Policy impacts on schooling gender gaps in developing countries: The evidence and a framework for interpretation

by

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Abstract

In many regions of the developing world girls continue to receive less education than boys. This paper reviews the evidence on the effects of policies in the education sector and outside it on household schooling investments in girls and boys, distinguishing between policies that are ostensibly gender neutral and those that explicitly target girls. It is frequently (but certainly not universally) found that the demand for girl's schooling is more responsive than boys' to gender neutral changes in school cost or distance as well as quality. Although these patterns can be interpreted in terms of parental preferences, this paper shows that they can also plausibly be explained within a human capital investment framework through assumptions about the nature of schooling cost and returns functions. Among these policies, increasing the physical accessibility of schools emerges as a measure that may result in disproportionate enrollment gains for girls. Where gender gaps are large or persistent, however, direct targeting of girls is probably necessary. Formal evidence from a number of demand or supply side interventions, including subsidies to households and to schools to enroll girls and the provision of girls-only schools, suggests the potential for targeted measures to yield substantial gains for girls. Many other policies, such as subsidized childcare or flexible school scheduling that address the opportunity costs of girls' time, hold promise but for the most part have yet to be subject to rigorous assessment. The paper discusses methodological problems in such assessments and concludes with suggestions for future research on policies to close schooling gender gaps.

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1. Introduction

The positive effects of education on economic growth and individual incomes and welfare are widely, even universally, recognized. It is also widely recognized that there are particular benefits to investing in female schooling because of externalities such as improvements in child nutrition and schooling and reductions in fertility (Schultz 2002). These economic efficiency arguments add to the strong equity arguments for increasing female schooling, and through this, women's economic opportunities and social status, in areas where girls have traditionally been disadvantaged in access to education. Achieving gender equality in education is included among the Millennium Development Goals and many developing country governments now officially recognize this goal as a priority.

Much progress toward gender equity in education has already been made in the last several decades (World Bank 2001; National Research Council 2003). In some regions, male and female equality with respect to enrollment ratios has largely been attained; in many Latin American countries, girl's secondary enrollments now actually exceed boys'. Still, as shown in Table 1, significant pro-male gender gaps remain in other regions, notably sub-Saharan Africa, South Asia, and the Middle East. In Africa, the ratio of girls to boys in primary school is 86% and in secondary school is just 75%. In South Asia the analogous figures are 85% and 81%. Regional averages also hide important variations. Within Africa, for example, gender disparities are particularly large in many West African countries. Notably, the Table indicates that regions where gender gaps are largest also tend to be where overall (male and female) enrollments are low.[1]

An important agenda for research is to identify policies that would lead to gender parity in education in environments where gaps are large or persistent. This paper therefore considers what research to date can tell us about the impacts on girls' (and boys') schooling of a range of education policies, including those related to price, accessibility, and school quality, as well as other policies that might alter household schooling investments by affecting the costs and returns to these investments. To help interpret the findings in the literature I begin by setting out a simple conceptual framework of parental investment in girls' and boys' human capital. The discussion makes the distinction between explanations of why *levels* of investments in girl's schooling might be lower than boys' (for example, higher opportunity costs of girls' time) and explanations of why *changes* in schooling in response to policies such as fee reductions or quality improvements might differ for girls and boys. The two are not the same, and it is the latter, of course, that is important for determining the appropriate policies to close education gender gaps. Different model assumptions provide alternative explanations of why impacts

[1] One can also compare genders with respect to direct education outcome measures, namely, test scores. Overviews of the developing country evidence, both from cross-country studies using standardized tests and from individual country analyses (based typically on pass rates on secondary leaving exams), provide a mixed picture (see National Research Council 2003; Oxfam 2005). In some countries or subjects boys do better; in others, girls. Where dropout or non-enrollment are significant, however, school based samples of test-taking children are not representative of all children, and for gender comparisons the problem is especially acute if girls are less likely to start school or more likely to drop out early. This implies that there will be greater selectivity into the testing sample for girls than for boys, and this will likely be associated with unmeasured ability that affects test performance, biasing estimates of gender differences.

of household income, school price, and school quality might be larger for girls' schooling than boys', patterns that occur frequently in the empirical literature.

The paper then considers evidence for two basic types of policies that may differentially affect the schooling of girls and boys: those that are 'gender neutral', i.e. that do not specifically target female (or male) schooling returns or costs; and those that are gender-targeted, i.e., that attempt to alter the costs or benefits of girls' schooling relative to boys'. The evidence I will discuss comes primarily from econometric analyses of schooling demand using representative household surveys. In addition, several randomized policy experiments have been carried out with gender as a focus either of the interventions themselves or of the measured outcomes. By and large I do not delve into the large body of non-experimental project evaluations that consider gender-focused interventions or outcomes, because few of these have been statistical or carried out rigorously enough to permit reliable inferences (few, for example, collect baseline information; see Kane 2004 for a review). Nevertheless, some such evidence is brought to bear when discussing certain policies that have apparently not been widely assessed by more formal means. Finally, policies not directly concerned with education, notably those involving the labor market and the market for childcare services, may affect schooling incentives and may do so differently for girls and boys. I consider the (quite limited) evidence on such policies as well.

I should make clear here that it is not the purpose of this paper to lay out the theoretical and empirical justifications for investing in girls' education. These justifications, including in particular the potentially large externalities with respect to children's welfare and economic growth, have been presented many times, most incisively by T.P. Schultz (1993, 2002). The focus here is instead on understanding parental schooling decisions—i.e., the private demand for schooling of girls and boys—which by definition do not incorporate externalities, and how these decisions respond to policies.

The remainder of the paper is structured as follows. The next section presents the model graphically (a mathematical presentation is given in the Appendix). This is followed in Section 3 by a review of the evidence on gendered impacts of policies. Section 4 summarizes and discusses implications for policy as well as for future research.

2. Analytical Framework

The model is a general two-period model of parental investment in daughters' and sons' human capital. For the first period parents must decide on the allocation of each child's time between schooling on the one hand and work activities in the home, a family farm or enterprise, or for wages, on the other. First period utility of parents depends on their consumption in that period, which in the absence of access to credit to finance school investments is reduced by the cost of children's schooling. The parents' second period utility is a function of the consumption made possible by transfers from children ('old age support'), which depends on the children's wealth, hence on their schooling. Children's wealth is also a function of experience accumulated in work activities during the first

period since this also increases their human capital. In this sense children's work time and school time represent competing investment choices for the household. Parents may also gain second period utility directly as a result of their children having more wealth, i.e., having higher welfare. Thus the model can explain parental schooling decisions through either self-interest (desire for remittances) or altruism toward children.[2]

The first order conditions for girl's and boy's schooling (see Appendix for details) indicate that parents invest in the education of each child until the discounted marginal utility of schooling equals the marginal cost. The marginal utility or marginal benefit equals the discounted utility of the addition to second period consumption from transfers out of the child's wealth (which increases with additional schooling), plus the direct utility gained as a result of the child having higher wealth. The marginal cost includes the reduction in first period consumption implied by the direct and indirect (opportunity) costs of additional schooling; the indirect or opportunity costs arise from reductions in the child's labor contribution to the family. Also included in marginal cost is the reduction in future transfers from the child that occurs because additional schooling reduces first period work experience, in turn reducing second period wealth.

Plausible assumptions in this or similar frameworks (Alderman and King 1998; Rosenzweig and Schultz 1982) can explain why investments in girls' human capital are often lower than boys'. Holding other factors to be the same for both genders, daughters will receive less schooling than sons if the remittance rate is higher out of son's wealth, if the marginal returns to schooling in the labor market are everywhere higher for boys than girls, or if the marginal cost of schooling is everywhere higher for girls. To yield gender differences in *changes* in the level of schooling in response to policies that alter costs or benefits, it is usually necessary to put more structure on the model. In a model in which children's human capital provides direct consumption value to parents (or one in which parents value the future utility, hence wealth, of daughters and sons differently) assumptions about the parental preference function could generate gender differences in the responses to policies that alter education costs or returns. In the human capital investment framework, such differential responses can arise from the presence of nonlinearities or discontinuities in the cost or benefits schedules.[3] Several plausible examples are sketched out in what follows.

Gender differences in the benefits of schooling

Garg and Morduch (1996) present a human capital investment model with concave earnings functions such that the marginal returns are positive but declining in the level of human capital (health in their model, but equally applicable to education). Further, it is assumed that discrimination in pay makes the earnings of women some fraction of those of

[2] Parental altruism could in principle extend toward their children's children, in which case schooling effects on the non-market productivity of a daughter (specifically, on her ability to insure the health and well being of her own children) may enter parental utility as a further benefit of schooling. Following most treatments in the literature, this factor is ignored. This assumption is discussed in more detail below in Section 3.6.

[3] Clearly the consumption and investment perspectives are not mutually exclusive, and any direct consumption value of children's human capital could be incorporated into 'benefits'.

men, so that the returns to girls' schooling are less than boys'. This would also occur if instead sons remit a larger share of their wealth to parents than daughters do, or if girls are less likely to enter the labor force as adults or to work as many years as boys.[4,5] It is straightforward to show (see Appendix) that for such earnings functions the marginal returns to boys' schooling are higher than for girls but also decline more rapidly as the level of schooling increases.

The top and bottom panels of Figure 1 show, respectively, total and marginal benefit and cost functions for this case. Equivalent linear cost functions for girls and boys are assumed, yielding marginal costs that are constant in years of schooling. This would occur if the household could borrow at a constant rate of interest to pay for schooling investments and annual school costs were constant in years of school. Examples of rising marginal costs (i.e., of convex total cost functions) are discussed below. As illustrated by the bottom panel, equality of marginal costs and benefits imply lower optimal investment in female schooling ($S_B > S_G$) because the marginal benefits function is higher for boys while marginal costs are the same for boys and girls.

Garg and Morduch are concerned to show how such differences in male and female returns, combined with household resource (credit) constraints, can lead to gender differences in the impacts of changes in income and in family size and composition. I touch on the effect of income below but here I note that these model assumptions also imply differential responses by gender to policies that change either the benefits or costs of schooling. This is illustrated with a gender neutral fall in school costs, represented in the bottom panel by the shift to the dotted MC′ line. The increase in optimal schooling for girls is larger than for boys (compare S_G'- S_G and S_B'- S_B). Because marginal benefits decline more slowly for girls, the adjustment needed to restore equilibrium after the shift in the marginal cost curve is larger for S_G than S_B. A similar outcome would occur as a result of a non-gender targeted improvement in the returns to schooling that shifted up the marginal benefits for girls and boys. Of course, if the benefits functions had different shapes such that marginal benefits were falling faster for girls than boys, these gender differences in impacts would be reversed.

[4] As discussed below in Section 3.6, even if increments to human capital of women are rewarded equivalently to that of men in terms, say, of hourly pay, the same expenditure on an additional year of schooling will result in a smaller increase in (expected) lifetime earnings for girls if they are less likely to be in the labor force or if they work over a smaller portion of their adult lifetime than boys.

[5] As Schultz (2002) points out, even if girls remit less than boys, instead giving their earnings to their spouse's family, there could nevertheless be high returns to educating girls through effects on brideprice (women with high earning potential are more attractive in the marriage market). On the other hand, if girls' future labor force participation is not likely, potential brides will more likely to be valued for their domestic skills. Parents may feel that some minimal schooling will increase these skills but that there are few benefits thereafter. Therefore, given the likely inverse relation of time devoted to schooling and time in domestic work, accumulation of this form of human capital may be perceived to be inversely related to the level of education beyond some point. Via negative effects on bride price this would tend to reduce the household's returns to educating girls.

Differences in schooling cost functions

Gender differences in responses to changes in cost or benefits can also arise from assumptions about the cost functions for schooling. What is required is for marginal costs to be increasing, and at different rates for girls and boys. There are several reasons why marginal costs may rise as the level of schooling investment increases. Families that are credit constrained have to finance schooling by reductions in first period consumption, and the value to the household of this foregone consumption will increase at the margin as consumption is further reduced (on the assumption of declining marginal utility of consumption). Or, a family may be able to access credit markets but only at increasingly higher rates as more is borrowed. Further, direct school costs such as fees are usually significantly greater for higher levels of schooling (a factor discussed further below). Finally, opportunity costs in terms of foregone child earnings or household production will increase with the duration of schooling simply because as children mature into adolescence and beyond their productivity in these activities increases.

Each of these factors would make schooling marginal cost curves slope upwards, but not necessarily differently for girls and boys. Reductions in current consumption or increases in the cost of funds as the level of schooling increases, as well as increases in direct school expenses, should be similar for girls and boys. On the other hand, it is possible for opportunity costs in terms of foregone household income or production to rise faster in years of schooling for boys than girls. This could occur, for example, if cultural factors or security concerns constrain girls but not boys from working outside the home for pay. If this is the case and if the labor market values increasing maturity or physical strength more than activities within the home do, potential earnings and thus the opportunity cost of not working will rise more quickly for a boy than a girl as each gets older, or equivalently as the duration of their schooling increases. Such a situation is represented by the total and marginal cost functions graphed in Figure 2.

The foregoing relies on a direct association of labor productivity and age or maturity and is plausible because older children are more developed emotionally and physically. However, in our model increasing opportunity costs (and at different rates for girls and boys) could also arise from the fact that children's work experience itself increases their stock of human capital, hence their future streams of income. Attending school reduces the time available for work activities, so more years of schooling means less accumulated work experience. If experience has positive but decreasing effects on second period wealth, this could also yield cost functions such as those in Figure 2 (see Appendix for the derivation). Marginal costs are now increasing in years of schooling, not because older children are inherently more productive than younger ones as above, but because the potential benefits from additions to children's work experience are larger at greater years of school (i.e., at fewer years of work experience).[6]

[6] Note that this situation is distinct from rising marginal costs that might results from the inverse relationship of time in school and time in family work activities over the course of the school year. The usual declining marginal product of labor assumption for, e.g., farm production, means that the marginal product of labor in this work, hence the shadow price of time, would be increasing in the time spent in schoolwork. However, this process refers to a production period, say an agricultural cycle, and yields increasing marginal indirect

Marginal costs are everywhere higher for girls in this example, reflecting (say) the strong demand for their time in household work, but they are rising faster for boys due to greater concavity of the returns to experience function for boys. The latter is possible because differences in the types of work in which girls and boys engage can imply differences in the returns to experience, though it should be noted that the assumption that boy's costs are more concave rather than girls is arbitrary. Because marginal costs are everywhere higher for girls, investment in their schooling is lower than in boys'. However, since their marginal costs are rising less quickly than boys', restoring equality of marginal costs and benefits after a gender neutral proportional increase in the returns to schooling, shown by the dotted line, requires a larger increase in schooling for girls.[7] A gender neutral reduction in school price would also lead to this outcome.[8]

Discontinuous schooling benefits or costs

Another possible source of differential male-female impacts of education policies is the presence of discontinuities in either the benefits or costs of schooling. It is not difficult to come up with plausible examples of either. Discontinuities in benefits will occur if school completion and receipt of a diploma are requirements for entry into well-paid formal (or possibly, public) sector employment. This 'sheepskin effect' shifts up the earnings function at specific years of schooling. For the case of a premium to primary completion, the marginal benefits to schooling would appear as in Figure 3. The figure also shows, as before, marginal costs to be higher for girls than boys, though here the marginal costs are linear in S; no assumption is made about the curvature of the cost function. There is a large initial gender gap in schooling, reflecting in part that the optimizing level for girls is on the lower, pre-primary completion portion of the benefits schedule. A gender neutral increase in the returns to schooling is depicted by the dotted marginal benefit lines. The increase in girls' years of schooling is larger than boys' because the new equilibrium for girls is on the higher (post-primary returns) portion of the curve. For the same reason, a gender neutral reduction in school costs would also raise girls' schooling more than boys'.

Discontinuities in costs can arise from the pattern noted above of household school expenses rising with each change in school level, e.g., from primary to secondary. This may reflect higher school fees and textbook requirements as well as higher transportation costs. With respect to the latter, secondary schools, for example, serve a wider catchment

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costs of school time within a given year or an even shorter period, not a change in the marginal cost of an *additional year* of schooling, which is what we are concerned with here.

[7] The quadratic assumption for returns in Figure 2 adds to the difference in girls' and boys' responses but is not required for it. The function depicted is the same for girls and boys, but a proportional increase in (total) quadratic benefits shifts up marginal benefits more at lower S, hence more for girls. Qualitatively, however, the same outcome would occur if returns were linear.

[8] As noted (fn. 5), for girls first period non-school experience may consist of time spent acquiring domestic skills. Rather than leading to future transfers to parents from labor market earnings, this may bring a higher bride price if young women with strong domestic skills are more highly valued as wives. The perceived marginal costs of schooling would then be calculated as reductions in bride price resulting from reductions in this experience. Obviously this could lead to marginal cost functions quite different from that for boys, whose work experience may instead be in farming or the labor market.

area than primary schools, hence on average are further away from households. This implies an increase in travel expenses and also in opportunity costs through increased travel time (or even, the need to pay for boarding at school). Marginal costs would then look as in Figure 4, where the discontinuity occurs after 6 years of school, i.e., at the start of secondary school. These costs do not differ by gender, but as in several earlier examples the benefits to schooling are assumed higher for males. Because of this the initial optimal amount of schooling for boys exceeds completed primary, while girls receive only a primary education: beyond 6 years, their marginal benefits are below the secondary school marginal costs. Hence this model of gender differences in schooling benefits with discontinuous costs provides a plausible explanation for the frequently observed pattern of lower continuation rates to secondary school for girls than boys.

In contrast to the other models discussed, in this model policies that alter schooling benefits and (secondary) school costs yield larger changes in boys' schooling. The figure illustrates with an improvement in returns. Boys move along the secondary schooling marginal cost schedule to S_{B}' For girls, whose initial marginal benefits are lower than boys', there is no increase because a proportional improvement in marginal benefits after 6 years similar to that for boys is still not enough to induce investments beyond primary, i.e., marginal benefits remain below marginal cost. Similarly, a policy that reduced secondary school costs equally for girls and boys may lead to more schooling for boys but have no effect on girls: specifically, given the initial benefits schedules, a reduction that is less than or equal to the interval a-b will leave girls' schooling unchanged.

Differences in school dropout/continuation probabilities

Higher opportunity costs for girls imply, all things equal, that they will receive less schooling than boys' but does not lead to predictions of different impacts of changes in school costs or benefits. If benefits are similar, this would require additional assumptions about the shapes of the schooling cost functions, as seen above: namely, that marginal costs are increasing and doing so at different rates for girls and boys. Even without this happening, however, there may be important indirect effects of opportunity cost differentials that operate through impacts on academic performance and the likelihood of school progression. If the demands on girls' time are greater, they will have less time per day available for schoolwork. Their attendance over the school year may also be more irregular. As a consequence, learning and exam performance may be lower for girls, leading to a higher likelihood of academic failure and an inability to complete (say) the primary cycle or meet entrance requirements for secondary school. Alternatively, differences in the academic performance of girls and boys may result from school factors that impinge on girls' ability to learn, such as a lack of encouragement of girls on the part of teachers.

Since academic success or failure cannot be predicted with certainty, risk becomes a factor in parental decisions about investing in their children's education. Especially when schooling returns are discontinuous, this can lead to large differences by gender in both the level of schooling and in the responses to policies.

Figure 5 presents a strong version of returns discontinuity such that there are no labor market benefits to schooling until a primary diploma is obtained (the implications carry through to the more general case of a shift up in the benefits function at grade 6). Therefore marginal benefits are zero until S=6 and positive and (we will also assume) declining thereafter. Assume that either the higher demands on girls' time while attending school or aspects of the school environment lead to a lower probability of their successfully completing the primary cycle and continuing to secondary school. Because girls' probability of graduating primary school is lower boys', the expected value of total and marginal schooling benefits is lower for girls, as shown. In addition, because of the difference in opportunity costs, marginal costs are higher for girls. The household invests in schooling of the boy to S_B. But given both the higher marginal costs and lower expected marginal benefits for girls (themselves possibly the cumulative outcome of higher opportunity costs), the household is at a corner solution with respect to the girl's education: $S_G = 0$.

The figure shows the effect of a gender neutral fall in cost, caused by a reduction in fees or other direct school costs. At lower marginal cost MC′, positive investments in girls' schooling become optimal and the household moves to S_{G}'. The gain in girls' schooling is much larger than for boys' because boys merely move incrementally along the continuous portion of the marginal benefits schedule. Similar results would obtain from a gender neutral improvement in the returns to schooling.

An interesting aspect of this model is that it suggests a tendency for gender differences in response to policies affecting school price (and also quality) to be larger when the initial gender gap itself is large. In the example in Figure 5 of girl-boy differences in dropout probabilities, girls are initially at a corner solution while the optimal schooling for boys is greater than completed primary, so the gender gap is large. Girls gain substantially relative to boys from the policy change by shifting up to the continuous segment of the benefits curve while boys just move along it. In contrast, if girls and boys both were initially on the continuous portion of the benefits curve the initial gap would be smaller, and gender neutral shifts in either marginal costs or benefits would have equivalent impacts on girls and boys rather than favoring girls. The same logic would apply to quality improvements as well, since as discussed below such improvements can be interpreted as upward shifts in the schooling benefits curves.

Similarly, in the situation depicted in Figure 3, there is a large initial schooling gap because girls and boys are on different segments of the benefits schedule, and the effect of a rise in benefits or fall in costs is larger for girls because it causes them to move to the higher (post-primary) segment. For initial positions in which both girls and boys are on the same portion of the benefits curve, hence where there are relatively small initial gender differences, the same shifts in benefits or costs lead to similar impacts for girls and boys. It is easy to demonstrate that the cases shown in Figures 1 and 2, of boys' marginal benefits falling faster than girls' or boys' marginal costs rising faster than girls', also can account for the association of large initial gender gaps and stronger policy impacts for girls. As discussed below in Section 3.3, for quality improvements, girl-boy differentials in responses (larger responses for girls) do tend to be observed in environments where the

gender schooling gap is large, though this could also be explained by selection in the choice of study environments. Also as discussed below, the model assumptions behind Figures 1 and 2 in particular lead to the prediction that increases in household resources will have larger effects on girls' schooling than boys', consistent with findings from a large number of empirical studies.

3. Evidence for impacts of policies on girls' and boys' schooling

Our review begins by briefly considering the evidence for gender differences in the effects of household resources on the demand for schooling. It then moves on to the impacts of education policies, including those related to school costs and availability, school quality, and other non-price attributes of schools. Next the more limited evidence for the effects of interventions in other sectors or markets, including the market for childcare services and the labor market, is considered. Typically the econometric analyses discussed below estimate probit models for the determinants of current enrollment or less commonly, discrete choice models for school type. Other education outcomes considered are grade attainment and school progression or dropout. I will also refer at times to studies that consider achievement indicators, that is, performance on tests.

One other prefatory note on methodology. There is considerable variation in how researchers compare the effects of covariates across gender. These comparisons should always be statistical. The fact that more often than not the models are nonlinear adds some complications for constructing the correct tests, though usually not major ones. For example, for probits for current enrollment, the appropriate comparative statics are the marginal effects, i.e., the change in the probability of enrollment for a unit change in the variable, and it is these which should be compared statistically (see Glick, Saha, and Younger 2004 Appendix 2.2 for detailed discussion).

In practice, girl-boy effect comparisons in the literature tend to be somewhat casual. One common practice is to infer that a gender difference exists if a variable has a significant impact on an outcome for one gender but not the other. For example, school cost may have a significant negative effect on girls' enrollment but not boys'. However, these two results together do not support the statement "girls' enrollment is more sensitive to cost than boys'". Given that we are dealing with probability statements, this can only be concluded based on direct statistical comparison of the impacts on girls and boys. It is entirely possible for there to be no significant difference in these impacts despite having one impact significantly different from zero and the other not. Nevertheless, my review of the demand literature adopts a liberal approach and includes results of the kind just described, both because these types of 'casual' comparisons are common and because otherwise the literature comparing gender impacts would become rather sparse.

3.1 Effect of household resources

Policies affecting incomes, of course, are not 'education policies'; they affect schooling outcomes only indirectly by changing the level of resources of the household.

Nevertheless, household wealth or income is almost always a powerful predictor of child schooling investments, so research that investigates whether these effects differ by gender is of significant interest. The issue is also of interest because of similarities in the way the conceptual framework presented above can be used to explain differential responses to changes in resources, on the one hand, and changes in school cost and quality on the other.

It is common for researchers to report higher income elasticities of enrollment or grade attainment for girls. The settings where this has been reported are diverse: India (Sipahimilani 1999, Basu 1997), Malaysia (de Tray 1988), Peru (Ilahi 1999), Mexico (Parker and Pederzini 2001), Turkey (Tansel 1998), Tanzania (Mason and Kankher 1996), and in West Africa, Guinea (Glick and Sahn 2000) and Senegal (Glick and Sahn 2005a). Schultz (1985) comes up with a similar pattern using national level time series data for some 90 countries over two decades, with gender specific enrollment ratios as outcome measures. The boy-girl differences vary considerably across the studies just enumerated but are often substantial: it is common to find coefficients on household income that are twice as large for girls as for boys. The larger income elasticities for girls in these contexts imply that the gender gap narrows with income: boys become less favored. Based on this evidence from demand studies (as well as a number of descriptive analysis of schooling gender gaps by income quantile, see Glick, Younger and Saha 2004 for a review), stronger income impacts on girls' education is sometimes treated as if it were an empirical regularity (see e.g., World Bank 2001).

However, other education demand studies do not find gender differences in income or wealth effects (e.g., Shapiro and Tambashe 2001 for Kinshasa, Congo; Glick, Saha, and Younger 2004 for Uganda and Madagascar). In a few cases researchers have found larger effects for boys, though this appears to be far less common than examples of larger benefits to girls. Alderman et al. (1997) for rural Pakistan and Bouis et al. (1998) for the Philippines both report significant impacts of household resources on boys' schooling outcomes but not girls'. Tansel (1997), looking at primary, middle, and post-middle schooling determinants in Côte d'Ivoire and Ghana, finds that, by and large, per adult household expenditures affects only girls' schooling in the former but only boys' schooling in the latter.

Therefore while a significant number of empirical studies point to stronger income impacts on girls' education, this is by no means a universal pattern. Is this because the existence of gender differentials in the impact of household resources depends on the size (or presence) of the initial gender schooling gap, which varies greatly across these samples? In the multivariate studies just discussed, it is hard to discern any such pattern. Thus, for example, increases in household resources benefit girls' schooling more than boys' both in Guinea, where there is a large pro-male enrollment gap, and Peru, where there is not.

Further evidence on this issue comes from Filmer's (1999) study using comparable Demographic and Health Surveys (DHSs) from 41 developing countries. Estimating probit models of enrollment for children age 6-14 that interact gender with a household wealth index, Filmer reports significant gender-wealth interactions in slightly less than half (18) of

the countries – but these cases are exactly equally divided between those showing higher wealth benefits for girls' schooling than boys' and those showing the opposite pattern.[9] However, closer examination shows that the countries where increases in wealth more strongly favored female enrollments also tended to have sizable average pro-male enrollment gaps, while most (7 of 9) of the countries where increasing resources brought stronger benefits to boys' enrollments had either no average gender gap or very small gaps in favor of one gender or the other. Therefore there is something of a pattern in these regressions using internationally comparable data.

However, to say that where one finds increases in wealth or income benefiting girls' schooling more than boys' one is also likely to see a large average pro-male schooling gap is not the same as saying that wherever such gaps exist, increases in resources will favor girls. Indeed, many of the DHS countries with large average gaps favoring boys exhibit no significant interactions of wealth and gender in Filmer's regressions. Therefore both this multi-country econometric analysis and the totality of the country examples discussed previously do not support either a general claim that increases in household resources will favor girls' education investments over boys' or the narrower claim that this will happen when boys initially are strongly favored. The evidence does suggest that pro-girl outcomes tend to occur more in contexts where the average or initial gender gap favoring boys is large.

Even if they are not always found, larger impacts of household resources on girls' education are frequently seen. Why would this occur? Two explanations arise from a consumption perspective, i.e., one based on parental preferences. Parents may view girls' education and health as more of a luxury good than boys', implying a higher income elasticity for the former. Or, 'inequality aversion' may be a normal good: at low incomes parents invest more in the human capital of boys if the labor market returns are higher for male schooling, but at higher incomes they increasingly allocate resources to girls as well because their desire for fairness in allocations increases (Garg and Morduch 1996).

In their discussion of health investments in children, Garg and Morduch offer an alternative explanation based on a human capital investment model, under the assumption of higher concave total returns to boy's human capital than girls' (and thus more rapidly declining marginal returns for boys). This case was depicted above in Figure 1. Poorer households lack access to credit markets to fund education investments, and thus are constrained by the level of current household resources. A simple way to portray this is to assume that rather than being able to invest optimally until the net marginal return (marginal benefits minus marginal costs) equals zero for both the daughter and son (occurring at S_B and S_G in Fig. 1), the household can only purchase some lower total amount of schooling for the son and daughter.[10] The household still allocates its

[9] See Filmer (1999), Table 8.

[10] A more accurate way to depict this, but leading to the same outcome, would be to have marginal costs rising in years of schooling for credit constrained households. This can occur if the cost of borrowing rises with the amount of schooling, or (for a fully constrained household that must finance schooling completely out of income) because the marginal value of foregone current consumption increases as schooling rises and current consumption falls.

investment budget so that the net marginal benefits are equal for the two, but this now occurs at some positive value. Given higher marginal benefits for boys than girls but equal marginal costs, this will always involve higher schooling for boys. An expansion of the total education budget as household resources increase means that equality of male and female net marginal benefits will be achieved at higher levels of S_B and S_G. Since marginal benefits, hence net marginal returns, are falling more slowly in years of schooling for girls, reaching the same (lower) value for net marginal returns for girls and boys implies a larger increase in girls' schooling.

A similar result would occur under the conditions depicted in Figure 2. In this case, marginal costs are higher for girls so their initial schooling is lower. But since girls' marginal costs are rising more slowly than boys', net marginal returns again are falling more slowly for them than for boys, hence an increase in household resources for education leads to a larger change in schooling for girls.

3.2 Effects of Price/Distance

Evidence from demand studies

Considering now the impacts of school factors, we begin with costs. School cost is represented rather broadly in the literature: in some cases it is measured by price (school fees or fees plus other obligatory expenditures) but in many or even most developing country studies it is proxied by the distance to, or just the presence of, a facility. Since in many countries public education is nominally free, distance to schools is frequently the only cost-related variable available in surveys. Distance is associated both with direct costs for transportation and with opportunity costs: more time spent traveling to and from school implies greater foregone income or output from a child's home, farm, or other productive labor. In some cases opportunity costs are expressed in monetary terms. To do this, the time spent traveling to school plus the estimated hours in school are multiplied by the relevant local wage or the individual's predicted hourly value of time based on a wage regression.[11]

Several important econometric issues arise in the estimation of price effects from non-experimental data, particularly when using school fees as opposed to distance as a cost measure. As these issues are part of a general set of problems that are encountered when using data on school characteristics, a more detailed discussion is saved for the next section. For now it may be noted that the magnitudes of the price effects are likely to be

[11] While this procedure is attractive conceptually, the use of wages to represent the opportunity cost of time is problematic in most environments because typically few children participate in wage labor. Even where such estimates can be obtained, their reliability is unclear. On the one hand, average wages or wages predicted from regressions may underestimate an individual's true value of time, since the decision not to enter the wage labor market may be due to marginal productivity in family firm or household activities being higher than the offered market wage. On the other hand, child wage labor may be rare because this market is highly imperfect: many parents are presumably unwilling to allow their children to work outside the home or family enterprise. In this case the market wage could be significantly higher than the child's marginal productivity of labor at home. Another approach to representing a child's cost of time is to apply some fixed proportion of the local adult wage, but this is clearly an ad hoc solution.

underestimated if the model lacks adequate controls for school quality. To the extent that schools that expend more resources on teachers and other inputs impose higher enrollment fees or other charges, school price and quality will be positively associated. Given the presumed positive effects of quality on demand, the omission of relevant quality attributes thus will make the effects of price appear less negative than they actually are.[12] Indeed, researchers will occasionally report that experiments with school price variables led to significant *positive* estimates of the effect of costs on enrollment or school choice. This suggests that in at least some of the cases where the expected negative price effects are reported, these may be smaller in magnitude than the true effects.

With respect to the evidence on differences by gender, many non-experimental studies using household survey data find that girls' schooling is more sensitive to cost than boys'. This is especially common when distance is used as a cost measure though it is sometimes reported for monetary costs as well. Distance to school or the absence of a nearby school has stronger negative impacts on female than male enrollments in settings as varied as India (Sipahimalani 1999), Ghana (Lavy 1996), Senegal (Glick and Sahn 2005a), Malaysia (DeTray 1988), the Philippines (King and Lillard 1987), and Pakistan (Hazarika 2001; Lloyd et. al. 2005).[13] In Kenya, higher school fees increase dropout probabilities for girls while having no effect on boys (Lloyd et al. 1998). In rural Pakistan, girls' enrollment but not boys' is sensitive to monetary costs (Lloyd. et. al. 2005). For Peru, using a cost measure that includes both opportunity costs and direct costs, Gertler and Glewwe (1992) find that price elasticities of probabilities of enrollment in different school alternatives (local and distant schools) are larger for girls. Gertler and Glewwe's results, however, are somewhat difficult to interpret, because they are not based on estimation of separate price coefficients for girls and boys; rather, the differences in elasticities are generated by gender differences in the values of the regressors (in particular, the dummy variable for being female, which has a strongly negative impact) in combination with the functional form of the nested logit predicted probabilities.

Schultz's (1985) study provides evidence from cross-country aggregate data. Using public education expenditures per teacher as a measure of the price of schooling, he finds greater price responsiveness of girls' than boys' education, measured by changes in gender-specific enrollment ratios. Note that for this result to reflect actual demand behavior by households as in the previous studies using micro data, one must assume that higher public expenditures for teachers translates into higher enrollment costs to households.

This is an impressive array of cases, but as with income/gender interactions, the results of Filmer's (1999) comprehensive analysis caution against making general claims about gender differences in impacts. Filmer uses information on the presence of primary or

[12] A higher price of schooling as well as higher quality may also be a reflection of high local education demand, again implying a downward bias in the (absolute value) of the estimated price elasticities.

[13] The reference here is to Hazarka's finding that girls' primary enrollment probabilities, but not boys', are negatively affected by distance. He also reports that the distance to middle school has a negative (marginally significant) impact on boys' primary enrollment but not on girls'. However, since few girls go on to middle school in rural Pakistan, the effect of distance to middle schools may not be relevant for girls or may simply be difficult to capture in the regression.

secondary schools in the local community, available for 19 countries with Demographic and Health Surveys, as indicators of access to schools. Controlling for other factors, including other local infrastructure characteristics, better physical access usually strongly encourages school enrollment of rural children 6 to 14. However, in only four cases is there a significant difference by gender in this impact, three showing a stronger effect for girls and one showing a stronger effect for boys. Similarly, Glick, Saha, and Younger (2004) find no gender differences in the (negative) effects of distance to schools on either primary or secondary enrollment for both Madagascar, where there are no gender gaps in enrollment, and for Uganda, where (in 1992, the date of the survey) significant gaps existed.

Still, in many cases girls' schooling is found to respond more strongly than boys' to changes in school distance or availability, while the opposite is rarely if ever found. How appropriate is it to interpret the former result as indicating that girls' schooling is 'more price-sensitive'? Although this interpretation is often made, it may not be valid. Responses to changes in travel time or distance to schools might differ by gender even if the impacts of a change in monetary costs, e.g., a fee reduction, would not. For cultural reasons or because of safety concerns, parents may be reluctant to allow girls to walk long distances to school on their own, in which case sending daughters to school may entail spending money on transportation, or else enduring psychological costs, that are not incurred for sons. Having a school in closer proximity thus can reduce the effective costs of girls' school attendance while having no effect or a smaller effect on costs for boys.

This can happen as well if the value to the household of the child's time is higher for girls. Distances to school in rural areas are often substantial, necessitating non-trivial reductions in children's time in productive activities after or before the school day. In terms of the model presented in Section 2, if the shadow wage is higher for girls, a decrease in distance to school that reduces foregone work time equivalently for girls and boys would shift the marginal cost function down more for girls, leading to larger schooling gains for them than for boys. A situation of greater psychological or transportation costs for girls' education would be represented similarly. In contrast, a reduction in school fees would lead to equal shifts in marginal costs for girls and boys.[14]

The fact that the estimated effects of distance may not be capturing what is normally thought of as a price effect in no way lessens the relevance for policy of studies relying on distance measures. Where stronger distance impacts on girls are documented, school construction programs that reduce the average distance between home and school will have disproportionate benefits for girls' education. Such studies also imply that the

[14] It should be noted that reported gender differences in the effect of school cost may reflect in part differing income elasticities for girls' and boys' education. This is because the reported price elasticities are usually uncompensated, that is, they include the income effects accompanying a price change. Estimates of the effect of distance similarly incorporate an income effect, since a reduction in time to school raises full income in the Beckerian sense. Studies using monetary measures of cost could easily net out the income effects if the model also included an income term, but this has generally not been done.

process of urbanization, which generally brings households in closer proximity to public services such as schools, should also have larger relative effects for girl's education.[15]

Evidence from program evaluations

A different source of information on how investments in girls' and boys' human capital respond to costs are evaluations of interventions that attempted to improve schooling outcomes via price or other financial incentives. Several such studies are especially valuable because they were based on randomized policy experiments, or else "natural experiments," in the sense that the subsidy was in effect assigned randomly. An example of the latter is the study by Angrist et al. (2002) of Colombia's national voucher system for private secondary schooling, in which a limited supply of vouchers was assigned to qualified low income public primary students based on a lottery system (hence was randomly assigned). Neither boys nor girls were more likely to receive the subsidy. Voucher recipients of both genders performed at least modestly better in terms of school attainment and test scores. These effects, however, were larger for girls, though for attainment the size of the differential depended on the sample chosen. In the full sample results, the increase in grade attainment relative to controls three years after getting the voucher was 0.12 years for girls, due both to reduced grade repetition and lower dropout, while the estimate for boys was half this magnitude and not significant.

Different impacts by gender were also seen for a rather different demand side intervention, the PROGRESA program in Mexico. Rural communities were randomly assigned to receive this intervention, which was designed to raise primary school enrollment among poor children by providing education and food grants to mothers conditional on their children attending school and being brought in for regular medical checkups (Skoufias 2001). As with the Colombia voucher program, PROGRESA served both boys and girls, though the subsidy was marginally higher for girls. Also similar to the Colombian case, while both boys and girls benefited, girls' primary enrollments increased more than boys'. The opposite occurred for overall secondary school enrollment rates but girls benefited especially strongly in terms of continuation from primary to lower secondary; the effects on overall grade attainment were slightly larger for girls (Morley and Coady 2003). In contrast, in another Latin American conditional cash transfer program, Nicaragua's Red de Protección Social program, there were equivalent strong enrollment benefits for young girls and boys (Maluccio 2002).

Finally, the Food for Education subsidy program in Bangladesh offered households a monthly food ration conditional on a child's school attendance. In the initial two years of the program, enrollment in schools participating in FFE skyrocketed (though some of the measured increases may have reflected shifts from non-FFE schools) and the gains were much larger for girls than boys—41% vs. 28% (Ahmed and del Ninno 2002). These aggregate data therefore suggest a much stronger girl schooling response to the price incentive represented by the conditional food ration. On the other hand, this pattern was

[15] Gender schooling gaps, especially at post-primary levels, do tend to be smaller in urban areas, though a variety of reasons in addition to greater accessibility are also at play, such as higher average incomes and parental education as well as exposure to modern attitudes and female role models in the mass media.

not found in an econometric analysis of the same program using household survey data carried out by Ravallion and Wodon (2000). Using village participation in the FFE program to predict the potentially endogenous household food ration, these authors report positive effects that were statistically similar for girls and boys.[16,17]

A very different source of evidence on the impacts of changes in direct costs is the recent experience of several countries in which primary school fees were eliminated or sharply reduced nationwide. In Uganda, Tanzania, and Malawi, such policies resulted in sudden and very large surges in enrollments, with girls' enrollments increasing the most (See Herz and Sperling (2004) and references therein). In one sense these major shifts in pricing policy can be viewed as large-scale natural experiments. Such an interpretation would be problematic, though, in part because the rescinding of school fees was to some extent a response to popular pressure, and thus also a reflection of the demand for education. In addition, factors other than the fee elimination were also at work, including major publicity campaigns to promote schooling. Even taking these factors into account, however, these country experiences point to the presence of substantial price responsiveness of education demand—greater than that implied by most of the studies on cross section micro data cited above—and especially large responsiveness for girls. Of course, where fee elimination or other policies actually come close to getting all children enrolled, as for example in Uganda in the late 90s, it is inevitable that female enrollments will rise more if they were initially lower than male enrollments.

Nevertheless, these experiences, together with the evidence from both schooling subsidy programs and demand studies using fees or other monetary measures of cost, suggest that the demand for girls' schooling is often more price responsive than boys' – not merely more sensitive to distance. A framework in which schooling or human capital was viewed in consumption terms would explain differences in price elasticities with reference to the structure of parental preferences for girls' and boys' human capital. Alternatively, we can look to the human capital investment framework for plausible interpretations, several examples of which were already shown in Section 2. The comparative static effect of a reduction in price will be larger for girls if, all else equal, marginal benefits fall less rapidly for girls than boys (as in Figure 1), the marginal costs rise less rapidly for girls (as in Figure 2), or if either of the two discontinuous returns scenarios of Figures 4 and 6 hold.

When price effects are larger for girls, policies that reduce the direct costs to households of sending their children to school, even if they do not single out girls for special treatment, will disproportionately raise female enrollments or attainment. Such

[16] However, since participation in FFE is contingent on enrolling a child, predicted program participation of the household, hence also the level of the food ration, must itself be partially a measure of school enrollment. Therefore the coefficient on predicted participation in Ravallion and Wodon's enrollment probits is difficult to interpret.

[17] In part due to the success of these earlier projects, conditional cash transfer programs on the PROGRESA model have been implemented in Brazil, Honduras, and other Latin American countries. Several other pilot programs designed explicitly to raise female enrollments through targeted price subsidies, or subsidies in combination with efforts to improve the school environment for girls, have been implemented in countries such as Guatemala, Bolivia, and Tanzania. To date, formal assessments of these interventions have not been published.

policies have a particular appeal: they achieve two important objectives—raising schooling overall and reducing the gender gap in schooling—while being apparently gender neutral. Obviously, the converse is also true: cost recovery schemes that raise fees will hurt girls' enrollments more in these environments.

Finally, a potentially important question for policy is whether gender differences in responses to price differ for the poor and the non-poor. If girls are more sensitive than boys to an increase in costs and this difference is largest among poor households, cost-recovery policies will reduce utilization by girls more than by boys and by poor girls most of all. However, very few of the studies reviewed in this paper have investigated this issue.

Targeted subsidies for girls' schooling

Education policies, of course, can also specifically target girls. Most would agree that where gender schooling disparities are large or persistent, targeting is warranted even if girls would benefit somewhat disproportionately from gender neutral policies. One targeting strategy operates on the demand side by lowering the costs to households of educating girls relative to boys (supply side measures that target girls are discussed below). Where this approach has been implemented, it has been very effective at improving gender equity in schooling. An early and much celebrated example is the Bangladesh school stipend program, begun in 1982 to subsidize household expenditures on girls' secondary education. In the first 5 years of the program, girls' secondary enrollment rates in program areas rose from 27 to 44 percent, more than twice the increase observed nationally (Bellew and King 1993).

Kremer, Miguel, and Thornton (2004) report on a policy experiment in rural Kenya in which half of the schools in the study were randomly chosen to offer merit-based scholarships to girls who achieved a certain percentile on standardized examinations. In addition to the incentives to parents, these schools also had an incentive to improve girl's attendance and performance as participating schools directly received part of the scholarships. Girl's attendance as well as test scores in the intervention schools were significantly higher than in the controls, as was teacher attendance. Even girls with low baseline achievement (who were not likely to win the scholarships) and boys enjoyed significant test score gains in the eligible schools, which the authors attribute to beneficial peer effects of being in classrooms with girls who were motivated by the possibility of a scholarship and thus worked harder.

Two earlier randomized evaluations, both in Balochistan Province, Pakistan, considered pilot programs to improve girls' access to local schools in a region where girls are significantly disadvantaged educationally. One of these, the Quetta Urban Fellowship program, encouraged NGOs to build new primary school facilities in poor neighborhoods by paying a subsidy to the school (not to families) for each girl enrolled. Enrollment growth of girls in the neighborhoods selected to participate in the pilot project was 33 percentage points higher than in control neighborhoods (Kim et. al. 1999). Enrollment increased slightly for boys as well. Kim et. al. suggest that the sharp increase in girls' enrollments was in part an outcome of reduced distances to schools that would accept them.

The second pilot program, in rural areas of Balochistan, supported village organizations in setting up and operating separate private primary schools for girls staffed by female teachers. Enrollment of girls initially rose 22 percent in program areas relative to control areas, while also rising 13 percent for boys (Kim et al. 1998). Because of revenue shortfalls and a lack of operational expertise the rural program proved not to be viable (Alderman et. al. 2003). Still, the initial success here and in the urban program in attracting female students was noteworthy. This presumably had to do in part with characteristics of the new schools that made them culturally appropriate for girls, not just with changes in price or accessibility. These characteristics are discussed further below.

3.3 Characteristics of schools and the learning environment

Definitions and methodological considerations

The heading of this subsection refers broadly to all non-price (and non-distance) characteristics of schools. It encompasses standard measures of school quality – number or qualifications of teachers, availability of blackboards and textbooks, and so on. It also refers to factors that affect schooling demand or academic outcomes but that may not normally be considered measures of service 'quality', such as the share of teachers in the school that are women. In reviewing this evidence, I follow Lloyd et al.'s (1998) distinction between characteristics of the school environment that are the same for boys and girls but nonetheless may have gender-differentiated impacts on outcomes, on the one hand, and aspects of the school environment that are different for boys and girls, on the other. The latter may be the intended outcome of policies to improve gender balance, as in a policy of supplying female teachers to encourage girls academically, or they can be largely unintended, as in a prevailing negative attitude among teachers and school officials toward girls' education. Generally, policies that change school characteristics of the first kind could be described as gender neutral, while policies that change aspects of schools or the school environment that are different for girls and boys are usually conceived of explicitly as means of improving girl's attainment or learning.

The evidence on quality or school characteristics impacts is somewhat more limited than on price impacts, reflecting the relative rarity of school or community surveys with good indicators of school quality (in contrast, price and distance measures can often be constructed directly from information in household surveys). Further, for most studies estimating the impacts of 'quality' in studies using non-experimental data, a good deal of caution in interpretation is warranted. One standard problem is measurement error in school characteristics. Another is omitted variable bias or biases due to heterogeneity in unobserved community or household characteristics (which is also a form of omitted variable bias). These can arise in several ways. Since school or community surveys often record only a limited number of attributes of local schools, schooling demand (or academic achievement) models necessarily will exclude a range of other education inputs, as well as somewhat more elusive factors such as the degree of teacher motivation or the commitment of the school director. These omitted factors also affect learning and enrollment and are likely to be positively correlated with the levels of one or more of the included attributes; for example, a highly dedicated school director is more likely to try to

keep the school infrastructure in good condition and to provide adequate teaching supplies to the staff. These associations will lead to an upward bias in the estimated effects of the observed school quality measures.

A similar positive bias occurs if, in communities where parents feel more strongly about schooling (thus tending in any case to enroll their children and assist them in learning), such parents also take steps to insure that local schools have more resources; quality is thus jointly determined with, or endogenous to, schooling outcomes. This would also result from a pattern whereby households with strong preferences for education move to areas where school quality is higher. In contrast to these examples, governments may purposely locate facilities or upgrade quality where the population is disadvantaged or for other reasons is less likely to send children to school; this would imply a downward bias in the estimates of the effects of school quality on demand.

It is clear that these factors, if present, will lead to biases in the estimates of the effects of school characteristics on schooling outcomes (enrollment or attainment as well as test performance). However, the implications are less clear with respect to biases in estimates of the *difference* in effects for boys and girls, which is of primary interest here. In particular, if omitted factors have equivalent effects on girls' and boys' schooling outcomes they will lead to similar upward or downward biases in the estimates for included regressors, and these will be eliminated from the difference in the girl and boy estimates.[18] Note, however, that the assumption of equivalent effects of unobservables may be strong, particularly given that the analysis is predicated on the possibility that the factors that we do measure affect the genders differently. If it is violated, there will be differential bias in the level estimates for girls and boys, and hence also a bias in the observed difference in the girl and boy effects.

Essentially the same idea motivates the use of household fixed effects techniques to test for male-female differences in the effects of regressors. Here the assumption is that household level unobservables (including education preferences and motivation, home inputs into learning, and ability) influence the levels of the outcomes for both girls and boys but that this effect does not differ systematically for girls and boys. Therefore differencing across gender within the household—estimating the boy-girl difference in outcomes rather than the level for each gender—isolates the true gender differential in the effect of the variable. Here too the implied restrictions may be strong. true gender differential in the effect of the variable. Here too the implied restrictions may be strong. One would have to assume, for example, that parents with strong preferences for human capital and who therefore may provide more home inputs into learning or move to areas where school quality is high do not also have relatively strong preferences for educating

[18] In standard omitted variable formulae, the bias in the estimated coefficients take the form of an additive term; if this level bias is the same for girls and boys, it drops out of the difference in the estimates. For measurement error, on the other hand, the bias takes the form (in the textbook case of a variable with random measurement error) of a proportional reduction relative to the true parameter. This means that the difference in the girls' and boys' estimates will be proportionately underestimated even though the (proportional) degree of measurement error bias is the same for both.

girls.[19] Still, this approach seems like a logical way to analyze gender differences in the effects of school (and other) factors affecting education outcomes. Despite this, in the literature considered in this review the use of household fixed effects or within family estimators remains rare; Pitt and Rosenzweig (1990) is the only such study of which I am aware that uses the approach to investigate differences by gender in the effects of a variable on schooling outcomes (infant sibling's illness in their case, not school characteristics). Further discussion of methodological approaches is reserved for the final section of this paper.

Aspects of school quality/environment that are similar for girls and boys

Turning to the available evidence, with respect to aspects of service delivery that are the same for girls and boys, there is evidence that school quality has stronger impacts on girls' schooling than boys'. Both Khandker (1996) for Bangladesh and Lloyd et al. (1998) for Kenya find that increases in indicators of teacher quality raise girls' enrollments or reduce their dropout probabilities but have no effect on boys' schooling. In rural India, Dreze and Kingdon (2001) report that various measures of school quality have larger or more significant impacts on girls' primary enrollments than boys'; the most impressive difference is in the impact of providing mid-day meals in schools, which raises the female enrollment probability by 15 percentage points.[20] King et al. (1999) find for Pakistan that merit-based grade promotions have greater impacts on girl's school continuation than boys' (though rather than an indicator of differential school 'quality' effects this could reflect a selection process whereby relative to boys, only high achieving girl students tend to get promoted for merit). In rural Pakistan, Hazarika (2001) finds that while having a local school with a water supply has similar effects on boys' and girls' primary enrollment probabilities, the proportion of local schools with blackboards is positively associated only with girls' enrollments.

Analysis of a natural experiment in India by Chin (2002) also points to stronger effects of school quality on girls. In this case the exogenous variation in quality was provided by the introduction of Operation Blackboard, through which the government was to provide an additional teacher to all primary schools initially with just a single teacher. Despite inadequacies in the implementation of this program, Chin is still able to reliably establish that an additional teacher increased girl's primary completion rate by 3-4 percentage points and literacy rates by 2-3 points. In contrast, there were no significant effects on boys.

The findings in these studies come from environments in which girls on average suffer a significant disadvantage relative to boys in the probability of attending school. It is not clear whether researchers in settings where gender enrollment gaps are smaller found no gender differences in quality effects and did not bother to report this result (which

[19] It follows that fixed effects or within family estimators will be less reliable for assessing gender differences in effects of programs or inputs designed specifically to target girls' schooling than for policies that are ostensibly gender neutral. Families living in communities with schools that have explicit pro-girl education policies may be those with strong preferences for girls' human capital relative to boys'.

[20] As these authors note, the free meal is a form of education subsidy. The stronger effect for girls therefore may be an indication of greater price responsiveness of the demand for girls' schooling.

would support the notion that stronger quality effects for girls occur where education gender gaps are large) or if they simply did not consider the question at all (which would not). That issue aside, one would like to know why, in the cases studied, the demand for girl's schooling responded more than boys' to changes in service quality that were apparently targeted equally to girls and boys. To start with, the possibility should be noted that 'high quality' schools in terms of standard indicators may also feature better (more supportive) learning environments for girls. For example, better educated teachers may tend to be more 'enlightened' and make efforts to encourage girls academically. Then at least part of the apparent gender differential in response to quality is actually due to other, unmeasured aspects of schools that differ for boys and girls.

Assuming this is not the case, it might be surmised that school and teacher improvements somehow affect girls' ability to learn more than boys', which in turn would induce parents to enroll girls or keep them in school longer. In terms of the conceptual framework discussed earlier, an improvement in school quality would increase the marginal benefits of schooling, since the increment to human capital from another year of schooling is larger when quality is higher. This raises the optimal level of schooling, and more so for girls than boys if girls' learning is more responsive to the change in quality. Note, however, that with the exception of the India study by Chin, this process can only be inferred indirectly from the evidence since these analyses consider only enrollment outcomes, not academic outcomes, i.e., test scores.[21] Moreover, it is not readily apparent why changes in quality should have stronger impacts on girls' learning.[22]

Alternative interpretations of girl-boy differences in schooling responses to quality that do not require differential learning effects are possible, based on gender differences in the schooling benefit or cost functions as outlined in Section 2. Define equivalence in learning impacts from improved quality as a situation where for any level of schooling S_i total benefits increase by some fixed proportion that is the same for girls and boys. Although the benefits curves for girls and boys thus shift up equiproportionately, the adjustments in the optimal levels of schooling for girls and boys will also be functions of the slopes of, or presence of discontinuities in, the marginal benefit and cost functions. For example, in the quadratic schooling benefits case in Figure 1, marginal benefits are declining faster for boys than girls, so the change in schooling required to restore equality of marginal benefits and costs after such a shift will be smaller for boys than girls: girls' schooling increases more. The same outcome could be generated by differences in the slopes of the male and female marginal cost functions and in fact is exactly what is

[21] One might look to analyses of test score determinants for direct evidence of differential effects of school or teacher characteristics on girls' and boy's learning. Studies of this type that separately estimate the determinants girls' and boys' performance are rare, but in any case one should recall the caveat made earlier (fn. 1). Since test score information is almost always collected on in-school samples, selectivity may badly compromise comparisons of the effects of school factors on learning for boys and girls in school-based samples unless the models convincingly correct for selection. Where gender gaps in enrollment are large, selectivity may operate differently for boys and girls, rendering such comparisons particularly problematic.

[22] If school and home inputs are substitutes in the production function for human capital, and girls receive lower levels of home inputs than boys, then the marginal product of additional school inputs will be higher for girls. However, it is more plausible to think of most home inputs (e.g., schoolwork supplies, homework assistance or study time) as complements to school inputs.

illustrated in Figure 2 by the upward and equivalent shift in girls' and boys' marginal benefits functions. Similarly, in the discontinuous returns cases depicted in Figures 3 and 5, it can easily be seen that equivalent girl-boy shifts in benefits from quality improvements will also tend to disproportionately raise girls' schooling.

Further, as discussed in Section 2, each of these models also predicts that stronger impacts of quality on girls' schooling will occur in situations where initial girl-boy disparities are large, consistent with the presence of significant gender gaps in the populations analyzed by the studies cited above. Again, however, it should be kept in mind that the pattern in existing research may be an artifact of the choice of study environments in which this issue was addressed.

Aspects of school quality/environment that are different for girls and boys

There is little doubt that in many countries the school learning environment favors boys over girls (World Bank 2001). A long list of factors potentially contribute to this situation, including a lack of female teachers, unfavorable teacher attitudes toward and treatment of girls in class, sexual harassment by male teachers or students, and curricula and textbooks that present favorable adult role models for boys but only traditional ones for girls. Relatively few econometric analyses have directly addressed the impacts of these factors, but they appear to confirm the potential for negative effects on girls' education. Lloyd et al. (1998) report that girls' dropout probabilities in Kenya are significantly influenced by teacher attitudes about whether math is important for girls, by differences in the (self-perceived) abilities of girls and boys to seek advice from a school staff member, and by differences (again, self-perceived) in the treatment of boy and girl students. Also in Kenya, Appleton (1995) finds that girls' exam performance, unlike that of boys', is negatively affected by unfavorable teacher evaluations of their abilities. Negative teacher attitudes toward girls and differential treatment of students based on gender in essence target boys for favorable treatment, but presumably are not the result of explicit policies to target students on the basis of gender. Nevertheless, policy potentially can change these school or teacher factors, for example, through appropriate teacher training or gender-focused monitoring of student performance.

The provision of female teachers is frequently cited as a means for encouraging girl's school enrollment and academic performance. In some cultures, many parents may simply be unwilling to send their daughters to school unless they can be taught by a female teacher. In other contexts, having female teachers could encourage parents to enroll daughters through beneficial impacts on girls' performance in school, which would occur if girls respond better to female teachers or if female teachers are more sympathetic to girl students. In line with one or both of these hypotheses, in Bangladesh, the presence of female teachers in local schools was found to increase girls' enrollment probabilities (Khandker 1996). Similarly, in cross-country regressions for Africa, Mingat and Suchaut (1998) find that having more female teachers is associated with higher enrollments and lower dropout rates for girls. Consistent with the idea that having female teachers boosts girl's performance, a five-country African study by Michaelowa (2001) finds that girls' learning gains in the 5th grade are larger when they have a female teacher, while boys' are larger when the teacher is male.

There is always the possibility in the foregoing studies that the presence of female teachers is itself a reflection of parental of community preferences for educating girls. For example, it is not uncommon for local communities or parents' associations to hire teachers to supplement those provided by the government, and they could choose to hire women if girls' academic success is considered a priority. Another possibility is that if teachers tend to work in regions where they were raised, localities with stronger traditions of (and hence also current preferences for) female education will have a larger supply of educated women hence of female teachers. Either situation would imply that the association of the share of female teachers and girl's education outcomes may not be causal or at least, may overstate the true causal relation.

Therefore rigorous program evaluations of interventions involving the placement of female teachers are of particular interest. In the pilot program in rural Balochistan, Pakistan, mentioned above, villages were assisted in opening primary schools for girls staffed by female teachers. As indicated, there were very significant gains in female enrollments in these villages compared with non-program villages. Unfortunately, the setup of this study, while providing strong confirmation of the value of the program overall, does not make it possible to disentangle the effects of its various elements, e.g., female teachers, girls-only schools, strong parental involvement, and effective reductions in distance to the nearest suitable school.

This is also an issue to some extent with the results of the randomized program evaluation by Banerjee et. al. (2000) of a policy in India designed to add teachers to informal schools run by an NGO. The program hired a second, female (if possible) teacher for schools in the treatment group. The intervention both significantly reduced the days the school had to be closed (which was one objective of the program) and led to a 50 percent increase in girls' attendance, while having no effect on boys. It is not clear whether the strong benefits for girls came from the increase in 'availability' (days open) of informal schools that were acceptable to parents for girls, from a general improvement in quality due to increase in the number of teachers, or from the fact that the additional teachers were female.[23] As with the Balochistan program, however, the results do point to a combination of measures that may lead to large gains for girls even if the precise pathways are not transparent.

With respect to another aspect of the school environment with potentially strong gender relevance, focus group analyses in a number of settings have indicated the importance for parents of having separate school toilet facilities for their daughters (See Herz and Sperling 2004). Girls' need for privacy becomes especially important once they reach puberty; the unavailability of separate latrines for girls during menses is said to be a major cause of girls dropping out before completing primary school. In the Bangladesh study cited above Khandker found that having separate toilet facilities for boys and girls increased girls' enrollment probabilities as well as their grade attainment. In Guinea, West

[23] However, the authors note that the effect on girls of adding a second female teacher is smaller when the first teacher is also female. This is consistent with a specific 'female teacher' effect where it is most important to have at least one such teacher to serve, for example, as a role model or counselor to girls.

Africa, construction of separate girls' and boys' latrines was a significant component of a major reform program for increasing both female and overall school enrollment in the 1990s. Both girls' and boys' enrollments rose dramatically over the period 1989 to 1997, but the female gains were much larger: starting from a low base, gross enrollment for girls more than doubled compared with a 65 percent proportional increase for boys (USAID 1999).

As in so many other cases, it is difficult to identify the specific effects on girls' enrollments of the policy of interest, construction of separate latrines, because several other gender targeted measures were adopted as part of the Guinea education program, including increases in the number of female teachers and provision of special assistance to pregnant students. Still, the provision of separate toilets or latrines for girls is one intervention for which the existing qualitative evidence of potential benefits seems very compelling. The fact that it should also be relatively inexpensive to implement this policy further commends it in environments where interviews with parents or girls themselves point to its desirability.

Before moving on to policies outside the education sector, it should be pointed out that none of the regression studies discussed here interact provider characteristics with measures of household resources to see if poor households are more or less responsive than the non-poor to changes in the attributes of schools. There has evidently been much less concern about this issue than about how price elasticities vary across income groups. It follows that the more refined distinction of looking at whether gender differences in response to quality vary by level of income has not been addressed either. It would be of particular interest to see if aspects of service delivery that are purposefully designed to increase girls' participation – for example, providing female teachers in primary schools – have stronger effects on enrollments of girls from poor families than from non-poor ones. In sum, the existing demand literature is not informative about the interactions of gender and income in determining the response to changes in cost or (even more so) in the characteristics of schools. Yet this information could be of value for designing policies to close the gaps in access to schooling that exist between poor and non-poor, and between girls and boys.

3.4 Policies that address the opportunity costs of educating girls

Typically in the developing world girls spend far more time than boys in domestic work activities. The idea that girls' access to education is constrained by household work obligations is supported both by ethnographic studies (Nieves 1981; Safilios-Rothchild 1980; Engle et. al. 1985) and econometric demand analyses (Glick and Sahn 2000; Deolalikar 1998; Levison and Moe 1998; Pitt and Rosenzweig 1990). The latter show girls' schooling to be more negatively affected than boys' (if boys' is affected at all) by the presence of younger siblings, or in the case of Pitt and Rosenzweig, by the illness of an infant sibling. It is clear that households do not consider the time of girls and boys to be

close substitutes in home production activities, a factor that obviously has more to do with cultural conditions than technological aspects of production.[24]

Given this pattern of child labor specialization by gender, policy measures such as subsidized childcare services that reduce household domestic work burdens would in effect target girls' education. Like subsidizing girls' tuition, public provision or financing of childcare would reduce the costs to households of educating girls relative to boys, in this case, the opportunity costs. The research just cited suggests inferentially that the benefits of such a policy to girls' schooling may be substantial. Unfortunately, while there are anecdotal accounts of community-based childcare services freeing up girls' time for school attendance (see Herz and Sperling 2004), there has been little rigorous analysis of the issue. Still, one well-conducted study for Kenya (Lokshin et. al. 2000) finds that lower local childcare center costs increase both maternal employment and girls' schooling, while having no effect on boys' schooling.

Girls may also benefit from flexibility in school schedules that help them balance school and domestic responsibilities. Flexibility could be provided by holding afternoon sessions for girls, or opening small satellite schools to be nearer to where girls (and for that matter, boys) live and work. Often it is informal or community schools that offer these options. Although here too there is a lack of formal evaluations, descriptions of a number of such interventions suggest that they can significantly raise the school attendance of girls (Herz and Sperling 2004 and Herz et. al. 1991 discuss several examples). In some contexts (e.g., Pakistan's Balochistan Province, see World Bank 1996) offering later sessions for girls can deal with a significant cultural barrier to their education: double sessions make it possible for girls to attend school separately from boys.

A number of other policies, though generally more gradual with respect to their implementation and effects, will also serve to reduce the overall burden to the family of household work and in so doing should increase girls' ability to attend school. These include infrastructure investments that provide electricity (making cooking more convenient and allowing refrigeration, thereby reducing the frequency of shopping) and convenient access to clean water (reducing the time needed for water collection, washing and food preparation). They include as well family planning services that lead to reductions in fertility, since fewer siblings mean a smaller burden of childcare on older sisters. Note that some of these time savings are likely be used to 'finance' increased activity of adult women in the labor market rather than just their daughters' time in school. As discussed below in Section 3.6, however, an increase in female participation in the labor force may itself raise the household's perceived returns to investing in girls' education.

[24] As implied earlier, however, this pattern of early gender specialization (girls to domestic work, boys to school or enterprise activities) may reflect constraints rather than parental preferences. If as adults girls are likely to spend more time in domestic work than market work, it may make sense to parents that they accumulate experience in non-market production rather than continue in school.

3.5 Public information campaigns to encourage girls' schooling

Where traditional beliefs make parents reluctant to send daughters to school, there may be an important role for programs using various media to promote the benefits of educating girls. For poorly educated parents in particular, such campaigns may be justified on efficiency grounds. They can supply information that these parents lack on many of the benefits to female schooling, for example, improved child nutrition. Because parents lack complete knowledge of the benefits, female schooling would otherwise be undersupplied from a social point of view. Such 'sensitization' interventions are attractive as well because they are inexpensive compared with, say, scaled up improvements in teacher training or textbook availability.

It is difficult to assess the effectiveness of such campaigns. For one thing, they tend to be implemented in conjunction with other education policies (nation-wide or local), making it hard to attribute enrollment gains specifically to the outreach efforts. For example, in the case of Uganda's universal primary enrollment strategy of the late 1990s, promotion of school enrollment through the media was an accompaniment to more dramatic policy changes, notably the elimination of primary school fees. Community-level policy experiments to assess the efficacy of mobilization programs are a possibility. Under such a design the programs would be carried out in some communities and not others. This experiment would still only be able to evaluate locally implemented programs, so it would not be informative about other potentially effective ways the government can spread information, i.e., through national level mass media such as radio or television.

In any event, claims have been made for the effectiveness of community based efforts to sensitize parents to the need to school their daughters. For example, both Kane (2004) Miller-Grandvaux and Yoder (2002) note a number of African projects in which community education campaigns, often in the context of programs to initiate new community (i.e., informal) schools, were associated with large gains in female enrollment or at least more gender equity than in existing public schools. However, here too it is not clear how important sensitization was in most cases given that other changes, such as a move toward flexible schedules, may have also induced more parents to enroll girls.

Discussions of such community information efforts also often emphasize the role of community 'participation' or active involvement in initiatives to raise girl's schooling. It is argued that this is an important determinant of program success (see Kane 2004). Rigorous evaluations of impacts are lacking. Barriers to such assessments include not just the presence of other policies associated with the female schooling initiatives, but the possibility that communities where participation in these initiatives is strong may be those where female education is relatively highly valued, or where women have a more prominent role in community decision making. These factors may lead to high rates of girls' enrollments even without the program. In principle, community randomized designs could be used to estimate the impacts of programs created to encourage local participation in girls' education.

More broadly, the concept of community participation is linked to the idea of decentralization of control over school management and supervision, a movement that has gained currency as a result of the serious inefficiencies and mishandling of resources seen

within many centralized school systems. Several community level experiments have recently been initiated to assess the impacts of providing communities with greater decision making power or else more capability to monitor school officials (See Glewwe and Kremer 2005 p. 45 for a brief description). These assessments apparently do not involve initiatives to raise girls' schooling, but a different and potentially important question is raised that such experiments could presumably address: does a transfer of power over schools from centralized authorities to local communities lead to greater, lesser, or unchanged gender equity in access to education? Or perhaps, to greater variation in gender equity, if communities are heterogeneous with respect either to preferences for equity or to women's power in local decision making?

3.6 Labor market policies

Implications of female and male patterns of labor market activity for returns to schooling

The human capital investment model implies that household schooling decisions are influenced by, among other factors, expected returns in the labor market. Therefore policies that affect the operation of labor markets may have significant impacts on incentives for private investments in girls' and boys' education. There is little direct evidence on this issue from studies using micro data, reflecting inherent difficulties in arriving at the appropriate counterfactual. Labor market policies typically operate at the national level, so researchers lack within-country variation in policy variables or associated variation in female and male education returns to include in models of schooling demand. Given this relative dearth of micro level evidence, the discussion in this subsection will be somewhat more conceptually than empirically oriented. [25]

To understand the implications for education demand of policies related to the labor market, it is necessary to understand the relationship between expected labor market outcomes and household schooling investments. This involves, naturally, the impacts of additions to schooling on the pay of women and men, which has been the focus of many studies in developing and well as developed countries. But the returns to education for women are more complex than this, because their participation and labor supply is usually more variable than men's. Because of their roles in childrearing and other domestic production, women are more likely to experience temporary or permanent withdrawal from the labor force. They may be less likely to enter the labor force at all, or may work part-time rather than full time. In most societies, therefore, parents would be correct in anticipating that daughters on average will end up spending fewer years full-time in the labor force than will sons.

[25] Labor markets, especially in agriculture, can often be characterized as local rather than national, providing spatial variation in female and male wages that might be used to estimate the effects of female and male potential earnings on enrollments of girls and boys. However, it is unlikely that schooling decisions would be affected only by what is observed in such local markets, because schooling provides options for remunerative non-agricultural employment and it may be anticipated that educated children (perhaps sons more than daughters) will migrate to urban centers for work.

Even where additions to schooling raise hourly compensation equivalently for males and females, these differences in labor supply imply that investment in another year of education of a girl increases expected *lifetime* labor market earnings (or average yearly earnings) by less than it would for a boy. The difference, in proportional terms, is essentially equal to the share of predicted full time equivalent years of labor force participation of a woman relative to that of a man. The effect of this on the anticipated benefits to investments in a girl's education relative to a boy's will depend on (1) the effects of schooling on labor productivity in non-market compared with market (i.e., labor force) activities, (2) the extent to which parents are aware of these productivity effects, and particularly if they are aware of the non-market benefits, and (3) the value parents place on these future non-market benefits relative to the daughter's market production.

The fact that typically during certain periods of their lives women allocate more time to home than market activities suggests that the marginal productivity of their time in the former—particularly in child rearing—is higher than the market wage during such periods. This does not, however, say anything about whether the effects of schooling on productivity are higher in market or non-market work. There is, to be sure, abundant evidence of the positive impact of women's schooling on non-market productivity, particularly as measured by child survival and nutritional status (Schultz 2002). However, these effects have not usually been directly compared with estimated returns to schooling in the labor market for the same population, so it is hard to answer question (1); this would be difficult to do, since all benefits would have to be assigned the same, e.g. a monetary, metric. In fact, for understanding household investment decisions the relevant metric would be parental valuations of these future non-market outcomes, in particular, nutrition and other aspects of the welfare of their daughter's children.

About these valuations (question 3) little is really known. Most researchers would consider it rather unrealistic to assume that parents fully internalize the welfare of the generation following the next one (i.e., their grandchildren) when deciding about educating their sons and daughters. This view is implicit in the near universal labeling—at least by economists—of the effects of female schooling on children's well being, including children's health and schooling, as 'externalities'. With reference to (2), in many contexts it is also likely that parents are not fully aware of the non-market productivity gains associated with female schooling. While there is little direct evidence of which I am aware on this issue, these considerations make it reasonable to assume that in parental decision-making about human capital investments of girls and boys, the effect of schooling on productivity in non-market activities carries less weight than its impacts on income. Therefore the smaller increase in expected annual and lifetime labor market earnings from additional schooling for a girl than a boy implies, all else equal, that the expected household benefits at the margin to educating daughters will be lower than for sons.

'All else' is not necessarily equal, however. The foregoing conclusion, which is based on differences in average lifetime labor force behavior of males and females, ignores the fact that schooling itself may strongly influence patterns of female participation and labor supply, hence lifetime incomes. For both genders, there will be a negative 'base' effect of schooling on total years in labor force because age at labor force entry is higher

for those who stay in school longer; indeed adult male labor force participation in the developing world as a whole has declined slightly in recent decades, in part because of increasing duration of schooling (Tzannatos 1999). For women, however, there may also be a positive participation and labor supply impact because schooling increases offered wages, hence the incentive to substitute time in the labor market for time in non-market activities or leisure (though the impact may also be negative because of the income effect associated with a higher wage). Education may also raise female participation by shaping girls' tastes for work and career. The lifetime labor supply of boys, in contrast, will be relatively inelastic to the wage rate, hence to schooling, because for men in any education category full time participation during prime working years is the norm.

Therefore any positive effects of education on the labor supply of women would raise the internal rate of return to investing in girls' education relative to boys', tending to offset the negative effects of lower mean labor female supply.[26] Empirically, in descriptive as well as multivariate analyses the relation of female labor force participation to the level of education often takes an inverted U shape: high for women with little or no schooling, lower for those with some education and then high again for those with substantial schooling (Smock 1982; Deolalikar 1993; Kingdon 1998; Glick and Sahn 1997). Among other factors, this pattern likely reflects the relative strengths of the substitution and income effects of an increasing wage as the level of schooling rises. In contrast, if one considers specifically female formal sector participation or wage employment, education has monotonically increasing effects on participation (Schultz 1993). Where labor markets are segmented, formal sector employees tend to be better compensated in terms of pay and benefits than informal sector workers with similar qualifications. Hence there may be high private returns to educating girls (and usually to boys as well) operating through effects on entry into well paying formal employment.

The foregoing discussion makes clear that from the point of view of understanding household decisions on educating girls and boys, research needs to consider gender differences in 'overall' returns to schooling comprising both effects on participation (and sector of employment and labor supply) and effects on earnings conditional on participation. Few studies of male and female earnings seem to have done this; instead, the main interest of these studies has been in comparing male and female pay controlling for labor supply and testing if additions to schooling and experience are rewarded similarly for men and women. With suitable controls for selectivity, this is appropriate for addressing questions of pay discrimination and gender differences in wage structure. But as indicated, household decisions about educating girls will also depend on girls' expected future involvement in the labor force, and how this is affected by their schooling.

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[26] To show this more formally, note that lifetime income or wealth equals the earnings per full time equivalent year employed (or the 'wage', denoted by W) times lifetime labor supply or years of full time work (L). Given the dependence of the wage on schooling, the private marginal labor market return to schooling (ignoring costs as well as the effects of schooling on age at entry) is $\frac{\partial(WL)}{\partial S} = \frac{\partial W}{\partial S} L + \frac{\partial L}{\partial W}\frac{\partial W}{\partial S} W$. Because of lower mean labor supply (L) for females, the first term on the right hand side will be smaller for girls, but if schooling increases female labor supply (because $\partial L/\partial W>0$), the second term will be positive hence greater than for boys for whom it is essentially zero as noted in the text.

With respect to policy, if private (household) schooling returns for girls are low relative to boys because their future labor supply is expected to be lower, policies that encourage greater female participation, hours of work, or continuity in employment should induce parents to invest more in the education of their daughters. In view of the constraints on women's labor force activity posed by their domestic and childcare responsibilities, one such policy (if not, precisely speaking, a labor market policy) would be to subsidize childcare services (see Glick 2002).[27] Public sector support of childcare is thus uniquely situated in that it can increase incentives to invest in girls' education in two ways: by raising expected future labor market benefits via positive effects on female labor supply and, as seen in the last section, by reducing the current (opportunity) costs of sending girls to school. Note that empirically it would be hard to tell these two effects apart when examining the impacts of childcare programs.[28]

Gender discrimination in the labor market

Regression estimates showing that an additional year of schooling results in a smaller improvement in hourly (say) pay for women then men would imply that incentives for investing in girl's education are lower than for boys', quite apart from the labor supply considerations discussed in the previous section. Such a pattern in earnings estimates is reported by Appleton et. al. (1999) for a sample of three African countries and Kingdon (1998) for India. Also in these contexts, girls receive less education than boys. These authors hypothesize, plausibly, that the inferior rewards to education for women are a cause of low female schooling investments. Unfortunately, since there is no way in these studies to identify the counterfactual, it is unclear how much of the gender gap in schooling is due to the differences in labor market returns to schooling, and how much to differences in remittances from sons and daughters, or perhaps, to culturally determined preferences.

In fact, these cases appear to be the exception rather than the norm. In a review of the developing country earnings literature, Schultz (2002) concludes that the proportional increase in hourly earnings from an additional year of schooling (measured by the coefficient on years of schooling in a log wage regression) is typically the same or higher for women as for men, whether or not selectivity of participation is controlled for. This suggests that returns in terms of compensation are not lower for women, but note that even if the incremental effects of schooling on wages are similar, the *level* of pay is generally still lower for women than men throughout the developing world (though rising more rapidly for women over time; see Tzannatos 1999 and Horton 1999). Much of this gap is

[27] Childcare would be an explicit labor market policy if the state required firms to provide this service to employees. This is not advisable, not just because it would be distortionary in the usual economic sense, but because it would create a strong disincentive on the part of employers to hire women (see Glick 2002 for discussion).

[28] Though this may depend on how long the childcare policy has been in place. It may take some time before parental expectations about the future labor force participation of daughters are affected by observation of the effects of these services on current female employment. Therefore if a childcare program is recent, as it would be in the context of a policy experiment, the estimated program impacts on girl's schooling are likely to measure only the current opportunity cost effects. They will thus understate the full long term effects.

due to the fact that women have lower mean levels of human capital as measured by education and experience. But some may be due to pay discrimination, leading to a lower expected female wage across the distributions of education and experience.[29] Lower wages mean that women will have less incentive than similarly schooled men to substitute time in the labor market for time in non-market activities, i.e., they will be less likely to enter the labor force or to work as many hours as men do. Unless this negative substitution effect is overwhelmed by the positive income effect of a lower wage, expected participation or labor supply of women will be reduced, hence so will parental returns to investing in girls' schooling via the mechanisms discussed above.[30]

Observed differences in pay for similarly skilled men and women may actually reflect not wage discrimination but discrimination in hiring for specific sectors of the labor market or in specific occupations. As with pure wage discrimination, this form of gender bias may reduce the private returns to girls' schooling through impacts on anticipated employment and labor supply. If women face barriers to employment, or because of such barriers they can only obtain work in relatively unremunerative or unrewarding occupations or sectors of the labor market, they may opt not to be in the labor force at all or for as long as men, reducing schooling returns by the reasoning above.

Although this outcome does not require that employment discrimination be more pronounced for women with higher schooling or skills, such a pattern obviously would further reduce the household's perceived returns to investing in girls' schooling. It is not clear whether this pattern occurs. As indicated above, education improves access to formal sector employment for women, which is often better compensated than informal work. However, even if education makes well paying formal employment possible for women, implying high private returns to their education, women still face barriers to hiring in many formal sector jobs that men do not. There is evidence that formal employers are often reluctant to hire women (see Hein and Anker 1986). Rather than outright preferences for male workers, the reason may be that women are perceived to be more likely to leave or interrupt their jobs to start families or care for children, or else to experience greater absenteeism due to family obligations.

Whether due to the biases or perceptions of employers or to women's own preferences for informal work (which is generally more compatible with childcare), a lower probability of formal sector employment for educated women reduces the returns to schooling relative to what they would be otherwise and relative to returns for boys. Given the typical skill requirements for formal sector entry, this may mean in particular the returns to post-primary schooling.[31] It follows that policies to increase women's

[29] In earnings regressions in which the incremental effects of schooling do not differ for women and men, this will occur with a sufficiently lower intercept (representing base pay) for women.

[30] To clarify, the similarity in female and male schooling returns in wage regressions refers to the incremental impacts of schooling on pay per hour (or month, or year) of work. The schooling investment decision, on the other hand, depends on expected lifetime earnings, hence is also a function of total years of employment. This in turn depends on the level of the wage, which is lower for women when there is pay discrimination.

[31] Figure 5 can be used to illustrate this under the simplifying assumptions that completed primary school is a requirement for formal sector entry and there is no benefit to schooling in informal work. In this case, the girls' expected marginal returns curve lies below boys' because primary or better educated girls have a lower

representation in formal sector employment—or for that matter, their ability to enter any high-skill/high-paying profession—should raise the perceived benefits to parents of keeping girls in school longer. If employer hiring practices are the issue, regulations or legislation to prevent discrimination in hiring, provided they are adequately enforced, can achieve this goal. On the other hand, to the extent that employer preferences for men reflect accurate expectations of greater female absenteeism or employment interruptions, it would be preferable to consider interventions outside the labor market itself that permit greater continuity in women's employment.[32] Once again, subsidized childcare services emerges as a potentially highly effective policy.

In many regions of the developing world women's low geographical mobility constitutes another possible barrier to entry into employment in which female schooling would pay off. Formal sector employment, unlike informal or self-employment (e.g., work on family farms) tends to be concentrated in cities or towns. If due to cultural restrictions or the demands on their time in the home women are not as free as men to migrate (or simply to commute long distances to work), they will be disadvantaged in access to formal employment even if employers would be willing to hire them. As for policy responses to this mobility constraint, several Asian countries (e.g., Taiwan and China) seem to have effectively dealt with it—perhaps not intentionally—by encouraging local level small scale industrial development in rural areas (see Schultz 2002 for discussion). These industries provide opportunities for educated women to apply their skills, thereby increasing the returns, and parent's incentives, to educating girls.

An important partial exception to the association noted above of level of education and formal sector employment, and certainly to the tendency of formal employers to favor men, is the participation of women in export processing manufacturing, particularly in Asia. Employment in export processing, at least in its early stages, is dominated by semi-skilled or low-skilled women. Although controversial for a number of reasons (see Mehra and Gammage 1999), this employment typically offers a pay premium over the informal wage or self-employment that would be the main or only alternatives for such women (Kusago and Tzannatos 1998; Glick and Roubaud forthcoming). While this signifies gains for many women, the easier access of women to well paid semi-skilled formal work implies a fall in the perceived benefits to parents of keeping daughters in school beyond the level required for this work, which in many cases would be no more than a primary education.[33] Discussions of the implications for women's welfare of policies promoting

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likelihood of admittance into the formal sector than similarly educated boys. Note that this assumes similar pay premia to formal employment for men and women.

[32] Interestingly, Anker and Hein (1986) show that such employer perceptions are often incorrect or exaggerated, implying somewhat counter-intuitively that interventions to insure greater continuity of women's employment are not necessary. However, observed low absenteeism and strong labor force attachment of female formal sector workers may reflect selection into the sector of women with especially strong career aspirations—or women with access to good private childcare alternatives. See Glick and Sahn (2005b).

[33] On the other hand, as export processing sectors move up the technological ladder, skill requirements increase. In the short term this favors men because of their higher average schooling, but also restores incentives to invest in the schooling of both boys and girls.

export processing should take into account these potential long term impacts on human capital formation.

Income and time allocation effects of women's employment

A very different way in which policies that improve earnings opportunities for women can affect girl's acquisition of human capital is by increasing women's influence over household schooling decisions. Where income is not completely pooled within the household—as has been shown to be the case for example in much of Africa (Fapohunda 1988; Munachonga 1988)—a greater share of household income earned (and controlled) by the woman implies greater spending on goods and services that she prefers. Similarly, where income is pooled, access to remunerative employment may increase a woman's bargaining power in decisions about the allocation of this income, in part because she can more credibly threaten to exit the partnership. If women *also* have stronger preferences than their spouses for girls' human capital, these factors imply that improvements in their labor incomes will lead to larger gains for girls relative to boys compared with equivalent increases in the income of the father. Thus is it possible, for example, that where subsidies for childcare increase both maternal employment and daughters' enrollment as in the study by Lokshin et. al. (2000), the enrollment gains for girls are due in part to greater bargaining power on the part of newly employed mothers, not just to the reduction in the domestic work burdens of girls.

Research on this question faces the challenge of the potential simultaneity of decisions regarding female labor market activity, on the one hand, and children's human capital on the other. For example, women who are themselves active in the labor market (and possibly also their spouses) may place a high priority on daughters' education and career opportunities, and this rather than a causal effect may explain an observed association of maternal income and daughter's human capital. Several studies that have compared the effect of increases in maternal schooling (rather than income) on girls' and boys' schooling or health outcomes find the gains for girls to be larger (Glick and Sahn 2000; Sahn and Stifel 2002; Thomas 1994). Since a woman's schooling should lead, via greater actual or potential earnings, to increased bargaining power vis-a-vis her spouse, these results are consistent with women having stronger preferences than men for girls' human capital. Other interpretations of these findings are possible, however (see Glick and Sahn 2000), so it remains somewhat hard to predict the gender impacts of policies to increase female involvement in income earning activities in these settings. In contrast to these examples, Thomas (1993) assesses the effect of income directly by estimating the effects of variation in the unearned income of the mother, which is more plausibly exogenous than labor earnings to work and schooling decisions. Consistent with the research just mentioned, Thomas finds that this income has larger benefits to the nutritional status of girls than boys, while no such gender difference is seen for father's unearned income.[34]

[34] Note this is distinct from the finding reported by many researchers (summarized in Schultz 2002) that women's income has larger effects than men's on children's schooling and health in general (i.e., for both girls and boys). This is strong argument for increasing women's incomes, but not a gender equity based argument.

Still, even this study is concerned only with the effects of female income, whereas policies that increase women's employment opportunities will affect not only their incomes but also their time allocation. It is plausible that increases in women's labor supply in response to wage or employment incentives will by accompanied by substitution in domestic work of daughters' time for that of mothers. A number of ethnographic studies, in particular from Latin America (see Elson 1995 and Benería and Feldman 1992) indicate that girls' schooling suffered when their mothers entered the workforce because the girls had to take over from their mothers in the home. It is significant, however, that these studies usually covered times of economic crisis rather than periods in which wage incentives or employment access were improving; the implications for girls' time use and schooling under the latter scenarios may be very different. Still, it is important to recognize that while labor market policies to enhance women's employment and earnings may disproportionately benefit girls through the maternal earnings/preferences link (and by raising returns via effects on girls' expected future participation and labor supply as discussed above), in some cases there may be negative impacts through time allocation responses. The latter would require additional measures to deal with childcare and other time constraints facing families.[35]

4. Summary and conclusions

4.1 Implications for policy to close schooling gender gaps

Several patterns—though not universal ones—emerge with regard to the impacts of education policies (and other policies) on the schooling of girls and boys. The findings in the literature have implications for policy to close gender gaps in schooling as well as pointing to areas for future research. Among potential policy levers that do not specifically target girl's enrollments, a common finding is that girls' schooling is constrained more than boys' by the distance to schools. This has been reported for countries where cultural factors would be expected to create strong barriers to girls' traveling from home to school and in countries where we might expect these barriers to be less important. Public investments that increase the local availability of schools are therefore likely to disproportionately benefit girls' enrollments. A number of studies, including several randomized policy experiments, find as well that girls' schooling is more sensitive than boys' to changes in fees and other direct costs. Where this is the case, demand side interventions that subsidize households' schooling costs will have larger benefits for girls. A smaller body of evidence suggests that the demand for girl's schooling may also be more responsive than boys' to improvements in school quality, pointing to another route through which policy may redress gender imbalances even while not specifically targeting girls.

A simple model of parental investments in children's human capital can explain these gender differences in responses to non-targeted education policies through appropriate assumptions about costs and benefits of schooling, specifically with respect to curvature or discontinuities in these functions. The same outcomes could be generated by a

[35] See Glick (2002) for detailed discussion.

model in which the schooling of children is viewed as a consumption good, based on assumptions about the nature of the parental utility function. Existing research generally does not allow one to distinguish these explanations, or for that matter, to distinguish between different model assumptions within the investment framework. However, one reason the latter has been emphasized here is that it yields a number of interesting avenues for further research on the nature of the benefits and costs of girls' and boys' schooling and on parental perceptions of these benefits and costs. Some of these are discussed below.

Where gender imbalances are large or cultural barriers to female education remain strong, it will likely be more expedient to directly target girls' schooling. This can be done though policies operating on the demand side or the supply side, or some combination of the two. There are several well-documented successes of demand side policies. Households have been shown to respond to incentives in the form of subsidies to enroll girls, as in the case for example of Bangladesh's long-standing policy of providing stipends for girls' secondary schooling. On the supply side, evaluations of several programs suggest that school managers or teachers will also respond to financial incentives to attract or retain female students. A handful of randomized experiments involved initiatives that combined several gender targeted measures, such as female teachers, girls-only schools, and reductions in distance to schools deemed suitable for girls. The favorable outcomes for these programs suggest that they can be models for use elsewhere, but it remains unclear which components led to the outcomes or if all them did, or if an important element of success was interactions among them.

Other measures hold promise as means of raising girl's schooling but appear not to have been evaluated formally in the sense used in this paper, i.e., using either randomized designs or careful statistical analysis of large scale household surveys in combination with school or program information. These include, among others, the provision of separate school bathroom facilities for girls and boys, flexible school schedules, the redesign of teacher training to change attitudes or behavior toward female students, and information campaigns to promote girls' education. Some of these measures would potentially reverse aspects of the school environment that in effect favor boys' learning, or would make schools more acceptable environments for daughters in the eyes of traditionally minded parents. Policies such as flexible or double shift school sessions and subsidized childcare services may serve to overcome the obstacles posed by girls' typically heavy domestic work obligations. Informal assessments suggest that each of the foregoing interventions can help girls, but what is needed now are careful formal evaluations in different environments.

Even for patterns that seem better established by rigorous research (summed up at the start of this section), this analysis has stressed, first, the methodological limitations of many studies, and second, the need to be wary of broad generalizations about differences in female and male schooling responses to changes in policy or other factors. The first point will be taken up below. The second point was brought home by our review of the impacts of household income, but is relevant as well for more direct policy levers such as proximity to schools. In contrast to the individual case studies examining the impacts of distance to schools, a systematic study of DHS surveys found little gender difference in the

enrollment effects of school availability. No similar study exists for other school factors – no equivalent comparable multi-country data are available to conduct such a study – but clearly we need to be cautious in our statements about gender differences here as well. The lesson then is that policies need to be based on analysis conducted in the country or context concerned rather than relying on broad (if widely accepted) generalizations.

Policies outside the education sector itself may have important implications for investments in girls' (and boys') education. The human capital investment model implies that labor market conditions will strongly influence these decisions. Although returns to education defined narrowly as the proportional increase in wages for an additional year of schooling generally appear to be no lower for women than men (and sometimes higher), expected differences by gender in participation and labor supply will also matter from the parents' perspective. This is especially the case if non-market productivity is valued less than market productivity. Policies that increase women's ability to participate in the labor force with greater continuity and in better remunerated work should increase female participation and labor supply and will thus also change expectations about girls' future participation and labor supply. In so doing, these policies will raise the private returns to investing in girl's education, even if they leave unchanged the gradient of log hourly pay with respect to the level of schooling. In some cases this will require antidiscrimination measures to expand employment opportunities for women. In others, it may entail subsidizing childcare to make it easier for women to engage in well-remunerated formal employment.

Given the focus of this study, I have not addressed a series of broader issues that are likely to be relevant to the success of policies for achieving gender equity in education. These include the overall level of financial and philosophical commitment on the part of the government to meeting equity goals; the potential benefits of implementing multiple rather than isolated interventions; and the role of donor support and the implications of the increasing emphasis on sector-wide budgetary support at the expense of project funding. Kane (2004) argues that broad public commitment to gender equity goals is essential and further, that countries that have achieved these goals have tended to do so using a wide range of interventions. The first point is probably inarguable. However, it is hard to know whether a multiple programs approach is essential (because of important synergies between interventions) or if instead successful outcomes occurred because one or two programs were working well while the others were not effective – or if the presence of multiple interventions merely reflects high public commitment that insures effective implementation. Obviously, the application of multiple interventions across the board rules out unambiguous analysis of the effectiveness of specific programs, a point brought out in several instances above. For this reason I have not delved into this and the other broad policy questions just enumerated, but this does not mean they are not important.

4.2 Implications for research

Experimental and non-experimental approaches

Clearly, important gaps remain in our knowledge of the gender equity impacts of many education and education-related policies. In view of a number of potentially serious problems with analysis on non-experimental data, including omitted and mismeasured variables and the endogeneity of policy regressors, there is a compelling case for expanding the use of randomized community or school level experiments to evaluate education interventions (Glewwe and Kremer 2006). This process is already well underway.[36] It would naturally extend to policies for improving female schooling. A few such interventions, like the provision of girls' schools in Pakistan and the addition of female teachers in rural India, have already been analyzed this way, while many others, such as offering flexibility in school schedules and subsidizing childcare services, have not.

For all their advantages, randomized studies have some shortcomings. They tend to be 'black boxes' (Heckman and Smith 1995): by themselves they usually shed little light on the behavioral mechanisms that underlie measured outcomes, which have been a major focus of this paper. Experiments also typically provide information only on short term responses to interventions, and often only for relatively small and homogenous subpopulations (especially in the case of pilot studies). Long term effects for the population as a whole, in contrast, can in principle—though practice is harder—be better captured by analyzing existing policies in large cross section surveys. Another concern is that the pilot projects evaluated in experimental research may differ significantly with respect to implementation from a scaled up program. For example, a small pilot study may be allocated more resources, have better supervision, and generate greater motivation on the part of teachers and families than the same intervention would if expanded to a national scale.

For the most part these problems are best characterized less as inherent limitations of randomized studies than as reflections of the way such studies have often been carried out. Many of these limitations can be addressed through changes in the design and scope of the experiment (Duflo and Kremer 2003). With appropriate data collection, structural modeling of behavior is possible in the contexts of experiments; follow-up periods can be extended to measure longer term impacts (an example of this is the evaluation of PROGRESA); the study can be made large enough to encompass diverse regions or populations, addressing the problems of sample homogeneity and scale. However, the last two elaborations in particular will raise costs and logistical complexity.

For these reasons as well as practical or political barriers to implementation of randomized study designs[37], research will continue as well to use non-experimental

[36] A number of experimental studies that are either underway or planned are associated with the Policy Action Lab at MIT. Glewwe and Kremer as well as Duflo and Kremer (2003) describe research to date and discuss logistical issues with respect to setting up these evaluations in developing countries.

[37] It is not always a simple matter to convince education ministries to undertake a randomized study of a specific intervention, especially one that has already been implemented and in which the ministry thus has a

approaches. This will include, in particular, analysis using standard household and community/school surveys. In part this is because such surveys are so widely available. They are carried out in a great number of developing countries, for a variety of purposes other than specifically the analysis of schooling, as the term 'multi-purpose survey' indicates. From this perspective, the marginal costs of obtaining household survey data for education analysis might be said to be quite low. Obviously this is not a justification for undertaking research that, because of the issues enumerated above, yields potentially misleading results. Researchers need to explore techniques, and possibly, collect additional data, to overcome these problems.

As noted earlier, if the focus is on measuring differences by gender in the response to policies, the burden of identification may be lower. Using household fixed effects or within-family estimators to estimate the difference in impacts on girls and boys potentially washes out household-level heterogeneity in schooling preferences or abilities that would contaminate estimates of the level effects. Community fixed effects, whereby the difference in mean girl and boy outcomes at the community level are considered, has a similar rationale with respect to community level unobservables. However, the plausibility of the assumptions underlying these strategies may be questionable (see Section 3.3). A further limitation is that knowledge of the *level* effects of policy variables on girls and boys, not just the girl-boy difference in effects, is important for policy analysis. This information would be needed, for example, to compare the costs and effectiveness of two competing policies for improving girls' (or girls' and boys') educational outcomes.

A variety of techniques exist for estimating the (level) impacts of policies when participation in or access to programs is not random, i.e., when key policy regressors are potentially endogenous to schooling outcomes. Development and refinement of these approaches is ongoing; Todd (2006) provides a thorough summary. The number of applications in developing country contexts, including in education, is growing, though these have not generally had gender as a focus. Using a regression analogue to difference in difference evaluation, some researchers have used household or community level panel data to estimate fixed effects models to control for time-invariant unobservable factors that may influence both policy variables and schooling outcomes (see Duflo 2001, Parker, Todd, and Wolpin 2005, and Pitt, Rosenzweig and Gibbons 1993 for examples).[38] In some cases a natural experiment may suggest itself. For example, some countries have policies on maximum class size that yield sharp discontinuities in teacher-student ratios around the level at which classes must be split to avoid exceeding the maximum size. The existence of this rule permits a regression discontinuity approach to estimating the effect of class size, a potentially endogenous variable, on school attendance or learning (see Angrist and Lavy 1996 and Urquiola 2001 for examples). A more generally applicable evaluation technique is propensity score matching, which compares outcomes or changes in outcomes of program recipients or program communities with those of observably similar or matched units (see Behrman, Cheng and Todd 2004; Jalan and Ravallion 2003). In some cases

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stake, or to get them to allow the communities or schools to first receive a new program to be randomly chosen for the sake of the evaluation.

[38] Unlike the within family or community estimators just described, these exploit variation over time in longitudinal data, not variation within the household or community in cross section data.

traditional instrumental variables approaches may be possible, for example, using variation in local population density as an instrument to predict class size.

These and related methods each must invoke certain assumptions to permit identification of the effects of policies. The plausibility of these assumptions will depend on the context. For example, fixed effects and difference in difference techniques must assume that unobservable factors associated with the policy variables only affect the level of the schooling outcomes, not changes in them over time. Matching methods assume that conditioning on observable characteristics is adequate to control for all differences in outcomes not caused by the program being evaluated. Discussion of these issues is also ongoing.[39]

Beyond these concerns, it should be noted that feasibility of applying a particular technique will often depend on the specific policy environment (e.g., the presence of a mandated maximum class size in the example above). The researcher will often have to gather additional data or detailed information on programs. For example, Duflo matched standard Indonesian household survey (SUSENAS) data to region-specific historical information on the country's 1970s school construction program, allowing her to calculate the extent to which specific cohorts were exposed to greater school availability, hence to estimate the effect of availability on school attainment. For the fixed effects models described above, panel data on households or (for community fixed effects) repeated cross section survey data are required. For evaluations of pilot projects or interventions that are limited in scale (like many discussed in this paper), standard nationwide household surveys are unlikely to be usable, because they may contain few households in the specific areas affected by the program. In this case, new and more focused data collection will be needed, and the availability of national household survey data is no longer an advantage.

Suggestions for future research

The conceptual framework and literature reviewed in this paper suggest several directions for research in terms of questions to be asked and data to be collected. These apply to analysis using household survey data as well as, in some cases, program evaluations, including experiments. The latter would be the case to the extent that there is interest in more structural behavioral analysis.

First, with regard to the nature of the data gathered, some considerations with respect to information requirements for techniques to estimate policy impacts using non-experimental data were just noted. A few additional points can be made. When using household surveys for such analysis, the need to complement these data with high quality surveys of local schools and communities is obvious. School surveys must contain fairly comprehensive information on school characteristics, not just a handful of standard indicators; as noted, lack of information on relevant inputs is one potential source of bias in the estimates of the effects of school quality. For understanding gender aspects of education demand and academic achievement, school surveys should also be designed to

[39] For example, see the debate over the reliability of propensity score matching in the Journal of Econometrics Vol. 125, (1-2) (March-April 2005).

collect information specifically on school characteristics that may differentially impact girls' and boys' enrollment and learning. This practice is not common. These characteristics would include, *inter alia*, the share of teachers that are female and the presence of separate latrines or toilets for boys and girls. School or teacher surveys can also elicit information on teacher attitudes and behaviors toward girl students, as in the study by Lloyd et.al (1998), a rare example of where this has been done. In some countries, existing administrative data on schools collected by the education ministry may be of high quality and suitable for merging with household or individual level data. However, these school databases may not contain many variables relevant specifically to gender-based analysis, other than perhaps the number of female teachers in each school.

Second, the human capital investment model suggests that a host of parental expectations shape decisions about the education of sons and daughters: expectations about labor market returns for girls and boys, about remittances (and possibly, bride price), and about the probabilities of school success and continuation. Information on these factors is often available in household surveys. For example, it is often possible to use the data at hand to estimate labor force participation and earnings equations for women and men. This would enable researchers to consider gender differences in overall labor market returns, incorporating both expected employment and earnings outcomes. Often data are also collected on remittances from grown daughters and sons and the schooling of these offspring. As indicated above with reference to the estimation of earnings returns to education by gender, the variation necessary to draw casual inferences with respect to impacts on schooling outcomes will generally be lacking. Still, the available information may make it possible to narrow down the list of possible reasons for gender schooling disparities. For example, if returns to schooling in the labor market are not lower for women then men, the reasons for low female schooling lie elsewhere.

Third, the range of educational outcomes considered in empirical research should be broad. Most of the research discussed in this review simply compared male and female enrollment determinants, though some also considered grade attainment. In most countries most girls as well as boys enter school; gender gaps begin or widen later, through earlier school dropout of girls. In view of this, the existing research on gender and schooling places disproportionate emphasis on simple enrollment indicators and not enough on how policies and household factors affect school continuation decisions for girls and boys, including primary completion and transitions to secondary school.

The determinants of academic achievement (test scores) and how these differ by gender have also received relatively little attention, in large part because test score data are less common. Yet obviously, many or even most education interventions are designed not just to increase enrollment but also to improve learning outcomes. Here the data requirements for obtaining reliable estimates are more demanding. Tests score data are typically school-based, but especially at higher grades, some children—more of them girls—will have dropped out of school, while other children may never have entered school. Therefore test data need to be linked to random samples of children in the community or school catchment area so as to be able to model and control for selection into the male and female student samples. This type of analysis remains rare. Glick and

Sahn (2005a) is an example using detailed school and household survey data. In the realm of policy experiments, several of the evaluations mentioned above (Banerjee et. al. 2000; Miguel, Kremer, and Thornton 2004) consider both test score outcomes and school participation effects.

Fourth, questioning of parents on perceptions and attitudes about the factors identified above would be a useful complement to demand estimation for understanding household education behavior. This is not to say that such information has not been gathered by social scientists. But economists, with their strong preferences for revealed preference approaches (i.e., demand modeling) normally do not pay a great deal of attention to these sources of information. However, there has been increasing interest in approaches to integrating standard quantitative methods with qualitative techniques that are more prominent in other social sciences (Kanbur 2003). It would impose relatively little cost at the margin to add a structured perceptions questionnaire to a household survey or to conduct qualitative interviews with a portion of the households surveyed. In some cases these approaches will be able to capture aspects of schooling decisions that standard surveys cannot, for example, the importance to parents of bride price considerations, or of teacher behavior toward girls.

Fifth, even without changing the nature of the data collected, researchers investigating schooling outcomes and gender should consider not just whether mean impacts of school price and quality differ by gender, but whether the differences depend on the level of household resources. This is straightforward but has usually not been done. It is particularly important where gender schooling gaps are largest at lower income levels, demanding that special attention be focused on policies that raise enrollment or school continuation of girls in poorer households.

Sixth and finally, with the exception of a number of program evaluations, the research reviewed in this study has focused on identifying the *effects* of policies on female and male education indicators. While this research program, as emphasized, is hardly complete, the issue of costs and more specifically the cost-effectiveness and scalability of different policies is obviously also crucial. For the bulk of the research reviewed here that has used household survey data, this has received less attention. Undoubtedly this is due in large part to the fact that obtaining the necessary information on costs of supplying various school inputs would entail a separate data collection task. For evaluations of discrete programs or for pilot studies, in contrast, costs are usually relatively well defined and more easily obtained.[40]

Information on costs and effectiveness of different interventions would allow research to address a number of important questions for policy. For example, how does the cost-effectiveness of intensive multi-faceted interventions such as that in rural Balochistan compare with simpler programs such as providing incentives to schools to enroll girls as in

[40] Examples of cost-effectiveness analysis of education programs are Wodon's (1998) analysis of Food for Education in Bangledesh and Coady and Parker's (2002) analysis of Mexico's PROGRESA program. Ongoing research on other conditional cash transfer programs will also include a cost-effectiveness component (see Morley and Coady 2003).

the urban Quetta, or providing tuition stipends to girls as in Bangladesh? Should programs to boost girl's education be very broad—applying to all girls—or instead targeted, say, to girls from poorer households or regions? The Bangladesh stipend program is very expensive because it has very wide coverage; it is essentially an entitlement program. While this may be important to insure political support, concerns have been raised about sustainability (Devarajan and Reinikka 2004). In addition, for any intervention to raise girls' schooling, the fiscal impacts need to be considered from both short and long term perspectives. As Schultz (2002) perceptively points out, policies that increase girl's education may, by increasing future female labor market participation at the expense of home production, significantly expand the tax base for governments in the long run.

When comparing policy options, it must also be kept in mind that the education objectives of governments in poor countries encompass (as they should) more than just raising female schooling or reducing gender gaps: in particular, many countries still need to increase overall enrollments of boys as well as girls, especially at post-primary levels. Certain policies that induce parents to send girls to school, for example, flexible school schedules, may have little positive effect on boy's enrollments and may even lower them by reducing available household schooling resources per child or by diluting school quality as total enrollments rise. In this respect, policies identified above that appear to raise schooling of both genders while benefiting girls disproportionately are attractive, at least in contexts where gender disparities are not so large that explicit gender targeting is called for.

Appendix: Model of household schooling investment

This Appendix outlines the two period model generating the specific cases illustrated in Figures 1-5 in the text. For a household with a boy and a girl child, the lifetime utility of the parents is written as:

$$U = U(C_1) + \delta U(C_2, W_g, W_b)$$

where C_t is consumption in period t, W_g and W_b are second period wealth of the girl and boy, respectively, and δ is the rate of time preference. A child's wealth in period two is a function of the investment in the first period in her schooling (S_i) as well as the level of first period labor in productive work (L_i) such as family farming that leads to the accumulation of remunerative skills:

$$W_i = W(S_i, L_i), \quad i=b,g$$

First period consumption is written

$$C_1 = Y + Y_g + Y_b - P_g S_g - P_b S_b$$

where Y is income of the parents, Y_g and Y_b represent the contributions of the girl and boy to first period household income (hence are functions of L_g and L_b), and P_g and P_b are the direct or monetary costs of schooling for each child. This identity constrains the household's expenditure on consumption and education to be equal to total current household income, a constraint that would be relaxed if the household could borrow in credit markets to finance school investments. Parents choose S_g and S_b as well as L_g and L_b to maximize lifetime utility subject to the first period budget constraint as well as (implicitly) the time constraint of the children, who allocate their time between labor and school activities:

$$\text{Max } L = U(C_1) + \delta U[C_2(W_g(S_g,L_g), W_b(S_b,L_b)), W_g(S_g,L_g), W_b(S_b,L_b)]$$
$$+ \lambda[Y + Y_g + Y_b - P_g S_g - P_b S_b - C_1]$$

The first order conditions for girl's and boy's schooling are:

$$\frac{1}{\delta}\frac{\partial U}{\partial C_2} r_g \frac{\partial W_g}{\partial S_g} + \frac{1}{\delta}\frac{\partial U}{\partial W_g}\frac{\partial W_g}{\partial S_g} = \lambda\left(P_g + \frac{\partial Y_g}{\partial L_g}\frac{\partial L_g}{\partial S_g}\right) + \frac{1}{\delta} r_g \frac{\partial W_g}{\partial L_g}\frac{\partial L_g}{\partial S_g}$$

$$\frac{1}{\delta}\frac{\partial U}{\partial C_2} r_b \frac{\partial W_b}{\partial S_b} + \frac{1}{\delta}\frac{\partial U}{\partial W_b}\frac{\partial W_b}{\partial S_b} = \lambda\left(P_b + \frac{\partial Y_b}{\partial L_b}\frac{\partial L_b}{\partial S_b}\right) + \frac{1}{\delta} r_b \frac{\partial W_b}{\partial L_b}\frac{\partial L_b}{\partial S_b}$$

where λ is the marginal utility of income and $r_g = \partial C_2/\partial W_g$ and $r_b = \partial C_2/\partial W_b$ are the remittance functions for daughters and sons, that is, the rates of transfer to parents out of children's second period wealth. The first order conditions imply that parents invest in the schooling of each child until the discounted marginal utility equals marginal cost. The marginal utility (or marginal benefit) of schooling depends on transfers from the additions to the child's wealth resulting from another year of schooling (first term on the left hand side) as well as on the direct effect on parental utility of the child having more wealth (second term on LHS).

Marginal costs of schooling include, first, the reduction in current consumption incurred by increasing the level of schooling, captured in the first term on the right hand side. This involves both direct costs P_i as well as indirect costs since additional time in school reduces the child's time in productive activities (i.e., $\partial L_i/\partial S_i < 0$), reducing first period household income. Second, the reduction in child labor in period one also means that the level of accumulated skills in income generating activities will cet. par. be lower, reducing period two wealth. This in turn reduces future transfers from the child (shown in last term on the RHS). It is assumed that this negative effect of reductions in experience is not overwhelmed by the positive effect of possible complementarities of schooling and work experience in the production of human capital.

Investments in girls' human capital will be lower than boys' if the remittance rate is higher out of boy's wealth $r_b > r_g$; if the marginal returns to schooling are everywhere higher for boys than for girls $\partial W_b/\partial S_b > \partial W_g/\partial S_g$; or if the marginal costs of schooling are everywhere higher for girls. As noted in the text, to explain gender differences in the effects of policies that alter the costs or benefits of schooling, it is necessary to put more structure on the model. The following presents the assumptions and derivations of the cost and benefits curves featured in several of the cases discussed.

Differences in benefits to schooling (Figure 1)

Earnings are assumed to take the quadratic form $W_i = \alpha_1 S_i - \alpha_2 S_i^2$ ($\alpha_1 > 0$, $\alpha_2 < 0$), thus increasing with additional schooling but at a decreasing rate. Ignoring the direct utility from children having more wealth, the parents' marginal benefits are (dispensing here with λ) $r_b(\partial W_b/\partial S_b) = r_b\alpha_1 - 2r_b\alpha_2 S_b$ for boys and $r_g(\partial W_g/\partial S_g) = r_g\alpha_1 - 2r_g\alpha_2 S_g$ for girls. If $r_b > r_g$, i.e., the rate of remittances out of son's income is larger than out of daughter's, the marginal benefits decline more rapidly for boys than for girls as S_i increases (the slopes of the marginal benefits are $-2r_b\alpha_2$ and $-2r_g\alpha_2$ for boys and girls, respectively). Several other situations would generate similar girl-boy differences in quadratic benefits and their gradients: women's wages being lower than men's (due to pay discrimination) by some proportion that is constant over schooling levels; a probability of female labor force participation that is lower than men's by some constant proportion; or similarly if total lifetime labor supply of women was lower. Section 3.6 in the text discusses the implications for girl vs. boy returns when participation or labor supply is lower for women than men but for women is also a function of the level of schooling, so that is for example an increasing proportion of men's as schooling rises.

Differences in schooling cost functions (Figure 2)

To simplify the exposition, assume that school attendance and work in alternative activities are mutually exclusive, and that the total years available for either is fixed at some level S_{max}. This could be, for example, 12 years if children start school at age 6 and leave by age 18 to marry or enter the labor force. Then $L_i = S_{max} - S_i$ and $\partial L_i/\partial S_i = -1$. Assume further that first period work experience and schooling are separable in the production of human capital and that experience increases wealth at a decreasing rate. Thus we can write $W_i|S_i = \beta_{1i}L_i + \beta_{2i}L_i^2$, $\beta_{1i} > 0$, $\beta_{2i} < 0$. Substituting the derivative of this function with respect to experience into the marginal school cost function and using $\partial L_i/\partial S_i = -1$ yields:

$$MC_i = P_i + \frac{r_i}{\delta}(\beta_{1i} - \beta_{2i}S_i)$$

where $\beta_{1i} - \beta_{2i}S_i = (\partial W_i/\partial L_i)(\partial L_i/\partial S_i)$. Given the concavity of the returns function for non-school human capital ($\beta_{2i} < 0$), the marginal cost of schooling is increasing in years of education, as shown in Figure 2.

Discontinuous returns to schooling (Figure 3)

For the case of a premium to primary completion the benefits function shifts up at six years of school. The earnings function depicted in Figure 3 is $W_i = (1-G)[\alpha_{1i}S_i + \alpha_{2i}S_i^2] + G\theta[\alpha_{1i}S_i + \alpha_{2i}S_i^2]$, $\alpha_{1i} > 0$, $\alpha_{2i} < 0$, where G is a 0,1 indicator of primary completion and θ is the earnings premium to primary completion.

Differences in school dropout/continuation probabilities (Figure 5)

Assume strong returns discontinuity such that there is no labor market benefit to schooling until a primary diploma is obtained. Marginal benefits are therefore zero until S=6 and, it is also assumed, positive but declining thereafter. Let G_g and G_b represent, respectively, the female and male probabilities of graduating primary school. Expected marginal labor market returns are then $G_g[\zeta_{1i}(S_i-5) + \zeta_{2i}(S_i-5)^2]$ for girls and $G_b[\zeta_{1i}(S_i-5) + \zeta_{2i}(S_i-5)^2]$ for boys. Figure 5 depicts the case where $G_g < G_b$.

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Table 1 - Enrollment ratios and gender education gaps by region

	Primary				Secondary		
	Net enrollment ratio[a]	Gross enrollment ratio[b]	Ratio of female to male enrollments	Ratio of female to male completion rates[c]	Net enrollment ratio[a]	Gross enrollment ratio[b]	Ratio of female to male enrollments
Sub-Saharan Africa	66.9	93.0	86.2	84.5	28.0	33.0	75.1
East Asia & Pacific	87.8	100.5	88.7	97.0	46.8	48.3	81.8
Europe & Central Asia	88.8	99.1	93.8	96.0	82.4	88.6	99.2
Latin America & Caribbean	91.5	108.9	93.8	108.1	56.8	69.0	102.4
Middle East & North Africa	81.6	99.1	86.9	93.3	61.2	67.3	86.9
South Asia	..	99.0	85.2	84.5	..	54.4	80.8

Source: UNESCO education statistics

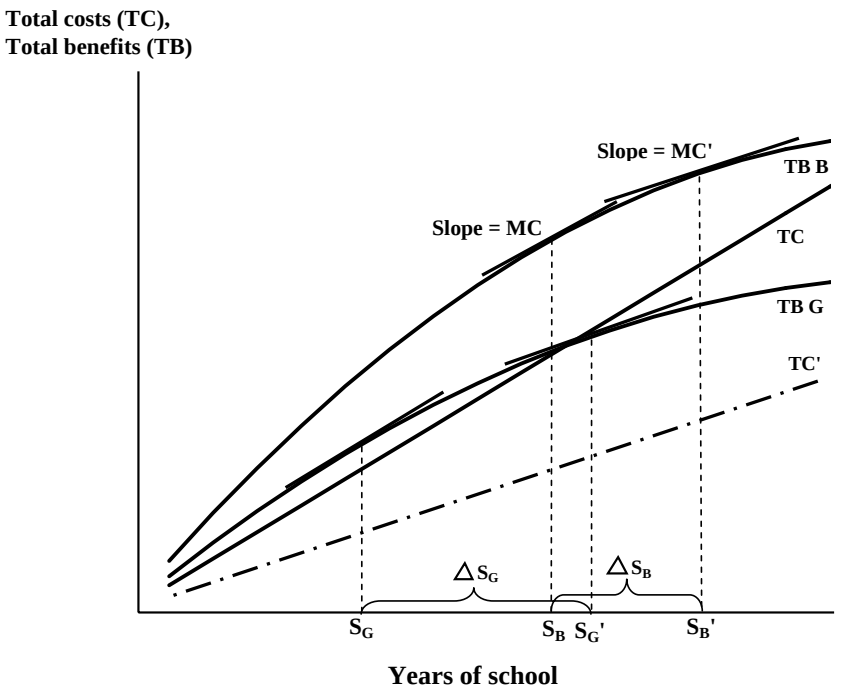
Notes:

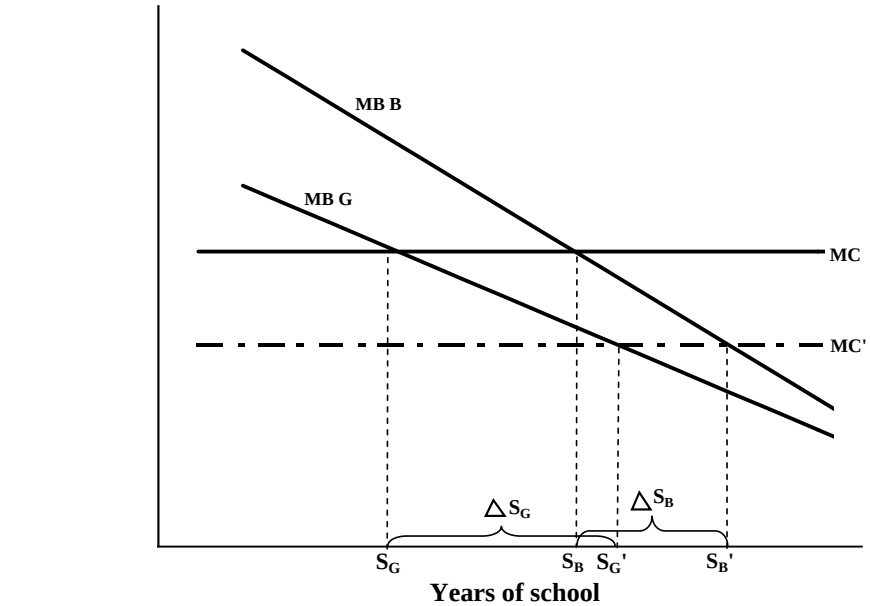
[a] Net enrollment =primary (or secondary) enrollments of primary (or secondary) school age children divided by number of primary (secondary) age children x 100

[b] Gross enrollment = total primary (or secondary) enrollments divided by number of primary (or secondary) age children x 100.

[c] Completion rate = number of students completing the last year of primary over the number of children of official graduation age

Figure 1 - Differential benefits to schooling by gender: effects of a price reduction





Notes to Figures:
G and B denote girls and boys, respectively. No letter means the cost or benefit function is the same for girls and boys. Dotted lines indicate the cost or benefit functions after the indicated policy change.

Figure 2 - Differential cost functions by gender: effects of an increase in schooling returns

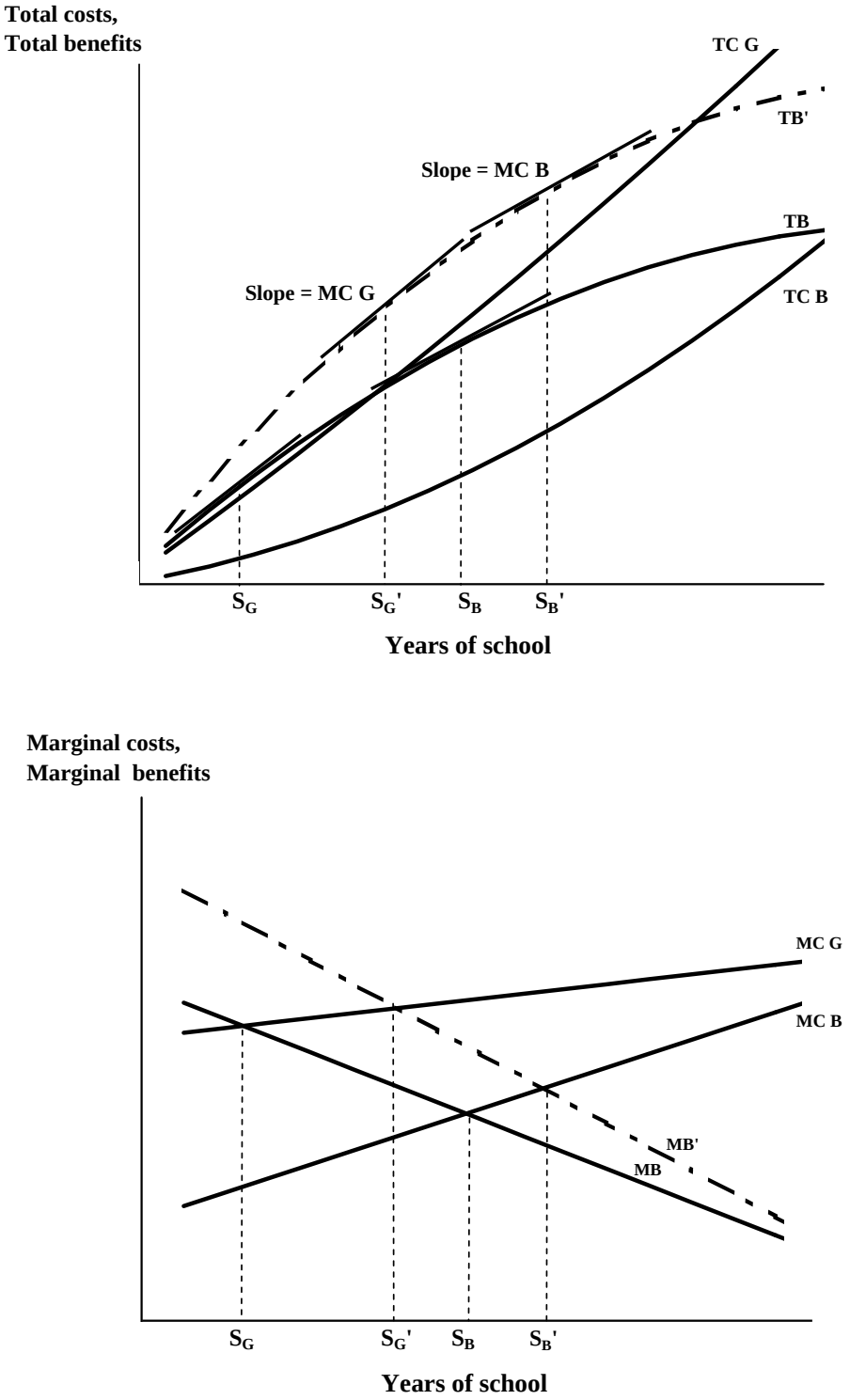


Figure 3 - Discontinuous schooling returns: effects of an increase in returns

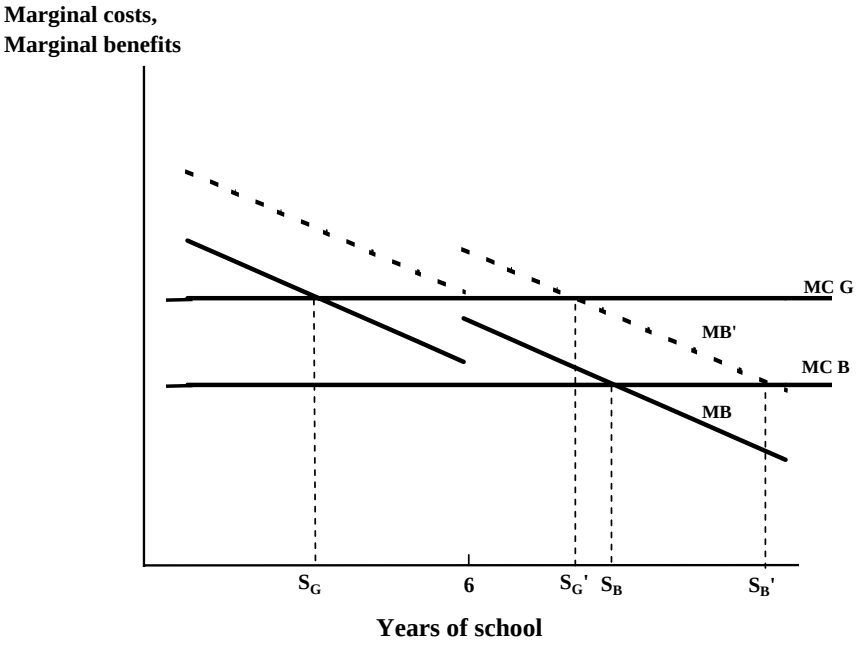


Figure 4 - Discontinuous schooling costs: effects of an increase in returns

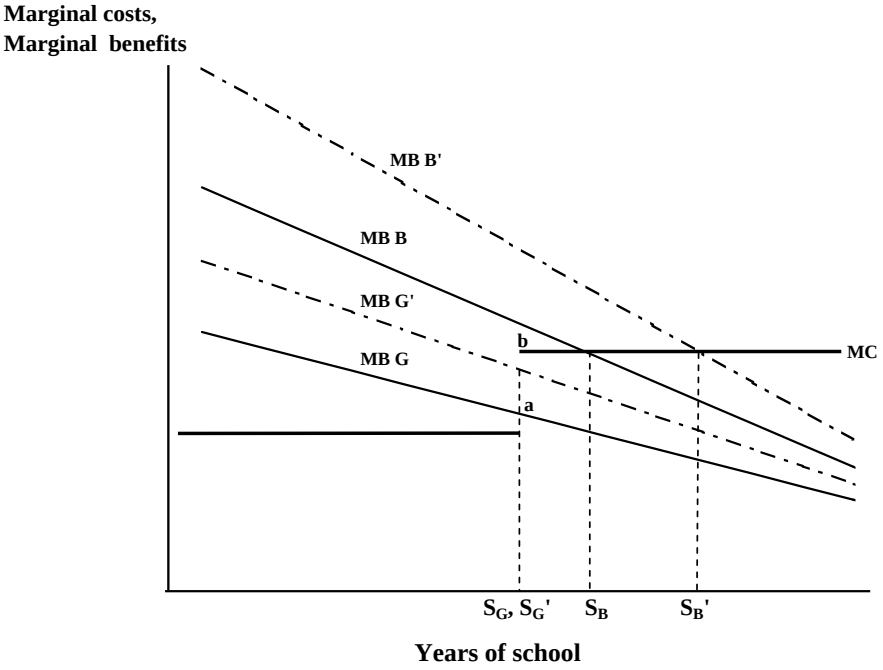


Figure 5 - Differential school progression probabilities with discontinuous returns: effects of a price reduction