, which also includes experience (for example, age-schooling-7), experience squared, and regional and rural/urban dummy variables if a national sample. Samples tend to be at least a thousand and often much larger including all wage and salary workers between the ages of 25 and 64. The coefficients on the education variable are all statistically significant at conventional levels. In several cases age is used in place of experience.

Sources: For Peru, see Khandker (1989), for India, see Malathy (1989), for others, see sources in Schultz (1989a).

wage employment. This knowledge of how to model wage participation decisions motivates the identification of these sample-selection corrections. Understanding how resources are pooled and labor market behavior is coordinated within the family may be critical to this process. The appropriate theory of family labor supply is therefore important to estimating without bias wage functions. More comparative research is needed to assess whether variations in the specification of models of labor supply behavior, such as by treating it as a cooperative bargaining process (for example, Schultz 1990; Thomas 1990), alter importantly the parameter estimates of the private returns to schooling of women and men. This matter promises to be more important in low-income than in high-income countries, but there are as yet too few studies of even high-income countries on which to base any generalizations.

X. Issues for Further Study

Schooling for women may be justified in terms of efficiency (high individual private market returns), social externalities (for example, reduced child mortality and fertility), intergenerational redistribution (for example, better health and education of children and a slower growth in population), and equity (an increase in the productive capability of poorer individuals relative to richer individuals). This paper has concluded by estimating for several countries the private efficiency of women's and men's schooling, while observing that health and nutritional investments may be equally important and involve similar issues. Aspects of social externalties and intergenerational redistribution are difficult to assess quantitatively but social returns that can be measured favor social subsidies for investments in women. Others have

discussed the justification for making transfers to women on the grounds of equity (for example, Tinker 1990).

During this century, human capital investment in women has increased relative to that made in men, at least as measured by either years of schooling or years of longevity.[17] These shifts in the gender composition of human capital formation have occurred at about the same time that women have entered in increasing numbers into the market labor force, particularly in employment outside of the family for wages (Schultz 1990). The coincidence of these trends in female labor force participation and their schooling support the conjecture that women realize more returns to their education through their work in the market labor force.

Most studies of labor force participation of women confirm that women with more education supply more of their time to market work, and more specifically to wage employment, holding constant male education or wages and nonhuman wealth. This is true in each of the four countries analyzed in this paper and is notable in many studies of Latin America in recent decades (ECIEL 1982). The release of time from childbearing and childrearing activities is also associated with women leaving home for market employment in the higher income countries (Mincer 1985). Which comes first, the market labor force commitment, the decline in fertility, or the educational attainment of women? Education is often treated as being determined first, based on an individual's expected returns to education and on parents' endowments, both educational and financial, that allow parents to promote their children's schooling. By this reasoning, fertility and specialization between home and market labor force skills are modified by prior educational attainment. To disentangle with greater rigor this lifecycle causal chain (or system), a suitable source of variation in schooling is needed that is

independent of the child's (or parent's) preferences for adult careers of childbearing or market employment. This source of variation in education may then be used to identify the effect of education on individual productivity and behavior. It should then be possible to infer how variation in women's education affects their wage opportunities as well as their fertility and labor force behavior and other choices involving migration and sector of employment (see Vijverberg 1993; Thomas and Strauss 1992).

The returns to education and health investments may interact and partially account for the shifting emphasis toward women's human capital. Medical knowledge appears to have contributed little to the decline in mortality before the twentieth century (McKeown and Record 1962; Preston and Haines 1991), and yet the creation and spread of public health and medical technologies are believed to be important factors in the demographic transition in this century. Have these new technologies given educated persons a new survival advantage? And in the case of women, the health advantage has been effectively extended to their children. If this is a relatively recent phenomenon, then it might help explain the shift of resources toward women's education, even when women in low-income countries are still primarily engaged in household production tasks within the family. Increased nutrition and health status of populations may also reinforce the rising productivity of more educated workers. Were this true, the contribution of education to labor productivity as estimated in wage functions could overstate the returns to schooling because of the failure to hold constant nutritional status. Thomas and Strauss (1992) support this hypothesis in urban Brazil.

Studies of human capital have emphasized the heterogeneity of labor. Much of that heterogeneity is a produced means of production, characteristics of

workers that are created by the secularly rising investment of families and society in the nutrition, health and schooling of people. How are we to explain that a widening circle of countries, indeed those that have been more successful in stimulating modern economic growth, are also tending to invest an increasing share of their human capital in women? With all the limitations of current data and statistical methods, this paper has reported for several countries estimates of private market returns to schooling that are of a similar magnitude for men and women. In some, but not all, countries educated male and female labor appear to be imperfect substitutes, and their relative supplies are inversely associated with the returns they receive on their skills. Specifically, when women have received a small fraction of the secondary or higher education in a society, women with these more scarce skills tend to receive a larger relative wage premium than do men. Although the relative wage returns to schooling for women and men may be of a similar magnitude, as in the United States, this does not imply, as we all know, that the level of women's wages is equal to men's. Private returns are approximated by the ratio of the wage of the more educated worker to that of a worker with less education (of the same sex), divided by the years a student must forego employment to acquire this extra education (Mincer 1974). Both the wage gains and opportunity costs of schooling are generally lower for women than for men, but roughly in the same proportion, implying comparable internal private rates of return.

Future research should estimate the effects of relative supplies of sex-specific educated labor on the level of and differentials in wages, holding constant for the effect of the composition of aggregate demand on these wage structures. That objective is beyond the scope of this paper, for it will require consistent compilation of microdata across many countries and perhaps

within them over time. But no evidence has emerged in this study that supports the view that educating more women, even if it involved educating fewer men, would lower potential aggregate output.

Beyond the market productivity of workers that should be captured by private individual returns flowing to those who invest in their own schooling, there are palpable external benefits to society, as measured by reduced child mortality, improved child nutrition and schooling, and decreased fertility and population growth. These social externalities of education are primarily associated with the education of women. Thus, there is an economic case for society to subsidize investments in women's schooling by a greater amount than men's.

Why then does the shortfall in female education and health relative to male education and health persist, particularly in South and West Asia, and in much of Africa with respect to schooling? The answer would seem to lie in the family decision-making process and parent's own traditionally defined interests, that may attach less value to the future productivity of daughters than to the productivity of sons. Parental claims on the adult productivity of sons may be more secure in custom and law in some family-cultural systems than their claims on daughters. If the allocation of private investments by parents between the schooling of boys and girls does not lead to the socially most productive pattern of investment in some countries, what should public policy do? Can the judicious application of the tools of public finance -- taxes and subsidies -- improve the allocation of these resources? Where does policy exert the most leverage to increase female enrollment rates or longevity? Research has only begun to address squarely this issue.

References

Ainsworth, M. and J. Munoz. 1986. The Cote d'Ivoire Living Standards Survey. Living Standard Measurement Study, Working Paper 26. The World Bank, Washington, DC.

Almeida dos Reis, J. G. and R. Barros. 1991. "Wage Inequality and the Distribution of Education." Journal of Development Economics 36:117-143.

Angrist, J. and A. Krueger. 1991a. "Does Compulsory Schooling Affect Schooling and Earnings?" Quarterly Journal of Economics 105:4 (November).

_____ and A. Krueger. 1991b. "Estimating the Payoff to Schooling Using the Vietnam-era Draft Lottery." Industrial Relations Section, Princeton University.

Becker, G. S. 1964. Human Capital. New York: Columbia University Press.

_____ and N. Tomes. 1979. "An Equilibrium Theory of the Distribution of Income and Intergenerational Mobility." Journal of Political Economy 87(6):1153-1189 (December).

Behrman, J. 1988. "Intrahousehold Allocation: Are boys favored?" Oxford Economic Papers 40(1):32-54.

Ben-Porath, Y. 1986. "Self Employment and Wage Earners in Israel." In Studies in the Population of Israel, Volume 30, ed. U. O. Schmelz. Jerusalem: Hebrew University, Magres Press.

Bielicki, T. 1986. "Physical Growth as a Measure of the Economic Well-Being of Populations: The Twentieth Century." In Human Growth, Volume 3, eds. F. Falkner and J. M. Tanner. New York: Plenum Press.

Bouis, H.E. and L.J. Haddad. 1990. Agricultural Commercialization, Nutrition and the Rural Poor: A Study of Philippine Farm Households. Boulder: Lynne Rienner Pub.

Boserup, E. 1970. Women's Role in Economic Development. New York: St. Martin's Press; London: George Allen & Unwin.

Card, D. and A. B. Krueger. 1992. Does School Quality Matter?" Journal of Political Economy 100(1):1-40 (February).

Chiswick, C. U. 1979. "The Determinants of Earnings in Thailand." Research Project No. 671-36. Washington, D.C.: World Bank.

Choi, K. S. 1991. "Changes in Wage Profiles in Korea During the 1980s." Yale University, New Haven, CT. Mimeo.

Cochrane, S. H., J. Leslie, and D. J. O'Hara. 1980. "The Effects of Education on Health." The World Bank Staff Working Paper 405. Washington, D.C.

Costa, D. 1992. "Height, Weight, Wartime Stress and Old Age Mortality: Evidence from the Union Army Records." Explorations in Economic History, forthcoming.

Deolalikar, A. 1988. "Nutrition and Labor Productivity in Agriculture." Review of Economics and Statistics 70(3):406-413.

_____. 1994. "Gender Differences in the Returns to Schooling Enrollment Rates in Indonesia." Forthcoming.

Dougherty, C. R. S. and E. Jimenez. 1991. "The Specification of Earnings Functions: Tests and Specifications." Economics of Education Review 10(2):85-98.

ECIEL. 1982. Determinantes de la Oferta de Trabajo en America Latina. Programa de Estudios Conjunctos sobre Integracion Economica Latinoamerica, Rio de Janeiro, Brazil.

Eltis, David. 1982. "Nutritional Trends in Africa and The Americas." Journal of Interdisciplinary History 12:453-475.

El-Badry, M. A. 1969. "Higher Female Than Male Mortality in Some Countries of South Asia." Journal of American Statistical Association 1234-44.

Eveleth, P. B. and J. M. Tanner. 1976. Worldwide Variation in Human Growth. Cambridge: Cambridge University Press.

Falkner, F. and J. M. Tanner, eds. 1986. Human Growth: A Comprehensive Treatise, Volume 3, 2nd ed. New York: Plenum Press.

Fields, G. and T. P. Schultz. 1982. "Income Generating Functions in a Low Income Country: Colombia." Review of Income and Wealth 28:71-87.

Floud, R., K. Wachter and A. Gregory. 1990. Height, Health and History. Cambridge: Cambridge University Press.

Fogel, R. W. 1986. "Growth and Economic Wellbeing: 18th and 19th Centuries." In Human Growth, Volume 3, eds. F. Falkner and J. M. Tanner. New York: Plenum Press.

_____. 1990. "The Conquest of High Mortality and Hunger in Europe and America." NBER Working Paper No. 16. Cambridge, MA (September).

_____. 1991. "New Sources and New Techniques for the Study of Secular Trends in Nutritional Status, Health Mortality and the Process of Aging." NBER Working Paper No. 26. Cambridge MA (May).

Foster, A. and M. Rosenzweig. 1994. "Information, Learning and Wage Rates in Low-Income Rural Areas." Forthcoming.

Friedman, G.C. 1982. "The Heights of Slaves in Trinidad". Social Science History 6(4):482-515 (Fall).

Fuchs, V.R. 1968. The Service Economy. New York: Columbia University Press for NBER.

Gertler, P.J. and H. Alderman. 1989. "Family Resources and Gender Differences in Human Capital Investments." Paper presented at a conference on "The Family, Gender Differences and Development," Yale University, Economic Growth Center, New Haven, CT.

Goldin, C. 1994. "The Meaning of College in the Lives of American Women: The Past One-Hundred Years." Forthcoming.

Griliches, Z. 1977. "Estimating the Returns to Schooling." Econometrica 45(13):1-22 (January).

_____. 1969. "Capital-Skill Complementarity." Review of Economics and Statistics 51:465-468.

Haveman, R. and B. Wolfe. 1984. "Education and Well Being: The Role of Nonmarket Effects." Journal of Human Resources 19:377-407.

Heckman, J. J. 1979. "Sample Bias as a Specification Error." Econometrica 47(1):153-162 (January).

_____. 1987. "Selection Bias and Self Selection." In The New Palgrave, eds. J. Eatwell, M. Milgate and P. Newman. London: The Macmillan Press.

Jain, B. 1991. "Returns to Education: Further Analysis of Cross Country Data." Economics of Education Review 10(3):253-258.

Jamison, D. T. and L. T. Lau. 1982. Farmer Education and Farm Efficiency. Baltimore, MD: Johns Hopkins University Press.

John, A. M. 1984. "The Demography of Slavery in 19th Century Trinidad." Unpublished dissertation, Princeton University, Princeton, N.J.

Jorgenson, D. W., F. M. Gollop, B. M. Fraumeni. 1987. Productivity and U.S. Economic Growth. Cambridge, MA: Harvard University Press.

Khandker, S. 1989. "Returns to Schooling and Male-Female Wage Differences in Peru." Paper presented at a Conference on the Family, Gender Differences and Development, Yale University, New Haven, CT. (September.)

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

Knight, J.B. and R.H. Sabot. 1987. "The Rate of Return on Educational Expansion." Economics of Education Review 6(3):255-262.

Lam, D. and D. Levison. 1992. "Declining Inequality in Schooling in Brazil and Its Effect on Inequality in Earning." Journal of Development Economics 37:199-225.

_____ and R. F. Schoeni. 1991. "Effects of Family Background on Earnings and Returns to Schooling: Evidence from Brazil." University of Michigan Discussion Paper.

Lavy, V. 1992. "Supply Constraints and Investment in Human Capital: Schooling in Rural Ghana." Department of Population and Human Resources, World Bank, Washington, D.C.

Londoño de la Cuesta, J. L. 1990. "Income Distribution during the Structural Transformation: Columbia 1938-88." Unpublished Ph.D. dissertation, Harvard University, Cambridge, MA.

Malathy, R. 1989. "Labor Supply Behavior of Married Women in Urban India." Economic Growth Center Discussion Paper No. 585, Yale University, New Haven, CT.

McElroy, M.B. 1990. "The Empirical Content of Nash Bargained Household Behavior." Journal of Human Resources 25(4):559-583.

McKeown, T. and R. G. Record. 1962. "Reasons for the Decline of Mortality in England and Wales during the 19th Century." Population Studies 16:94-122.

Mincer, J. 1974. Schooling Experience and Earnings. New York: Columbia University Press.

_____. 1985. "Inter-country Comparisons of Labor Force Trends and of Related Developments." Journal of Labor Economics Volume 3, No. 1, supplement, S1-S32.

Michael, R. T. 1982. "Measuring Non-Monetary Benefits of Education: A Survey." In Financing Education, (eds.) W. W. McMahon and T. G. Geske. Urbana, IL: University of Illinois Press.

Moock, P. and J. Leslie. 1986. "Childhood Malnutrition and Schooling in the Terai Region of Nepal." Journal of Development Economics 120:33-52.

Murphy, K. M. and F. Welch. 1990. "Empirical Age-Earnings Profiles." Journal of Labor Economics 8(2):202-229 (April).

Okojie, C. 1991. "Fertility Response to Child Survival in Nigeria." In Research in Population Economics, Volume 7, ed. T.P. Schultz. Greenwich, CT: JAI Press, Inc.

Parish, W.L. and R.J. Willis. 1994. "Daughters, Education and Family Budgets: Taiwan Experiences." Forthcoming.

Pitt, M. and M. Rosenzweig. 1986. "Agricultural Prices and the Health and Productivity of Indonesian Farmers." In Agricultural Household Models eds. I. Singh, L. Squire and J. Strauss. Baltimore MD: Johns Hopkins University Press.

_____, _____, and M. D. N. Hassan. 1990. "Productivity, Health, and Inequality in the Intrahousehold Distribution of Food in Low Income Countries." American Economic Review 80(5):1139-1156 (December).

Pope, C. L. 1992. "Adult Mortality in America Before 1900." In Strategic Factors in Nineteenth Century American Economic History, eds. C. Goldin and H. Rockoff. Chicago: University of Chicago Press.

Preston, S. H. 1976. Mortality Patterns in National Populations. New York: Academic Press Inc.

_____ and M. Haines. 1991. The Fatal Years. Princeton, N.J.: Princeton University Press.

_____ and J. A. Weed. 1976. "Causes of Death Responsible for International and Intertemporal Variation in Sex Mortality Differentials." World Health Organization Report.

Psacharopoulos, G. 1989. "Time Trends in the Returns to Education." Economics of Education Review 8(3):225-331.

_____ and M. Woodhall. 1985. Education for Development. New York: Oxford University Press.

Ram, R. and T. W. Schultz. 1979. "Life Span, Health, Savings and Productivity." Economic Development and Cultural Change 27(3):399-422 (April) .

Rosenzweig, M. R. and T. P. Schultz. 1982. "Market Opportunities, Genetic Endowments and Intrahousehold Resource Distribution." American Economic Review, 72(4):803-815 (December).

_____. 1983. "Estimating a Household Production Function." Journal of Political Economy 91(5):723-746 (October).

Sahn, D.E. and H. Alderman. 1988. "The Effect of Human Capital on Wages and the Determinants of Labor Supply in a Developing Country." Journal of Development Economics 29:157-183.

Schultz, T.P. 1981. Economics of Population. Reading, MA.: Addison-Wesley Publishing Co.

_____. 1987. "School Expenditures and Enrollments, 1960-1980." In National Academy of Sciences Background Papers, eds. D. G. Johnson and R. Lee, Population Growth and Economic Development. Madison, WI: University of Wisconsin Press.

_____. 1988. "Educational Investment and Returns." In Handbook of Development Economics, Volume 1, eds. H. Chenery and T. N. Srinivasan. Amsterdam: North Holland.

_____. 1989a. "Women and Development: Objectives, Framework and Policy." Working Paper WPS-200, Women in Development Division, Population and Human Resources Department, The World Bank, Washington, D.C. (April).

_____. 1989b. "Accounting for Public Expenditures on Education." Paper presented at a conference on Human Capital and Economic Growth, Buffalo, NY (May).

_____. 1990. "Women's Changing Participation in the Labor Force: A World Perspective." Economic Development and Cultural Change 38(3):457-488 (April).

_____. 1992. "Marriage and Fertility in the United States: The Role of Welfare and Labor Markets." Yale University, New Haven, CT. Mimeo.

_____ and A. Tansel. 1992. "Measurement of Returns to Adult Health: Morbidity Effects on Wage Rates in Côte d'Ivoire and Ghana," Discussion Paper No. 663, Economic Growth Center, Yale University, New Haven, CT.

Schultz, T.W. 1975. "The Ability to Deal with Disequilibria." Journal of Economic Literature 13:827-846.

Stolnitz, G. 1955, 1956. "A Century of International Mortality Trends." Volume I Population Studies 9: 24-55; Volume II Population Studies 10:17-42.

Strauss, J. 1986. "Does Better Nutrition Raise Farm Productivity?" Journal of Political Economy 94(2):297-320 (April).

_____. 1989. "The Impact of Improved Nutrition on Labor Productivity and Human Resource Development." In Political Economy of Food Consumption and Nutrition Improvements, ed. P. Pinstrup-Andersen. Baltimore, MD: Johns Hopkins University Press.

_____, P. Gertler, O. Rahman and K. Fox. 1994. "Gender and Life-Cycle Differentials in the Patterns and Determinants of Adult Health." Forthcoming.

Tanner, J. M. 1981. A History of the Study of Human Growth. Cambridge: Cambridge University Press.

Tansel, A. 1993. "School Attainment, Parental Education and Gender in Côte d'Ivoire and Ghana." Economic Growth Center Discussion Paper No. 692, Yale University, New Haven, CT.

Thomas, D. 1990. "Intrahousehold Resource Allocation." Journal of Human Resources 25(4):635-664 (Fall).

_____. 1991. "Like Father, Like Son: Gender Differences in Household Resource Allocations." Economic Growth Center Discussion Paper No. 619, Yale University, New Haven, CT (January).

_____ and J. Strauss. 1993. "Health, Wealth and Wages of Men and Women in Urban Brazil." Paper presented at the Conference on Women's Human Capital and Development, Bellagio, Italy (May).

Tinker, I. 1990. Persistent Inequalities: Women and World Development. New York: Oxford University Press.

United Nations, Department of International Economics and Social Affairs. 1987. Fertility Behavior in the Context of Development, Population Studies 100. New York: United Nations.

United Nations. 1982. Levels and Trends of Mortality Since 1950, Dept. of International Economic and Social Affairs, ST/ESA/SER.A/74, New York

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

Vallin, J. 1983. "Sex Patterns of Mortality." In Sex Differentials in Mortality, eds. A. D. Lopez and L. T. Ruzicka, Dept. of Demography, ANU (Canberra).

van der Gaag, J. and W. Vijverberg. 1987. Wage Determinants in Côte d'Ivoire, Living Standards Measurement Study, Working Paper No. 33, World Bank, Washington, D.C.

van Wieringen, J. C. 1986. "Secular Growth Change." In Human Growth, Volume 3, eds. F. Falkner and J. C. Tanner. New York: Plenum Press.

Visaria, P. M. 1971. The Sex Ratio of the Population of India, Census of India 1961. Volume I, Monograph 10. New Delhi, India: Office of the Registrar General (n.d.).

Vijverberg, W. 1994. "Educational Investments and Returns for Women and Men in Côte d'Ivoire." Forthcoming.

Waldron, I. 1983. "Sex Differences in Illness Incidence, Prognosis and Mortality." Social Science Medicine 17(16):1107-1123.

_____. 1986. "What do we Know About Causes of Sex Differences in Mortality?" Population Bulletin of the United Nations, No. 18.

World Bank. 1981. World Development Report for 1981. Washington, D.C.

_____. 1991. Social Indicators of Development 1990. Baltimore, MD: Johns Hopkins University Press.

_____. 1992. World Development Report 1992. New York: Oxford University Press. (Supplementary Data, IV.B).

Endnotes

1.For example, in Thailand in 1975 this measure suggests that women could expect to be enrolled for about seven years if they experienced the age specific enrollment rates prevailing in 1975 from age 7 on (in other words, .81 x 7 years + .23 x 5 years + .027 x 5 years = 6.96 years). A ratio of this summary measure of schooling investment for women relative to men in Thailand in 1975 is .91. But this female/male ratio of enrollment rates declines from nearly parity at the primary school level to .82 at the secondary level to .68 at the post secondary school level. Clearly, this synthetic measure of per child investment in schooling is not adjusted for the repetition rates, and should therefore be viewed as years of exposure to schooling rather than years completed as typically measured in censuses to approximate a stock of human capital.

2.Another interpretation is that the higher levels of investment in women's schooling contribute to greater social product and income. In this case, ignoring nonlabor inputs, one might fit an aggregate production function by regressing the logarithm of GNP (lny) per adult (potential workers over age 15) on the expected years of male (S_m)and female (S_f) school enrollments (lagged a decade to better correspond with the stock of schooling in the labor force). These regressions for 65 countries for which all three levels of enrollment rates are available back to 1960 yield the following estimates for 1970 and 1980:

(1) For 1970 $\quad \ln y = \underset{(35.2)}{5.02} + \underset{(2.02)}{.098}S_m + \underset{(4.18)}{.169}S_f \qquad R^2 = .85$

(2) For 1980 $\quad \ln y = \underset{(21.6)}{4.63} + \underset{(1.45)}{.110}S_m + \underset{(2.81)}{.182}S_f \qquad R^2 = .78$

where absolute values of the t ratios are reported in parentheses beneath the OLS

coefficients. For details on the composition of the sample and sources of data, see Schultz (1987, 1989b). This cross-sectional evidence of production suggests that the "return" on female schooling is substantially higher than that on male schooling. Identifying the aggregate production function parameters from the parameters of household demand functions is not currently feasible. Only these partial correlations between schooling and income are available, that require more structure than is commonly provided in either the literature on aggregate growth models with human capital inputs or private or social demand models for schooling.

3.Preston (1976, Table 6.10) reports relationships between the difference in age standardized male and female mortality and country characteristics based on data drawn from the 1960s. Although I did not compile the cause-specific mortality rates examined by Preston, the aggregate mortality levels for males and females were consulted to ascertain whether the gender differences in overall mortality (measured by the sex difference in life expectancy at birth) continue to be related in the 1980s to the same variables found to be important by Preston, and whether changes within countries also confirmed the causal relevance of the same variables in explaining changes occurring over time. In the case of the share of agricultural employment (measured among males, to reduce the cultural variations across countries in whether women are counted as being active in agriculture), there continues to be greater female than male mortality in populations more dependent on agriculture, and the relationship is also evident in changes over time and is particularly strong among children less than five years of age. Urbanization performs as an alternative proxy for agriculture, but the two variables are highly correlated and thus cannot always be used together

as explanatory variables. Education of women relative to men reduces female mortality relative to male in the 1980s (and in the 1960s) and in the change relationship from the 1960s to the 1980s. One relationship that Preston noted, but is absent in the 1980s or in the time series changes, is the proportion of the population in large cities (over a million), after holding constant for agricultural share. The interaction of animal fat in the diet and gender differences in schooling that Preston considered performs more poorly in predicting overall gender differences in mortality in 1980 than the two variables considered separately. If the ratio of female to male education is summarized, more plausibly, by the entire span of schooling (in other words, expected years enrolled), and is not to be limited, as in Preston's study, to Level 1 (primary), the explanation of female-male longevity is substantially more significant.

4.Most comparisons that document the growth in stature over decades or centuries within a population are derived from administrative records of the military, and thus pertain only to males. By the nineteenth century, school studies of physical growth of male and female children had become common, but they were most useful in confirming changes in the timing of the adolescent growth spurt and the onset of puberty. They are much less useful for documenting changes in the adult height for men and women over time. Relatively few males and far fewer females were still in educational systems by age 18. This well-educated population is not likely to be representative of the entire population (Tanner 1981; Falkner and Tanner 1986).

5.The association between height and mortality of male and female slaves in Trinidad during the nineteenth Century was founded by John (1984) to be

significant only for male adults, whereas child mortality is several times more responsive to height fluctuations in the population than adults. Friedman (1982), on the contrary, found significantly higher survival rates for both males and females who were taller, controlling for origins, occupation, and other factors. See also summary by Fogel (1986).

6.See endnote 4.

7.The increased taxes that the more educated individual pays back to the state can be viewed as an externality, if the added taxes contribute to a reduction in tax rates that reduce the distortionary burden imposed on resource allocation. The returns to human capital can be effectively taxed only when educated persons hold jobs where their productivity is readily monitored by the state, such as in wage employment.

8.A child implicitly borrows from her or his parents to invest in schooling and is thereby obliged to support parents in the future when parent productivity may be lower. Repayment could take alternative forms, such as supporting younger siblings through their schooling, marriage or borrowing requirements (see Parish and Willis 1994). Thus, the family may smooth consumption as would a credit market, because of the distinct life cycle phases of investment, production, and consumption that individuals experience. Even when financial markets and government social insurance schemes provide for old age support without relying on children, the young may still be credit-constrained, and their educational investments may depend in part on the altruistic behavior of their parents. Extreme forms of "dynastic altruism" that assign equal weight to own and

offspring consumption may be unrealistic. A gap between the parent-private return to investment in the schooling of their children and the child's individual-private return could arise from credit market constraints and would suggest arrangements outside of the family are needed to allow children to invest optimally in their own education.

9.This consideration of equity might lead parents to invest more than the efficient amount in the children whose educational investments yield lower returns, or parents might consider transferring to these children nonhuman capital assets from which competitive returns would presumably be earned (Becker and Tomes 1979). There is, however, little evidence that this pattern of portfolio balancing behavior is empirically common even within rich families.

10.The exclusion restriction that secures identification depends on the researcher knowing some information that influences the probability of sample selection, but does not affect the market wage offer. Functional form assumptions regarding the selection equation, for example, normal errors in a probit equation, can provide formal identification, but not a particularly strong theoretical or empirical basis for identification. See later discussion in sections IX and X.

11.But education and health are themselves interdependent. The connections between education and health are not yet clearly documented, in part because mortality or morbidity rates are not often available for analysis by educational attainment. Recent research has linked mother's education to the survival of her children in low-income countries (Cochrane et al. 1980), whereas other studies

have suggested that nutrition and health of children can affect their school achievement (Moock and Leslie 1986). Height is believed to be largely determined by nutritional status of the individual before reaching age four (Fogel 1990). Height can then be viewed as an indicator of long-run nutritional status that is essentially fixed in early childhood and may therefore be assumed exogenous in an adult's wage function in the same way that education is. Weight or a body-mass index or current caloric intake or acute illness, on the other hand, are more reasonably viewed as simultaneously determined with current productivity and income. Calorie consumption as an indicator of short run nutritional status can be estimated as a determinant of productivity by instrumental variable methods but may only be a quantitatively important determinant of labor productivity and wages at very low levels of income or calorie intake (Strauss 1986). See also Thomas and Strauss (1992).

12. Increases in a mother's schooling decreases mortality of her children. This pattern is widely replicated in surveys from countries in every region of the world. An added year of mother's education is associated with a 5 to 10 percent reduction in child mortality (Cochrane et al. 1980). Levels of mortality tend to be higher in rural than in urban populations of low-income countries, but the proportionate reduction in child mortality associated with an additional year of mother's schooling is about the same magnitude in both urban and rural areas of the same country. Although father's education in years is also correlated with lower child mortality, it has a smaller coefficient than mother's education. The correlation between women's schooling and lower child mortality across low-income countries is also robust to the inclusion of income per adult, men's schooling, caloric consumption, and other factors.

13.The less-educated are most likely to benefit from a family planning information campaign and by subsidized birth control and the supply of associated services. However, it may be noted that these data from the 1970s do not yet reveal much latent demand to restrict traditional fertility levels among African women, either among those with high or low educational levels, perhaps because of the high overall levels of child mortality in Africa (Okojie 1991). The Demographic Health Surveys from the late 1980s are documenting regions in Africa where demands are beginning to change, but these surveys lack economic information to facilitate analyses of the economic determinants of fertility or the independent effects of health and family planning programs.

14.Most research on the sorting of students by ability and its effects on estimated wage returns to schooling has analyzed these relationships for males, and then mostly in the United States. It is possible that the investments of families in the schooling of daughters is more (or less) responsive to the ability of the girls than in the case of boys (see Parish and Willis 1994). Alternative hypotheses regarding the family's objectives in educating sons and daughters will need to be rigorously formulated and tested. We may expect then to be able to reject in some settings the simplified wealth-maximizing model of the family that is assumed to treat boys and girls as identical.

15.The probability of participating as a wage earner can then be estimated as a probit model jointly with the wage equation for the censored sample of wage earners. Maximum likelihood methods, where the covariance (rho) between the errors in the two equations is estimated, is the standard means of estimation,

although the two-stage method (if the standard errors are adjusted) is also consistent although less efficient than the joint procedure (Heckman 1987).

16.The sample selection correction can be statistically identified from the nonlinearity of the probit wage earner selection equation with its normally distributed error (Heckman 1987). However, in most economic contexts it is desirable to have a stronger basis for identifying the model than only a relatively arbitrary assumption as to functional form. Exclusion restrictions based on a theoretical framework are the preferred estimation strategy. However, asset income may not in all contexts be independent of the wage rate if, for example, the assets represent accumulated savings that are a positive function of past wages, or if asset income encourages more investment (consumption) in unobserved health and nutritional inputs that augment labor productivity. Land may also have relatively little value for self employment in some parts of the world, and land per household may be allocated in some regions of Africa by the community in proportion to the number of unskilled workers in the household, and not be a good indicator of wealth per person or per adult, for example, in Côte d'Ivoire or Uganda.

The return coefficient on education in the wage function could be biased by multiple sources of sample selection. For example, suppose the multiple choices that determine sample selection involve different processes of, say, migration from rural to urban labor markets, working in the paid labor force, and working as a wage earner. This chain of decisions appears to be often sensitive to the educational attainment of the individual (Schultz 1988). If unobserved factors related to wages and schooling are associated differentially with the probabilities of each choice in the chain occurring, the procedure to correct for

selection bias requires the covariance between the errors in each choice process and the wage function to be estimated. Vijverberg (1994) proposes such an approach in his paper on Côte d'Ivoire and Thomas and Strauss (1992) implement a similar scheme in their analysis of urban Brazil.

17.Most indicators of adult health status or morbidity are based on self-evaluations of a survey population and are criticized as being excessively subjective. Consequently, comparisons of the health status of men and women across cultures based on these indicators are controversial (Schultz and Tansel 1992). Height and Body-Mass-Index appear to predict mortality and the onset by middle age of chronic diseases (Fogel 1990; Costa 1992), but these anthropometric indicators of adult health have not yet been systematically collected for women, as well as for men, to assess how sex differences in these indicators vary across groups in a society, across populations at different stages in the development process, or over time within a population. More research is therefore required to describe systemically the inputs of nutrition and health investments, and to assess the consequences on adult health, productivity, and welfare for females and males separately of gains in nutritional status, or, more specifically, adult height. It is conjectured that because the declines in mortality have been generally more favorable for females than for males, other objective indicators of health, such as height, will show a similar pattern with economic development. The empirical basis for this presumption is currently very limited.