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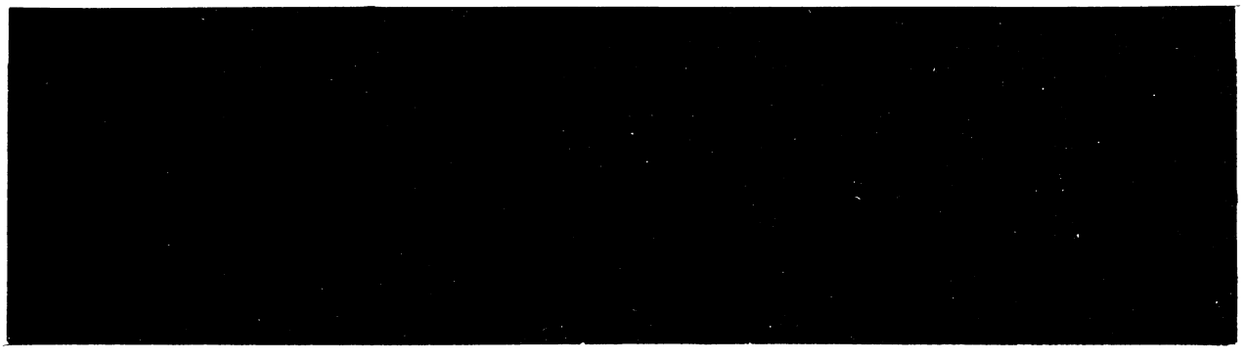

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Differences Between the Returns and Investments in the Education of Women and Men

T. Paul Schultz

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Differences Between the Returns and Investments in the Education of Women and Men

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Evidence is presented on investments in years of schooling in men and women across countries and within countries over time. The ratio of enrollment years or public educational expenditures on women relative to men is increasing toward unity for industrially advanced countries in the second half of the Twentieth Century, and is approaching this balance in Latin America and South East and East Asia. But in South and West Asia and Africa young women receive about half the amount of public expenditures on education as do men. This paper examines evidence on wage differentials by educational attainment for men and women to assess whether the lower levels of investment in schooling of women than men in many low income countries is explained by a lower private or social return to schooling among women. To calculate these returns to schooling, analysis relies on potentially unrepresentative subsamples of wage earners. A sample selection statistical correction methodology is proposed and implemented to deal with this problem. It assumes that an individual's ownership of land, assets, and nonearned income raises the opportunity value of the individual's time in nonwage activities, and thereby reduces the likelihood of being in the sample of wage earners, without influencing market wage offers. Estimates from Thailand, Cote de'Ivoire, Ghana and elsewhere, as well as for the United States, are compared to assess how corrected returns to schooling are related to the wide variation in school investments between women and men across contemporary low income countries.

1. Introduction

The economic returns to education or full time training are often summarized in terms of the percentage increase in wages that is associated with an individual spending an additional year acquiring a skill (Becker, 1964; Mincer, 1974). These estimates of returns to training activities are based mostly on nonexperimental data, which might yield biased comparisons for a variety of reasons. Yet analyses of nature's experiments, such as twins, or randomized interventions, such as lotteries, have not produced evidence that relative wage gains as conventionally attributed to schooling are seriously distorted, at least not among males (Griliches, 1977; Angrist and Kreuger, 1991a,b).

Less attention has been directed to another limitation of most studies of the returns to human capital. Individuals who decide to invest in more or less human capital are excluded from most such comparisons if they are not currently working for wages. The selection of the working sample is thus nonrandom and may bias estimates of private and social returns to human capital. Whereas about 60 percent of adult men and 30 percent of adult women are wage earners in high income countries, the fraction working for wages is only half as large in low income countries, 35 and 15 percent, respectively (Schultz, 1990a). Estimates of the productive returns to human capital may be biased, therefore, because they are based only on wage earners, and the potential bias is likely to be more severe when the fraction of wage earners in the population is relatively low, as in low income countries, and especially for women (Schultz, 1989). This paper explores how to incorporate information on persons outside of the wage labor force in a microeconometric analysis of human capital returns. Models of wage labor force participation are first reviewed to motivate the specification of the identification restriction implicit in the model that corrects for the sample selection rule. Wage functions are then estimated, guided by standard working assumptions in the field.

These functions imply the private returns to schooling for women and men based on wage differentials, correcting for the identified source of sample selection bias. Social returns would ideally require additional information on public expenditures on education and social externalities of education. Unfortunately, school expenditures are rarely disaggregated for female and male

students, and social externalities of educating men and women can occasionally be estimated in physical terms, but not in monetary values such that they could be included in the calculation of social returns to schooling.

The evidence presented below on school investments in men and women raises many puzzling questions. Years of schooling completed by men and women are admittedly a crude indicator of either the opportunity cost of producing education or the productive value in the labor market of the enhanced skills of the educated worker. Recognizing the limitations in such measures of schooling, it appears that there has been mid-twentieth century convergence in industrially advanced countries between the year of schooling completed (or in the years enrolled) by women and men. The gap has also closed in many low income countries, primarily in Latin America and East and Southeast Asia. By contrast, South and West Asia and much of Africa continue to provide young women with little more than half the number of years of schooling received by men, and, as described below, when these investments are translated into public expenditures, the fraction received by women is still smaller (Schultz, 1987).

Are these large regional differences in the educational investments in women relative men explained in terms of corresponding differences in private individual, family, or social returns to schooling of females and males? If not, are there other aspects of the institutional arrangements surrounding investments in schooling that could account for why countries would invest public and private resources in education with limited regard for the social and private returns they obtain from these activities?

Section 2 documents these patterns in school investments in men and women across regions and across birth cohorts within countries. Sections 3 and 4 outline the conceptual and measurement problems involved in estimating private and social returns to schooling. Section 5 illustrates the externalities of education that differ for educating men and women. Patterns across countries and levels of schooling in estimated returns are summarized in Section 6. A method for estimating the sample selection corrected returns to schooling is described and implemented in Sections 7 and 8. A brief concluding section ends the paper.

2. Differences in the Investment in Schooling of Women and Men

In the poorest countries, where the level of educational investment is lowest, women receive, on average, the smallest share of schooling opportunities. Two empirically documented reasons that poor countries invest in fewer years of education for their children is that they are indeed poor and face a relatively high price for schooling. Their poverty suggests that governments and families may be credit-constrained in making long run human capital investments if high returns do not call forth greater resources. In addition, the salary of a teacher in these countries relative to the standard of living can be very high. This relative price of schooling appears to be as important as real per capita income in explaining cross country variation in public investments in schooling (Schultz, 1987).

Public or private expenditures on the schooling of men and women cannot be separated in most data sources, but student enrollment rates can be disaggregated by gender. Estimated income and price elasticities tend to be larger in absolute value for female enrollments than for male (Schultz, 1987). Increasing incomes and decreasing the relative price of teachers, according to estimated cross-sectional relationships, are associated with reducing the gap between enrollments of women and men. The question that has not been explored, to my knowledge, is whether the differences in educational investments across countries and within countries over time are a response to gender differences in private wage returns or social returns to schooling in those countries, or whether the differences signal an inefficient allocation of investment resources in education. This paper will consider this question in a few countries.

The average number of years of schooling completed by men and women in various age groups is available from population censuses from a few countries in a few census years. Enrollment rates by sex are more widely available and are published in the UNESCO Statistical Yearbook for most countries annually over the last few decades. A single measure of "expected years of school enrollment" can be constructed by multiplying the gross enrollment rates at each school level, by the duration of study at that level in years, and summing over levels.[1]

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[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 to 24 (i.e., .81 x 7 years + .23 x 5 years + .027 x 5 years = 6.96 years). A ratio of this summary measure of

This measure of "expected years of schooling enrollment" is converging in absolute terms across low and high income countries, as shown in Figure 1. Women today are receiving nearly as many years of enrollment as men in industrially advanced, high-income countries (Figure 2). In recent years, Latin America and East Asia are quite similar to the high-income countries according to this measure of schooling of women relative to men. 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 that men do. This pattern for Latin America, Africa and high-income countries is based on UNESCO regional estimates representing all countries of the world. I have computed my own estimates separately for the subregions of Asia from individual country gross enrollment figures. The ratio of female to male expected years of enrollment is increasing from 1950 to 1985 in every region, as shown in Figure 2, except for a small setback reported from China in 1980.

Years of schooling completed are shown by age for seven selected countries in Figure 3 as recorded in censuses. The ratio of female to male education is plotted in Figure 4. At older ages, the relative gap between men and women in educational attainment tends to be substantially larger than at younger ages. Attainment and enrollment data, which come from independent sources, imply similar estimates of years of educational investments by birth cohorts for the same countries. Expected years of enrollment are available from many more countries than are estimates of educational attainment, but enrollments describe only current physical units of investment and not historic trends or the stock of human capital available to the economy at any point in time. From either source there is evidence that women's years of schooling are catching up to that of men's across countries ordered by increasing per capita income, and over time within countries that are achieving more rapid economic growth in the period 1960-1980 (Schultz, 1987).

Expected years of enrollment by sex can be partially adjusted in 47

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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. (For further discussion see Schultz, 1987.) Clearly, the synthetic measure of average stock of 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.

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

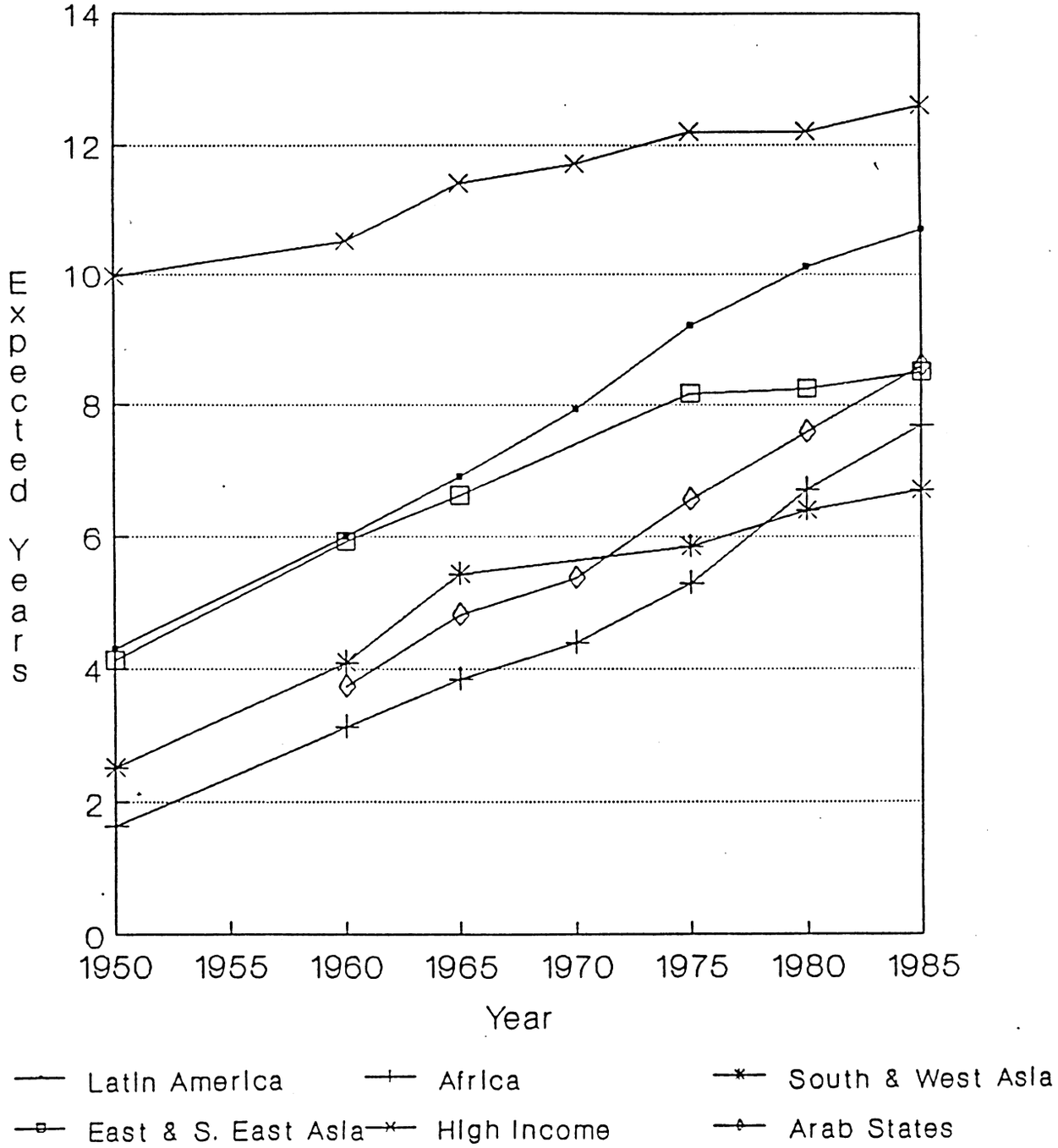


Fig. 2: Female to Male Expected Years of Enrollment by Region, 1950 to 1985

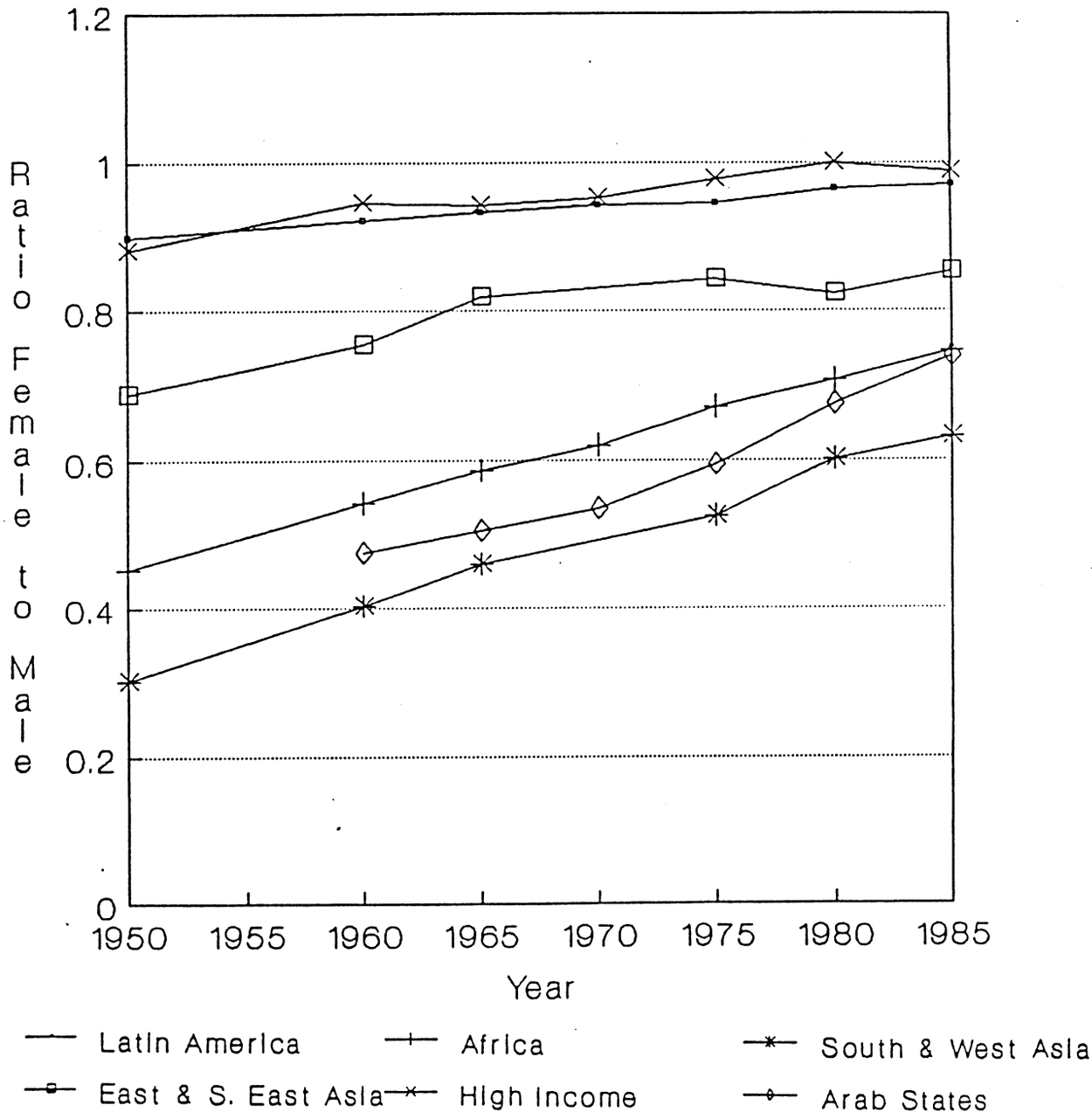


Fig. 3: Years of Schooling Completed, by Age, for Selected Countries

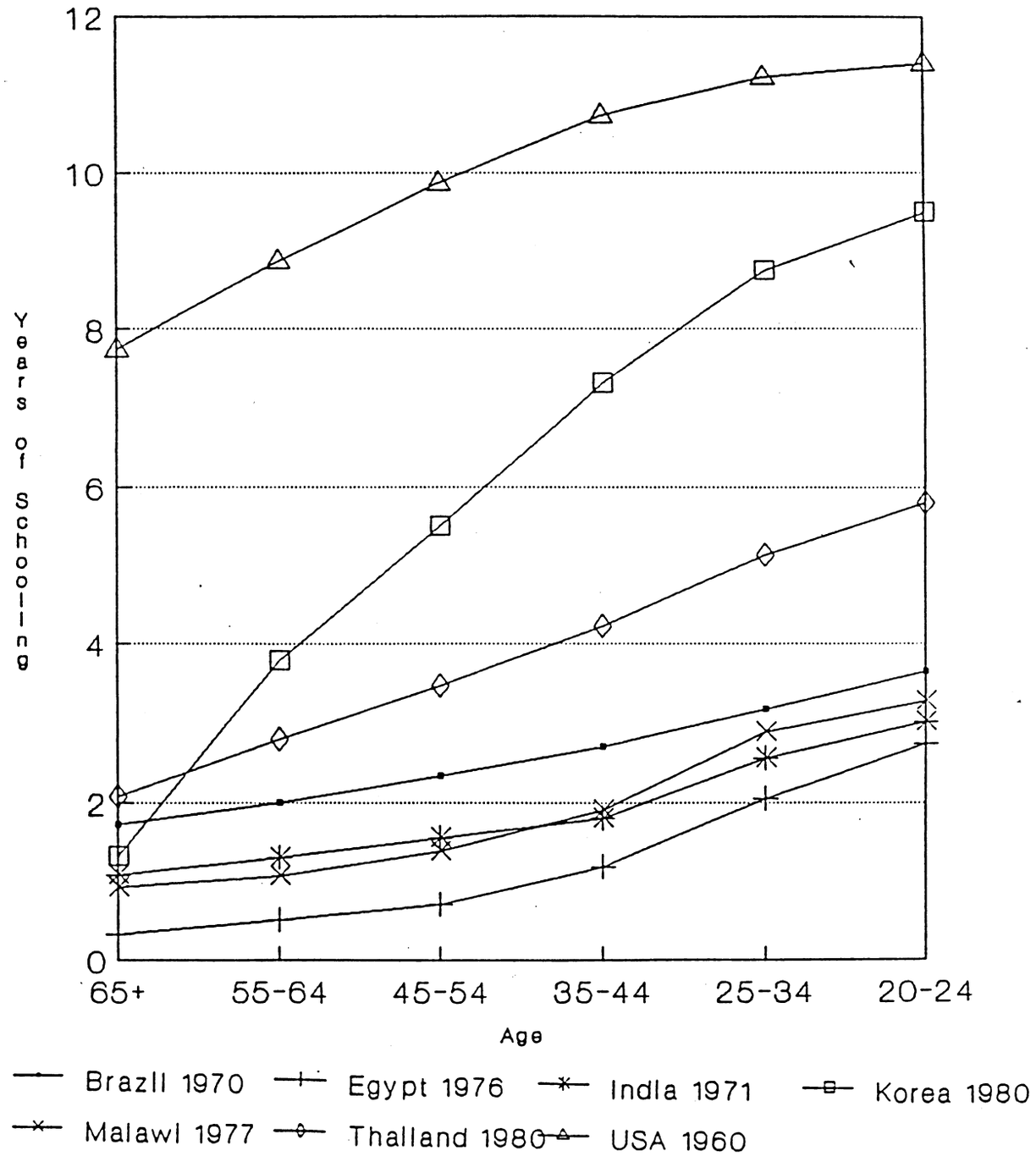
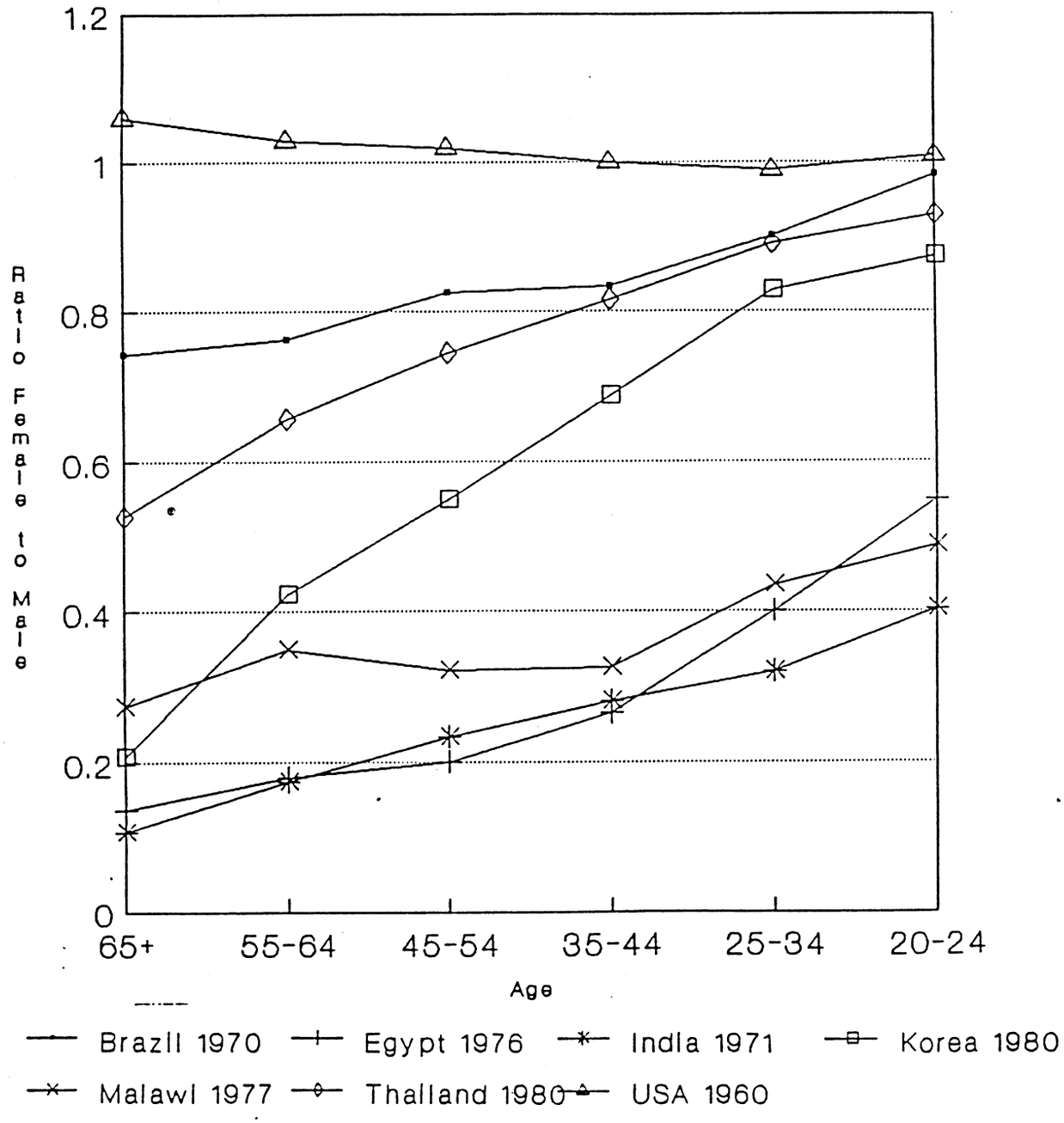


Fig. 4: Female to Male Years of Schooling Completed by Age, from Selected Countries



countries for differences in average public expenditures per student at the three levels of schooling: primary, secondary and higher. This adjustment incorporates the tendency for the public subsidy to a year of education to increase markedly at the secondary and university levels in low-income countries (Psacharopoulos and Woodhall, 1985), and for the fraction of female students to decline at higher levels in the school system. This partial adjustment neglects any within-school level differences in expenditures on male and female students that may also be important at higher levels, but is not currently documented.

Table 1

Expected Years of Schooling Enrollment and Annual Public Expenditures Per School-Aged Child, 1960s and 1970s for Available Countries

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.	.91	.76
Africa (13)	5.7	455.	.73	.50
Latin America (8)	8.0	801.	1.03	.83
East & Southeast Asia (6)	9.4	913.	1.00	.86
West & South Asia (5)	7.3	1234.	.59	.52
High Income Countries (15)	12.0	6854.	1.02	.93

a Country is included if UNESCO Yearbooks report for at least five years the required data on enrollments by sex, and public expenditures by three levels of schooling. See list of countries and years under footnote #2.

b Expected enrollments are derived by summing the weighted gross enrollment rates for the three school levels where the weight is the number of years, the school level is assumed to last (i.e., breadth of age group used to denominate gross enrollment rate). See text, page 14.

c Public expenditures for each school level includes the current expenditures that are so allocated plus the proportionate share of capital expenditures, where female and male students are assumed to receive the same expenditures on their education within the same school level. Capital expenditures are smoothed by a five year moving average, and interpolated in a few cases.

Table 1 reports the levels of the expected years of enrollment and the real expenditures in 1970 dollars per school-aged child for 140 country-year observations where data are included at five year intervals for 47 countries.[2] These estimates should be treated with caution because this small sample of countries may not be representative of the regions I have distinguished or of the world as a whole. Relatively few youth attend school beyond the secondary level in many countries. Nonetheless, the inclusion of the higher level of education increases by 26 percent the total public outlays on education. Because women receive an especially small fraction of these opportunities for higher education in some countries, the ratio of female to male public expenditures on education is .76 for the full sample (i.e., world), although women receive 91 percent of the years of education as do men. In Africa, the female to male ratio of years of enrollment is .73 and 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 starts at parity, it declines to .83, .86 and .93 respectively, when converted to the ratio of public expenditures. In the South and West Asia region the ratio of female to male enrollments start at .59 and declines further in terms of public expenditures to .52. Thus, there remains today a division in developing countries between those that are approaching parity in educational expenditures in women and men (>.83) and those who are not (<.52).

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. In Africa, enrollments increased nearly as rapidly as expenditures,

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[2]Data derived from UNESCO Statistical Yearbooks, Paris, various years. 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 (1960-1980), Portugal (1975-1980), Spain (1965-1975), Yugoslavia (1960-1970), France (1970-1980), West Germany (1960-1980), Netherlands (1960-1965).

despite the tendency for growth to be concentrated at the secondary and higher levels of schooling for which we noted the costs per student-year are much higher. This suggests that the African school systems have reduced their costs per enrolled student, probably through a reduction in the relative cost of teachers (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 19th century in the United States (Fuchs, 1968; World Bank, 1981). The capacity of an educational system to reduce the cost of teachers--the dominant input to education--can contribute importantly to the rate of expansion in enrollments, even without a rapid growth in public resources allocated to education.

Table 2

Annual Growth Rates of School Enrollments and Public Expenditures per Child, by Region, 1960s and 1970s, for Available 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	.74	.85
Africa (13)	3.3	3.7	1.6	.70
Latin America (8)	2.3	5.2	.07	1.2
East & Southeast Asia (6)	1.1	3.3	.81	1.8
West and South Asia (5)	2.8	7.7	1.5	.45
High Income Countries (15)	.95	7.2	.10	.52

Notes: See Table 1 and footnote 2.

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 ratio in the region of .52, as shown in Table 1.[3]

3. Individual and Social Returns to Education

Returns to education can be calculated from information on the benefits and costs of the educational investment. These returns can be reckoned from the perspective of the individual, the parents, or the society. The private individual's future after-tax gains in productivity associated with schooling are offset by private costs of two types: the opportunity cost of the production lost to the family because the individual attended school rather than working in the home or labor force, and the privately-supported expenditures on schooling, such as student fees and books. To compare the production gains over a future working lifetime with the initial costs of schooling, the gains must be discounted back to the time of the investment, and the discount rate that lowers the discounted gains to just equal the discounted costs is by definition the internal rate of return to the individual's private investment in schooling. Individuals are assumed to maximize their lifetime wealth by investing first in forms of human and physical capital that earn them the highest private rates of return. They are expected to invest until they have exhausted investment opportunities for which the internal rate of return exceeds the interest rate at which they can borrow.

In reckoning education's costs from the perspective of the society, public sector subsidies to education should also be included with the private costs of education. On the other hand, there may be additional social benefits from the educated individual's increased future productivity and altered behavior that are

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[3]The five countries included in my sample from West and South Asia--Afghanistan, Iran, Iraq, Kuwait and Syria--may not be representative of the region. But other partial sources for India and Pakistan does not indicate that these two large countries have invested more heavily in women relative to men or increased this ratio more rapidly than half a percent per year.

not captured in the individual's private after tax gain in productivity. The increased taxes that the more educated individual pays back to the state can be viewed as such an externality, if the added taxes contributes to a reduction in tax rates and in the distortionary burden that taxes impose on resource allocations. The returns to human capital are taxable only when educated persons hold jobs where their productivity is readily monitored by the state.

More educated workers may also modify their labor supply to taxable activities, but in different ways for men and women. Taxable labor supply increases 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 their education or may decline (Schultz, 1989).

More importantly, education, particularly for women, influences the health, longevity, and welfare of the individuals and their immediate family. It also influences family size. If these effects are seen as social as well as private benefits, they are also externalities of 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 simply adjust the private individual returns downward by adding into the computation the public expenditure costs of education.

Despite the measurement difficulties, the difference between social and private returns is a conceptually useful criterion for allocating public resources (including education) among competing programs to maximize social welfare. If private individual resources were initially allocated efficiently to activities generating the highest individual returns, social subsidies should optimally supplement private resources so as to channel them to those activities where social returns exceeded private returns by the largest margin.

An intermediate aggregation between the individual and the society is the family, or more specifically, parents whose interests span more than one

generation. Educational decisions are made by parents for their children, or at least those decisions are heavily 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 that lead them to invest in the schooling of their children? One economic interpretation of the family is that it provides an institutional context for people to transfer resources over time. A child implicitly borrows from her or his parents to invest in schooling and may thereby be obliged to support parents in the future when parent productivity may be insufficient to meet their own consumption. Repayment could take alternative forms, such as supporting younger siblings through their schooling, marriage or borrowing requirements. Thus, the family may provide an alternative to the credit market because of the distinct life cycle phases of investment, production, and consumption that individuals pass through that can thereby be smoothed across generations.

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. One definition of private efficiency in educational investment would require parents to treat their children's future consumption as of equal value to their own consumption. This form of "dynastic altruism" may not accurately describe all parents. A gap between the parent-perceived private return to investment in the schooling of their children and the child's individual private return could then arise and credit markets would be required outside of the family to allow children to invest optimally in their own education. This imperfect ability to internalize in the family all of the individual private returns to human capital investments in children could explain the common practice of public subsidies for education, as well as interventions in credit market to assist investors in human capital, such as need-based scholarships and student loans.

In addition, parents may not treat all children as equal. The private returns to schooling 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. This consideration of equity might lead parents

to invest more than the efficient amount in the children whose educational investments yielded lower returns, or parents might transfer to these children compensating assets in the form of nonhuman capital from which competitive returns would presumably be earned (Becker and Tomes, 1979). There is, however, little evidence that this pattern of behavior is empirically common.

Having established these distinctions, the educational investments in men and women can be analyzed as a potential instance of market failure that could benefit from the intervention of public policy. What factors might motivate parents to invest systematically more in the education of boys than of girls? 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 premium to educated female labor as to educated male labor. This line of reasoning presumes that male and female labor is technically different in the sense that they are imperfect substitutes for each other in some activities.

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 investments will not be privately efficient. Subsidized loans for female education could, under these conditions, promote a more efficient pattern of investment in which those investments with the highest private returns were given appropriate priority and economic growth maximized.

4. Issues in Measuring the Returns to Schooling

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 slightly the returns to education, but introduction of these controls does not alter appreciably comparisons of the private individual's

returns to education for men compared to women (Schultz, 1989).

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. But analyses of self-employed men and women in a variety of countries, including Thailand, Colombia and Israel, did not detect major differences in the monetary returns to schooling associated with working in wage and non-wage sectors (Chiswick, 1979; Fields and Schultz, 1982; Ben Porath, 1986). Again, this problem is difficult to resolve entirely, but whatever biases it may exert on estimates of the returns to education, they are probably relevant to both men and women.

Third, many individuals are not in the labor force. If the rates of return to education can only be estimated for those who are "self-selected" into the labor force, and often only 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, 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 bias in the estimation of the private returns to schooling arising from the potentially unrepresentative observed sample. 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 affected by the choice of assumptions and specifications underlying the statistical approach. There is, however, a relatively firm theoretical basis for the statistical identification of the sample selection model in this case of wage functions, as will be discussed below.

5. 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, fuel, the fetching of water, and maintenance of housing, for which there are sometimes market-priced equivalents. But in practice, the complexity of imputing a value to goods one produces and then consumes leads to their frequent omission from our records. Moreover, untradable home-production activities, such as child-rearing, are ignored entirely as an economically valued output 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 their capabilities and control over resources. Improving the productivity of women through human capital investments is a social objective to advance economic development. But increasing women's productivity also appears to channel associated new streams of income and resources toward particular forms of consumption and investment in food, medical care, and schooling of children. Raising women's productivity through educational investments has the consequence of reducing child mortality and fertility, holding constant for men's education and productivity.[4]

The effects of male and female human capital on fertility are complex. In most societies, fertility is lower among women who are better educated and can expect to receive higher wage rates. Education increases a woman's potential

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[4]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% 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 is also correlated with lower child mortality, it has a smaller impact than mother's education. The most progress has been made in studying farmers, who produce a few major outputs that can be valued in competitive markets and who are constrained by technological production processes that agricultural scientists have described in a general form for decades. A survey of 37 farm-level analyses from a wide variety of low income countries assessed the effect of farmer education on agricultural profits, controlling for the use of other productive inputs. The net productivity of farmers was on average nine percent higher if they had completed four years of primary schooling compared with none. Incorporating data on the public cost of schooling, the authors concluded that in the 1970s Malaysia received a 25-40 percent social rate of return on public investments in rural primary education, Thailand 14-25 percent, and South Korea 7-11 percent (Jamison and Lau, 1982).

income, but also increase 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. Because of the time a mother spends with children, wage opportunities increase the cost to her of having children. Increases in the labor productivity and wage rates of men, on the other hand, appear to enhance the attractiveness of a large family 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 is fixed, should have an

TABLE 3

Measures of Cumulative, Recent, and Desired Fertility: Averages for World Fertility Survey Countries Reporting, By Region and Respondent's Education

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 Age standardized

b Of ever-married women, Age 40-49 years

c Age adjusted

Source: United Nations (1987), Table 112 and 115.

unambiguous effect of reducing fertility and slowing population growth.

Although male education is not held constant, the tabulation of fertility by woman's education in the 50-odd countries where the World Fertility Surveys were conducted during the 1970s illustrates this pattern in Table 3. 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 (col. 1) and "desired" fertility (col. 3) (across all ages) is a rough indicator of 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 age 40-49 is concentrated in Asia and Latin America within the least educated strata of women. This is the group that is most helped by a family planning information campaign and by subsidies for birth control supplies. However, these data 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).

6. International Patterns in Returns to Investment in Schooling

There are notable limitations to estimates of the returns to human capital, but the accumulating evidence from studies in many countries, based on a wide variety of working assumptions and sources of data, imply that private and social returns to primary and secondary education are between 5 and 40 percent per year. One survey of empirical studies in 22 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). An increasing number of studies suggest that secondary schooling has become a bottleneck, with returns being higher at this level of schooling than at the primary level (Schultz, 1988). Rates of return to a specific level of education tend to be lower in more industrially advanced countries that have already invested more in the schooling

of their adult population than have the low-income countries. 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, particularly in Africa. But short run swings in macroeconomic conditions can also substantially modify private returns to schooling, particularly among new entrants to the labor force (Schultz, 1988).

But, as already noted, the majority of studies of returns to education are limited to wage earners, who may be a small fraction of a low-income country's labor force and adult population. Evidence on returns to education among self-employed workers requires more data and different analytical methods, although existing studies confirm in selected settings similar returns as to wage earners (e.g., in agriculture 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 40 years can be interpreted, from this micro-economic perspective, as an economically-justified response of these people and their governments to the high returns they expect to earn from increased outlays on schooling compared to the returns on alternative physical forms of private and social investment (Schultz, 1988).

7. Gender Differences in Returns to Schooling and Measurement Bias

Research is needed to clarify how the derived demands for male and female labor, distinguished by its levels of education, are affected by the aggregate economy. The stock of technological opportunities available for producers, the existing physical capital, the composition of output determined by domestic resources, consumer preferences, and trade regimes, may all eventually help explain why private returns to schooling for men and women differ across countries and change over time.[5] In this paper I will emphasize the composition

[5]The different composition of output and organization of production in different national economies may affect the derived demands for educated male and female labor. Unfortunately, little is now known about such demand or institutional factors responsible for the high contemporary returns to education or sex differentials in these returns. Several hypotheses for the high level of returns to schooling warrant more study.

The increasing stock of transferable technology that can be productively adapted by more educated workers is emphasized by T. W. Schultz (1975); the

of men and women with the same education, presuming that the gender balance of supplies of educated labor in the population is one factor affecting relative wage ratios between those of the same sex with different amounts of education.

The primary problem with extending the empirical analysis to gender differences in returns to schooling is the need to incorporate the nonmarket returns to education for women (Schultz, 1989). Since nonmarket output cannot be comprehensively evaluated in monetary terms, it is convenient to rely on the subpopulation of wage earners. Correcting for the potential bias introduced because of the selective character of this sample of wage earners is, however, mandatory (Heckman, 1987). 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 market wage offers for all women or all men, or to affect differentially this bias between women and men. This remains an open question for empirical research, one that may in the future be analyzed together with the composition of output and employment, the capital intensity of production, and perhaps measures of sex segregation in employment by industry and occupation.

It may be useful to trace through two specific forms of sample selection that illustrate how bias in estimating returns to schooling might arise at different ends of the distribution of educational attainments. In the first case, assume that virtually all women with higher education work for wages, but that only half of those who have only secondary education work for wages. Suppose that the half of the secondary school workers who work for wages are not a representative sample, 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

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mobility of workers to seek their most productive jobs, especially for women to transfer out of agriculture, and frequently into manufacturing and ultimately into services (Fuchs, 1968) appears to parallel modern development. It has been debated whether physical capital investments complement or substitute for human capital. In other words, are rates of return on schooling increased (or decreased) as the production process becomes more physical capital intensive? Capital investments in the 19th century are believed to have been "biased" toward saving unskilled labor and hence increased returns to skills, whereas analyses of contemporary U.S. manufacturing found a complementarity between capital intensity and returns to educated labor (Williamson, 1990; Griliches, 1982). The capital intensity and composition of output could also be responsible for different demands for educated female and male labor, if the two types of labor are not perfect substitutes for each other in a sufficient variety of production activities, or occupational segregation by gender precludes, at least in the short run, equilibrating the sex composition of workers.

case, understate (overstate) the productivity gain an average person could expect to receive by continuing on to obtain a higher education. To correct for this 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.[6] I will assume that this identifying variable is the individual's ownership of land and 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 not expected to influence his or her market wage offers.[7]

A second form of selection bias might arise among the lowest educational strata in a modern welfare state. Suppose, for example, that persons in this group who decide not to engage in wage employment are the least productive workers in this low education group. This second pattern of selection could be reinforced by public assistance programs and minimum wage legislation that provide workers with alternative support if they do not accept a wage job, in the first case, and limit employers from offering a low enough wage to make it profitable to hire (at the minimum wage) the less productive members of this group. This form of sample selection bias might emerge when unemployment, welfare, and disability insurance benefits are set at relatively high 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 working sample of wage earners becomes more representative of

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[6]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 preferred 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).

[7]The sample selection correction can be formally identified from the nonlinearity of the probit wage earner equation with its normally distributed error in distinction to the linear semi-logarithmic wage equation (Heckman, 1987). However, in most economic contexts it is desirable to have a stronger basis for identifying the model than off of functional form assumptions. Exclusion restrictions based on a theoretical framework is a preferred specification.

the entire population, as the level of education approaches the population average. Consequently, standard estimates of private wage returns to primary education would be biased downward in this second example of possible sample selection bias, when the majority of the population attains more than a primary education, and welfare institutions dissuade the least productive individuals in the least educated group from working for wages.

8. Empirical Evidence of Private Returns of Schooling

Several case studies are first reported to suggest how the private returns to years of schooling at three educational levels can vary for women and men. These returns are calculated first as conventionally reported by ordinary least squares (OLS) for wage earners, and second as corrected for sample selection, where property income and assets are used to identify the selection correction procedure. In combination with a few other wage studies reported in the economics literature, some patterns emerge in the relationship between returns and investments in schooling of women and men.

Thailand is a country that has grown rapidly for the last several decades. Women have historically played a major role in the 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 in Table 4 are estimated from the two most recent rounds of the Socioeconomic Survey (SES) collected in 1985/86 and 1988/89. Estimates of returns to schooling based on similar assumptions from this survey in 1975/76 and 1980/81 have also been calculated (Schultz, 1989). 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. In 1985/86 and in earlier surveys primary schooling returns are increased when sample selection is taken into account and secondary schooling returns are decreased, 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 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- 7 percent in 1985/86 and 20-12 in 1988/89.

TABLE 4

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

Year--Unit of Earnings (Sample of Wage Earners/ Population)	Without Correction			With Correction		
	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 estimation sample is restricted to wage and salary earners between the ages of 25 and 54. Selection correction terms are included in the earnings functions to capture the probability of participation in the labor market and of selecting wage employment. Hectares of irrigated and dry land owned and nonearned income identify the selection model. See Schultz, 1989 for further discussion and full estimates with other control variables and parallel estimates for 1980/81 and 1975/76.

b The absolute value of t ratio is reported in parentheses beneath regression coefficient on years of education within each level of schooling. Statistically different from zero (no return) with a confidence of .005 if t >2.6. All returns are highly significant.

c The absolute value of the asymptotic t ratio is reported in parentheses beneath regression coefficients on years of education within each level of schooling. Statistically different from zero (no return) with a confidence of .005 if t >2.6. All returns are highly significant.

Wage ratios associated with each year of primary schooling, corrected for sample selection, have been of a similar magnitude for men and women. 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 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, returns to schooling for men and women appear to be of a similar magnitude with women's returns exceeding men's most noticeably at the secondary level where the supply of educated female Thai population relative to male is lowest.

Table 5

Estimates of Private Rates of Return to Schooling in Côte d'Ivoire and Ghana by Gender, Without and With Correction for Sample-Selection Bias

Country, Year and Sample (Sample of Wage Earners/ Population)	Without Correction (OLS)			With Correction (JML)		
	Primary	Middle	Secondary	Primary	Middle	Secondary
Côte d'Ivoire 1985-87, Age 15-65						
Female (376/9099)	10.9 (4.08)	24.3 (7.45)	22.4 (9.95)	7.8 (1.26)	20.9 (2.71)	20.2 (4.22)
Male (1452/7832)	14.0 (11.5)	27.4 (15.3)	22.4 (18.0)	11.6 (7.03)	24.1 (10.3)	20.0 (11.5)
Ghana 1987/88, 1988/89, Age 15-64						
Female (454/6067)	-1.0 (.34)	14.5 (3.95)	10.4 (8.30)	-1.2 (.31)	14.2 (2.97)	10.1 (2.07)
Male (1471/5605)	-1.3 (.72)	7.0 (3.15)	11.8 (15.1)	-1.3 (.78)	7.9 (2.73)	12.3 (9.27)

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. Economic growth until the 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 influence returns. The wage 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. This interpretation is confirmed in other investigations of wage determinants in Côte d'Ivoire (Van der Gaag and Vijverberg, 1987).

Ghana began the 1960s with a more educated population than Côte d'Ivoire, but with women also receiving only half the number of years of education as men. Because of either the low quality of primary schooling or its oversupply in a stagnant economy, no private returns are evident to years of primary schooling in Ghana, for either sex. At the secondary level where women have obtained 61 percent as many years of schooling as men, the wage ratios for more educated women are almost twice as large for women as for men, 14 percent per year compared to 7.9 percent respectively. These higher private returns for women's secondary schooling are not replicated at the university level where women have obtained only 40 percent as much education as men.

The United States is examined in Table 6, as a polar case where wage earners are common, and education is more equally divided between men and women. Not surprisingly, the sample selection procedure indicates that the nonrandom selection of wage earners is not a major source of bias in the U.S. data. But there is nonetheless a tendency, when sample selection bias is corrected, for women's private returns to higher education, where they are least represented in the hierarchy of skills, to increase more than male returns. Moreover, these corrected private returns to higher education are distinctly higher for women

than men, both among blacks and whites. One interpretation of this pattern is that the derived demand for workers with a college education treats men and women as imperfect substitutes and assigns a relatively larger premium to the more scarce factor, college educated women.

TABLE 6

Estimates of Private Rates of Return to Schooling in the United States, in the 1980 Census, by Sex, Without and With Statistical Correction for Sample Selection Bias[a]

Sex (Sample of Wage Earners/ Population)	Without Correction by School Level:			With Correction by School Level:		
	Primary	Secondary	Higher	Primary	Secondary	Higher
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)	3.34 (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 logarithmic hourly wage rate function is estimated from a sample restricted to wage and salary earners in 1979 reporting weeks worked and usual hours worked per week in 1979. The sample includes all black and one in ten white persons age 15 to 64 from the 1 in 1000 Public Use Sample A of the U.S. 1980 Census of Population. Other controls include ethnicity (Hispanic), and Urban (SMSA). The sample selection equations also include the linear and quadratic form of the 1979 income received from dividends, interest and rentals, and state of residence duration of unemployment benefits in weeks, and AFDC maximum cash and food stamps benefit for a single mother and child. Maximum likelihood methods are used to jointly estimate the probit selection equation and the wage equation and the coefficients on years of education are multiplied by 100 to be in percent.

b The absolute value of the t ratio is reported in parentheses beneath regression coefficients on years of education within each level of schooling.

c The absolute value of the asymptotic t ratio is reported in parentheses beneath regression coefficient on years of education within each level of schooling.

There are relatively few studies of the returns to schooling for men and women that have corrected estimates of the wage function for the sample selection bias introduced by analyzing only wage earners or labor force participants reporting income and hours. The findings from several such studies are contrasted in Table 7, where these corrections for sample selection, if they have a marked effect on estimated returns to schooling, tend to increase returns for

women. The similar levels of education among men and women in Latin America might suggest that sample selection bias would be less important in this region as a differential sign of labor scarcity. Consistent with this hypothesis, the 1985 estimates of male and female returns to schooling for Peru were not greatly affected by the sample selection correction. Consequently, the first six studies reported in Table 7 for various Latin America countries are reported, even though these early studies did not correct for sample selection. There is again no evidence from these studies that individual private rates of return to schooling among wage earners are generally lower for women than for men. Indeed, they tend to be higher on average. However, estimates of the returns to women's schooling will be 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, regions where such an analysis would be particularly valuable for understanding why parents invest more in the schooling of their sons than of their daughters.

To estimate without potential sampling bias the individual private rates of return to schooling, the researcher must first understand what determines an individual's allocation of time to wage employment. This knowledge is used to implement sample-selection correction procedures, which will implicitly depend on how the family unit is conceptualized that pools resources and coordinates labor market behavior. How these forms of family behavior are theoretically modeled may therefore be of importance to properly correct wage functions for sample selection bias. Alternative approaches to the family decision making process should influence how the sample selection rule is specified and what family variables are treated as exogenous or beyond the influence of the individual or the family. Comparative research is needed to assess whether variations in these aspects of model specification of labor supply behavior alter importantly conclusions on the returns to schooling of women and men.

TABLE 7

Private Rates of Return to Schooling of Women and Men

Country, City, or Regional 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 (Secondary/Urban)	1985	28.7 *	17.0 *
Peru (Secondary/National)	1985	14.6 *	8.8 *
Indonesia (General High School) National	1986	9.6 +	6.2 +

* Selection corrected.
\+ Fixed effect for family.

Sources: For Peru, see Khandker (1989), for India, see Malathy (1989), for Thailand and the US see above Tables 2 and 3, and for others, see sources in T. Paul Schultz (1989).

9. Conclusions

Schooling for women may be justified in terms of efficiency (high individual private market returns), social externalities (reduced child mortality and fertility), equity (an increase in the productive capability of the poor relative to the rich), and intergenerational redistribution (better health and education of children and a slower growth in population).

Estimation of private returns to schooling in several countries, correcting for the potential bias introduced by relying on only wage earners, confirmed that private wage returns are of a similar magnitude for women and for men. Indeed, frequently when women have received much less than half of the years of secondary or higher education in a society, women with these more scarce skills receive a larger wage premium.

This pattern is not uniformly evident, but that is not surprising because the composition of output, distribution of natural resources, and the demand for educated labor differs across economies. Future research should estimate the effects of relative supplies of educated labor and the effects of the composition of demand on wage structures for women and men. That is beyond the scope of this paper. But no evidence has emerged that would support the view that educating more women even if it involved educating fewer men would lower the aggregate productivity of the population.

In addition to the market productivity of workers that should be captured by private individual returns flowing to those who might invest in their own schooling, there are external benefits to society, such as reduced child mortality, improved child nutrition and schooling, and decreased fertility and population growth. These quantified externalities of education are primarily associated with educating women. Thus, there is a strong case for society to subsidize investments more in women's schooling than in men's.

Why then does the shortfall in female education relative to male education persist in South and West Asia and in North and sub-Saharan Africa? Part of the answer undoubtedly lies in the family decision making process and the perception of parent's own interests that attach less value to the future productivity of daughters than to that of sons. Parental claims on the adult productivity of boys may be more secure in some family-cultural systems than their future claims on girls. If in some countries parents' allocation of school private investments

between boys and girls does not lead to a socially optimal pattern of investment in human capital what should be the role of public policy? An inefficient allocation of investment resources, as appears to exist now in some countries, even if we do not know the precise cause, can be improved by a judicious application of taxes and subsidies. Yet few studies have looked for points of policy leverage whereby the environment of the family could be modified to achieve at least some increase in female enrollment rates. The fundamental features of society that divide low income countries into the two groups distinguished in this paper warrant more study. Governments and societies need to be appraised of the long run productive and social opportunity costs of investing less in the education of girls than in boys.

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