A Bargaining Model for Gender Bias in Education in Poor Countries

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Abstract

Human capital accumulation is one of the main engines of economic growth and this is the reason why, in the past 30 years, many LDCs introduced laws for compulsory education and increased their investment in public schooling. However, the level of education in most poor countries is still very low, particularly for girls. Gender bias in education is not only a problem of inequality; better educated women, in fact, have lower fertility rates, are more efficient in home production, have more healthy children and contribute to a more equal household's resources distribution.

The object of this work is to develop a model for household decision making in order to better understand what variables affect parents' decision to educate less girls than boys. In the first part, a household bargaining model is developed in which mother and father have different preferences over consumption, leisure and children's education. As a result, sons' and daughters' years of education depend on each parent's preferences, decision power and the different costs and returns to educate girls and boys.

The second part contains a simulation of different policies for increasing women's education using figures coming from the Living Standard Measurement Studies of Ivory Coast. The experience of many LDCs shows in fact that compulsory education is not sufficient to reduce gender bias in education and therefore policies should be based on a deeper understanding of households' decision making process.

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Introduction

Macroeconomic analyses demonstrated that human capital accumulation is one of the most important factors in the development process (Denison, 1962, for US; Lucas, 1988; Barro and Sala-I-Martin, 1995) and microeconomic analyses showed that better educated people have better job opportunities, higher salaries and an easier access to information (Mincer, 1974; Becker, 1975; Rosenzweig, 1995).

Many researches in development economics (Subbarao and Raney, 1992; Gould, 1993; Dasgupta, 1993; Haq, 1994a, 1994b) showed the importance of investing in female human capital. Increasing female education in LDCs, in fact, reduces fertility rate (Cochrane, 1979), ameliorates children's health conditions (Thomas, 1990, 1994; Haddad and Hoddinott, 1994; Subbarao and Raney, 1995), and changes the patterns of households' consumption with a reduction in income share for adult goods (Folbre, 1984; Rosenzweig and Wolpin, 1988; Haddad and Kanbur, 1990; Pitt *et al.*, 1990; Hodinott and Haddad, 1995).

However in poor countries people are still inadequately educated and this affects mainly women. Table 1 shows the gross enrolment ratios in different areas for boys and girls. The percentage of boys and girls enrolled in primary schooling increased dramatically between 1970 and 1997 in all areas, but in Middle East and North Africa, in South Asia and in Sub-Saharan Africa the percentages of girls enrolled is still far from 100%, thus the gender gap is large.

In Sub-Saharan Africa, in fact, 37% of girls do not attain primary school, only 11.9% receive secondary education and 0.9% tertiary education (CamFed, 1995). In South Asia and Latin America the situation is less dramatic, but still women have very low levels of education.

Table 1

Gross enrolment ratio in primary education
(% of people in the corresponding age)

	1970	**1980**	**1990**	**1997**
	Men			
East Asia and Pacific	96.2	117.4	122.0	118.3
Latin America and Caribbean	107.4	105.6	106.2	116.9
Middle East and North Africa	79.5	90.1	90.0	92.1
South Asia	86.0	90.5	102.6	106.8
Sub-Saharan Africa	62.3	88.7	81.9	84.1
	Women			
East Asia and Pacific	84.9	103.0	114.8	117.6
Latin America and Caribbean	104.3	102.7	103.7	110.2
Middle East and North Africa	48.4	67.5	72.4	76.9
South Asia	52.4	60.1	77.1	83.3
Sub-Saharan Africa	42.8	70.2	67.6	69.4

Source: UNESCO (1999)

The UNESCO (1993) forecasts for the years 2020 seem to confirm South Asia and Sub-Saharan Africa as the areas in which education and gender bias in education are matters of major concern (see Table 2). Without any intervention it will be difficult to increase human capital accumulation in those poor areas and this will be a considerable obstacle to economic development.

Table 2

UNESCO forecasts for the year 2020 (%)

	no education	**some years of primary education**	**some years of secondary education**	**some years of tertiary education**
		Male		
East Asia and Pacific	1.8	40.6	40.0	17.5
Latin America and Caribbean	5.6	51.6	25.1	17.6
Middle East and North Africa	0.2	43.9	45.6	10.4
South Asia	8.1	50.2	33.7	8.0
Sub-Saharan Africa	11.3	69.2	17.7	1.9
		Female		
East Asia and Pacific	2.3	42.4	39.2	16.1
Latin America and Caribbean	6.5	46.5	31.3	15.7
Middle East and North Africa	0.3	52.4	40.8	6.5
South Asia	17.3	54.0	24.3	4.4
Sub-Saharan Africa	23.0	63.4	12.8	0.8

Source: UNESCO (1993)

Even if many investments in schools have been done in the past 30 years, the lack of governmental resources, also due to the adjustment programs that force governments to reduce public expenditure, prevents poor countries from reaching the objective of universal education. According to the World Bank (200), LDCs spend on average 3.3% of their GNP for public schooling, while the corresponding figure for rich countries is between 5.4%. For instance, in Nigeria public expenditure on education in 1997 was 0.7% of GNP, 1.2% in Myanmar, 1.4% in Indonesia and Burkina Faso. Only Zimbabwe and Namibia increased considerably their investment in education: between 1960 and 1995, Zimbabwe passed from 0.5% to 8.5% of GNP for public schooling, while Namibia passed from 2.1% in 1980 to 9.1% in 1997.

In actual fact, poor families do not send their children to school both because they have no money for fees, uniforms and books, and also because children represent an important help in the domestic activities: they can work in the subsistence agriculture, they can help in gathering wood and water, and in looking after animals. Moreover, data on child labour (ILO, 1996) show that often children are also an indispensable source of income for their families: more than 120 millions of children between 5 and 14 years did

full-time paid work in 1995. This phenomenon is particularly relevant in Asia and in Africa[1].
If in rich countries the costs of growing up a child are greater than the revenues that the family obtains from child's work; in poor countries the costs are usually low and the benefits high. As a consequence fertility rates are high in almost all LDCs (Corbridge and Watson, 1985; Dasgupta, 1993).

In this paper I make use of a household bargaining model to investigate why parents invest more in their sons' than in their daughters' education. This is relevant in order to identify policies for gender gap reduction.

The paper is organised as follows: in the first section an analysis of the costs and benefits of educating boys and girls is presented; section 2 contains a short survey of household decision models; in the third and the fourth section I present respectively a non-cooperative and a bargaining model for household decision making; section 5 shows how mother's and father's different preferences, decision powers and the costs and returns to female schooling interact to produce under-investment in girls education; in section 6 the model is simulated using Ivory Cost data while in section 7 calibration is used to shows the effects of alternative policies. Conclusions follow.

1. *Women education in poor countries: why so low?*

The analysis of the causes for the low level of education, and in particular of women's education, in poor countries must be analysed by considering both the costs (direct and indirect) and the returns for the families of sending their children to school.

In poor countries, like in developed countries, both private and public returns to education are positive: better educated people are more productive in market and domestic activities, earn higher incomes and can spend more on health care for themselves and for their children. In particular, public returns to female education are very high because better educated women get married later, are more inclined to accept contraceptive methods, have better job opportunities and therefore want less children. Moreover, better educated women are also more productive in child rearing activities and spend more for their children health. Subbarao and Raney (1995) simulated the effect of an increase in female education: if the enrolment rates in poor countries in 1975 were twice the actual rates, in 1985 fertility rate would have been 29% lower and infant mortality rate 64% lower.

Psacharopoulos (1985) computed the private rates of return to education and demonstrated that they are higher in poor countries than in rich ones. In particular private and public returns to primary education are very high: the social benefits of a better educated population are more evident where the average level of schooling is low.

[1] In 1995 the participation rates for children between 10 and 14 years were 26.2% in Africa, 12.7% in Asia and 9.77% in Latin America and Caribbean. The forecasts for the year 2010 are 22.5%, 5.6% and 5.5% respectively (ILO, 1996).

It is therefore important to analyse those factors that affect patents' decision of investing in children's education and why it is "convenient" for poor household to educate more boys than girls.

The reasons for gender bias in education can be grouped in three:

- the high costs (both direct and indirect) of sending a girl child to school;
- the low private returns to women's education;
- the role of women in traditional societies.

Direct costs are represented by uniforms (compulsory in most LCDs), transport costs, school fees[2] and materials. Scholarships are very rare and girls have more difficulties than boys to obtain them or to find the economic support of relatives to finance their education (CamFed, 1995).

The indirect cost of educating a female child is given by the opportunity cost of the time that she usually spends in helping their parents. Girls, especially in South Asia and in Africa, help their mothers in the subsistence agriculture, in looking after the younger siblings, in gathering wood and water. These works start when they are five or six years old, and are often incompatible with schooling because they keep girls busy for many hours every day. Even when girls go to school, domestic works divert them from studying and therefore their outcomes are often poor, thus the rate of dropout of girls is higher (Glewwe, 1998).
Obviously, also boys help their parents in the productive and domestic activities, but they start to work later because they are usually charged with more heavy tasks, especially in agriculture[3]. As a consequence, they can study at least for few years.

At the same time the rate of return to women's education perceived by the households is low for many different reasons. First of all, most of women's work is within the family, absolutely essential for household survival, but unpaid.
Moreover, women have few opportunities to find jobs because of the low level of economic development and the consequent low labour demand, but also because of discriminations in the labour market; firms tend to prefer men workers because they are considered more productive. As a result, the rate of female unemployment is higher than the rate of male unemployment in almost all countries.
Even when they find a job, women face quite often wage discrimination. The Human Development Report (UNDP, 1995) shows that usually women's wages are lower than men's wages and the situation is particularly dramatic in poor countries: the ratio between female wage and male wage reaches 0.42 in Bangladesh. UNDP identifies three reasons for gender wage gap: women are concentrated in less-skilled/less-paid jobs; unions are weak in those sectors in which women are employed; in many countries there is not a legislation to protect women during pregnancy.

[2] The lack of public resources makes it almost impossible to guarantee free education for all, even for primary education.

[3] Blinder (1998) found that in 1990 in Mexico boys were more likely than girls to be in the labour force: between 12 and 14 years 11% of boys and only 3% of girls worked; between 15 and 19 years the percentages are 47% and 18% respectively. Ray (2000) found that in Peru and Pakistan girls work especially in the domestic activities, while boys have higher participation rates. Skoufias (1994) showed that in rural India girls devote more time to home activities than boys and the opposite is true for time at school.

The high fertility rate is certainly another factor that reduces returns to women's education (Echevarria and Merlo, 1995): when there is not a legislation to protect women during pregnancy and childbearing, they have to leave their jobs and after it becomes difficult to re-enter the labour market.

However, many studies showed that returns to women's education are even higher than returns to men's schooling (Appleton *et al.*, 1995; CamFed, 1995; Berhman and Deolalikar, 1995), but these results are referred to public returns, measured by considering also fertility rate reduction[4] and the effect on children health (Lam and Duryea, 1998). When parents decide how much to invest on their children education, they do not consider these effects and therefore under-evaluate the returns to their daughters' education. As a consequence the level of investment in female human capital is sub-optimal and there is room for policy actions.

In deciding the investment in education, parents do not consider only the earnings that their children will possibly get (altruistic purpose), but they also evaluate how many resources their children will transfer to them when adult. In poor countries, in fact, there are not pension systems and old parents survive thanks to the resources they receive from their adult children[5]. Better educated children will have higher income and they will transfer more resources to their old parents. This support to old parents is given mainly by sons: in many traditional societies, in fact, when a woman gets married she becomes a member of the husband's family and therefore it is less convenient for her parents to invest on her education since the future benefits will go to the husband's family (Rosenzweig and Schultz, 1982; Browning and Subramaniam, 1994; CamFed, 1995; Garg and Morduch, 1998).

Another important reason for gender bias in education is related to the role of women in traditional societies. Often, in fact, women carry out mainly subsistence agriculture or domestic works, very tiring in poor countries where it is necessary to walk for hours to find water or wood, essential tasks for the survival of the household members. Apparently these tasks do not need particular knowledge and families perceive girls education as a waste of time (Gachukia, 1994b).

The last obstacle to girls education is due to the long distance of houses from schools[6]: parents are also worried about the moral integrity of their daughters because, as some researches have pointed out (CamFed, 1995), the risk of sexual harassment by schoolmates, but also by men teachers, is high. For this reason the prevalence of men teachers contributes to take girls away from schools.

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[4] The inverse relation between education and fertility rate is not linear, as the famous Cochrane's study (1979) demonstrated: for very low level of schooling an increase in women's education can even produce an increase in fertility rate. The inverse relation, however, is true in urban areas and in less poor regions.

[5] Dasgupta (1993) argues that, for a poor family, a child is both a *consumption good*, because she/he gives utility to their parents, a *production good*, because she/he helps in productive and domestic activities, and an *insurance good* because she/he is the only guarantee for her/his parent to survive when they become old and they cannot work any more. See also Gertler and Glewwe (1992).

[6] Tansel (1997) showed that the negative effect on school attendance of distance to school is greater for girls than for boys.

Another explanation of gender bias in education, suggested by Blinder (1998), is that parents invest the same amount of money in sons and daughters. However, girls receive less education because the money is used to endow them with a dowry. The higher is the dowry, the higher is the probability for them to get married with a wealthy man. On the contrary, parents educate boys in order to assure them higher incomes and "better" wives (with higher dowry). With this strategy, parents try to guarantee higher future incomes and wealth to all their children.

The model for household decision making proposed in this paper takes into account all these issues in order to analyse which are the most relevant factors that affect parents' decision about children education and to identify and measure the effects of alternative policies to increase female education in poor countries.

2. *Household decision making models*

Traditional economic theory, and in particular general equilibrium theory, considers only individuals as decision-makers and does not take into account the role of household in the decision process. However, most of the decisions concerning consumption, saving and investment, labour supply and fertility are taken within the family and not by an individual memeber.

The fist attempt to introduce the household in the economic theory has been done by Becker (1965, 1974), Becker and Lewis (1973) and Becker and Tomes (1976). They assumed the household as a decision-making unit, characterised by a single utility function that is maximised subject to a single budget constraint. The main advantage of this approach is that it simplifies the analysis by considering the household decision process analogous to the individual decision process.

The assumption of a single utility function to represent household's preference ordering has been deeply criticised. To obtain a unique household utility function, in fact, it is necessary to aggregate the utility functions of all components, but the Arrow's theorem shows that this does not produce an aggregate utility function with all the desirable characteristics of asymmetry, negative transitivity, Pareto efficiency, independence from irrelevant alternatives and absence of a dictator[7].

Gorman (1953) showed that the necessary and sufficient condition for the existence of an aggregate utility function valid for all possible income distribution is an indirect utility function with the following functional form:

$$V(p, y_i) = \alpha(p) y_i + \beta_i(p)$$

where i is referred to the individual, y is the income and p is the prices vector.

Under this assumption, changes in income distribution that leave total income unchanged do not affect total consumption.

An aggregate utility function can be obtained also under the assumption of homothetic preferences and constant income shares (Chipman, 1974; Shafer, 1977; Shapiro, 1977).

[7] See Kreps (1990) for more details on the Arrow impossibility theorem.

Alternatively we have to assume the presence of a dictator in the household that takes all decisions. The dictator can be altruistic and care about the welfare of all household members[8], but this assumption remains unsatisfactory and produces dynamic inefficiency in multiperiod models[9].

In order to avoid the theoretical problems posed by the traditional unitary model, a new approach (Manser and Brown, 1980; McElroy and Horney, 1981) has been developed starting from the Nash (1950, 1953) bargaining model: household decisions are the result of a bargaining process among members who differ in their preference orderings and decision powers. Rational individuals, with the same ability to bargain, cooperate in order to obtain a gain, which is divided between them.
In the bargaining model, contrary to the unitary models, the final resources allocation depends also on the different power of each member within the household. This is a function of the opportunities outside the family: when the well-being that each member can obtain outside the household is high, the threat of leaving the family is more credible and household resource allocation must guarantee at least the same welfare as the exit option does. Therefore, the decision power depends on the conditions in the labour market, on the possibilities offered by the marriage market and on the traditional values that establish, for example, the degree of acceptance of divorced people (especially when they are women). Rosenzweig and Schultz (1982), Haddad and Readon (1993) and Harris (1995) showed how in poor countries the low decision power of women produces resources allocation more advantageous for adult males.

This new approach to household decision-making process enabled economists to analyse important issues related to labour supply (Schultz, 1990), marriage (McElroy, 1990), fertility decisions (Schultz, 1990) and gender bias in calorie intake, health care and education (Thomas, 1990). These studies are particularly relevant in setting policies concerning family, taxes, social security and gender equality that, to be successful, must be based on a deeper knowledge of the allocative process of household resources.

In the following paragraph, I develop a non-cooperative model for household decision process. The outcome of this model will be used as a threat point in the bargaining model developed in Section 4.

[8] In the literature this is known as *Rotten Kid Theorem* and it was Becker's response to the criticisms to the unitary model assumptions.

[9] If parents transfer resources to their children only in the first period, children in the second period do not have any incentive to maximise the household utility function instead of their own utility function because they can not be threaten to reduce the amount of the transfer.

3. *A non-cooperative model for household decisions*

Gender gap in education can be explained using different models. Becker and Tomes (1976) used a unitary model in which altruistic parents choose the "quantity" and the "quality" of their children. Quality depends on both endowed ability and education received. When parents are equally interested in all children and the cost of educating children with different abilities is the same, altruistic parents invest more on less able children in order to compensate for differences in ability. Therefore, if returns to female education are lower and parents do not prefer boys, girls receive more education in order to reach the same income level as their brothers. However, when the cost of educating a girl is greater than the cost of educating a boy, parents can decide to invest more on boys' human capital and to compensate girls with a cash transfer that makes their final incomes equal to their brothers' incomes (see also Davis and Zhang, 1995).

Behrman, Pollak and Taubman (1982) integrated the Becker and Tomes' unitary model by considering the two opposite cases of inequality adverse parents and parents who care only about the efficiency of their investment. Only under the assumption of inequality adverse parents we do not find gender bias, while in the "efficiency" case parents tend to invest more on high-returns children[10].

The results of these unitary models are not completely satisfactory because with an unique utility function it is not possible to consider cases in which mother and father have different preferences and different decision powers. In his survey, Doss (1996) reported a strong evidence against common preference models.

In the model presented here, fathers and mothers are considered separately, to allow for differences in preferences. Let's consider a household composed by a father-husband (m = male), a mother-wife (f = female) and two children, a boy (b) and a girl (g)[11].
Individuals live three periods: in the first period they are children and they live with their parents that invest in their education; children's consumption is set equal to zero. In the second period, people get married and have children; in this period they decide the level of consumption, labour supply, and investment in children education. In the third period, individuals are old and they do not work, but they survive thanks to savings and to the transfers they receive from their children (in most of the poor countries there are no pensions).

Following McElroy and Horney (1981) and Lundberg and Pollak (1993), there are two types of goods:

1. private goods, consumed by individuals in the second and third period of their life;
2. public goods for the couple, consumed only within the family that, in our case, is the level of children's education.

[10] Behrman (1988) applied the model to gender bias to food distribution an Indian rural village and he found that preference for males is the result of an efficiency strategy of investment, especially during famine periods.

[11] The case of polygamy is not considered as in Smith (1994) and Appleton (1996).

Parents have egoistic preferences that depend on private and public goods[12]. The intertemporal utility function is assumed additive separable in the two periods of adulthood[13], twice continuously differentiable and strictly quasi-concave, and therefore:

$$U^m = U_1^m(c_1^m, x_1^b, x_1^g) + U_2^m(c_2^m) \quad \text{and} \quad U^f = U_1^f(c_1^f, x_1^b, x_1^g) + U_2^f(c_2^f)$$

where c_t^i is the consumption of market goods for parent *i* in period *t*, x_1^j is the investment in child *j*'s education (*j* = *b* ,*g*) expressed in years, p_t^i is the price of private goods in period *t*[14] and p_1^j is the cost of one year of schooling.

The labour supply is assumed inelastic and equal to one. Parent's income is given by the sum of non-labour income I^i and labour income $\overline{w}^i(1+\eta^j \overline{x}_0^i)$, where $\overline{w}^i$ is the wage of the non-educated worker, $\overline{x}_0^i$ is the level of *i*'s education and η^j is the rate of return to education. If there are no discriminations in the labour market, $\overline{w}^i$ and η^j are equal for men and women.

Parents make decisions about investment in children education conditional on the following set of assumptions:

1. the cost of one year of education (p_1^j) may be different for boys and girls (usually the opportunity cost of girls education is higher[15]);
2. returns to education $\eta^j \in [0,1]$, may be different for girls and boys because of discriminations in the labour market[16];
3. there exists a "social norm" according to which every adult gives a fraction $\lambda^j \in [0,1]$ of her income to her old parents[17]. The value of λ^j is, in general, different for men and women[18].

Since household decisions concern present consumption, future consumption and investment, it is necessary to make some assumptions about expectations. I assume static expectations and therefore λ^i , η^j , $\overline{w}^i$ e I^i are constant over time and across generations

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[12] A good is defined "private" if the consumption by one individual excludes consumption by other individuals; the opposite is true for a public good. Given two private goods c_1 and c_2, consumed exclusively by individual *1* and by individual *2* respectively, and a public good *x*, we can have: egoistic preferences when individual's utility function depends on the quantity of private and public good consumed and therefore $U_i(c_i, x)$ for *i = 1, 2* ; caring preferences when individual's utility function depends also on the level of utility reached by the other individual and therefore $W_i = (U_i(c_i, x), U_j(c_j, x))$; altruistic preferences when all goods are public and therefore $U_i(c_i, c_j, x)$. In the model preferences must therefore be considered egoistic.

[13] In fact in period zero, childhood, individuals do not consume.

[14] The prices of consumption goods for *m* and *f* are supposed different because spouses can consume different private goods. In fact, Patton (1993) found that in Ivory Coast women spend less money than men on "adult goods" such as alcohol, cigarettes and food outside home, and more money on food, domestic goods and goods for children.

[15] See Gertler and Glewwe (1992) for rural Peru and Pitt and Rosenzweig (1990) for Indonesia.

[16] Kingdom (1998) found that in Uttar Pradesh returns to women's education are 45% lower than returns to men's education. Rosenzweig and Schultz (1982) explained male-female differences in child survival rates in rural India as a consequence of the different expected returns to labour that affect parental investment in sons and daughters.

[17] The value of λ^j can be made endogenous if we assume altruism toward parents.

[18] Rosenzweig and Schultz (1982) and Garg and Morduch (1998).

and hence we have $\lambda^i = \lambda^j$, $\eta^i = \eta^j$ and $\overline{w}^i = \overline{w}^j$ for $i = m$ and $j = b$, and for $i = f$ and $j = g$ respectively.

In the non-cooperative solution each parent chooses the level of her own contribution to each child education given the spouse's contributions, *i.e. m* pays $x_{1,m}^b$ years of boy schooling and $x_{1,m}^g$ years of girl schooling. The choice of these contributions is done simultaneously to the choice of c_1^m e c_2^m in order to maximise *m*'s utility function subject to the budget constraint and to spouse (*f*) contributions to children education $\overline{x}_{1,f}^b$ and $\overline{x}_{1,f}^g$, that *m* considers as given. The Cournot-Nash equilibrium is given by the two couples of parents' contributions to children education $(x_{1,i}^{b\,*}, x_{1,i}^{g\,*})$, where *i*= *m, f.*

m's maximisation problem can be written as:

$$\max_{c_1^m, c_2^m, x_{1,m}^b, x_{1,m}^g} U^m = U_1^m[c_1^m, (x_{1,m}^b + \overline{x}_{1,f}^b), (x_{1,m}^g + \overline{x}_{1,f}^g)] + U_2^m[c_2^m]$$

subject to:

$$p_1^m c_1^m + p_2^m (1+r)^{-1} c_2^m + p_1^b x_{1,m}^b + p_1^g x_{1,m}^g = (1-\lambda^b)[\overline{w}^m (1+\eta^b \overline{x}_0^m) + I^m] +$$
$$+ (1+r)^{-1} \frac{1}{2} \{\lambda^b [\overline{w}^m (1+\eta^b x_1^b) + I^b] + \lambda^g [\overline{w}^f (1+\eta^g x_1^g) + I^g]\}$$

where $x_1^j = x_{1,m}^j + \overline{x}_{1,f}^j$ and *r* is the real interest rate.

The sum of *m*'s private consumption in the two periods plus the amounts devoted to children education must be equal to the sum of *m*'s income (less the transfer made by *m* to his old parents) and the transfer that *m* will receive in his old age from his adult children, assuming that parents divide equally the resources received from their children. *r* is used to actualise future values. If there are not liquidity constraints the present value of consumption is equal to the present value of incomes.

The demand functions for $x_{1,m}^b$ and $x_{1,m}^g$ are conditioned to the value of $\overline{x}_{1,f}^b$ and $\overline{x}_{1,f}^g$ chosen by *f* and therefore they must be considered as reaction functions. Since $x_{1,m}^b$ and $x_{1,m}^g$ can not be negative, *m*'s best reply functions are given by:

$$B(x_{1,m}^b) = \max\left\{\hat{x}_{1,m}^b (\overline{x}_{1,f}^b, \overline{x}_{1,f}^g, p_t^m, p_t^j, \lambda^j, \overline{w}^j, \eta^j, \overline{x}_0^m, I^m, I^j, r), 0\right\}$$
$$B(x_{1,m}^g) = \max\left\{\hat{x}_{1,m}^g (\overline{x}_{1,f}^b, \overline{x}_{1,f}^g, p_t^m, p_t^j, \lambda^j, \overline{w}^j, \eta^j, \overline{x}_0^m, I^m, I^j, r), 0\right\}$$

where $j = b$ and g and $t = 1, 2$

If *f* chooses a level of contribution to *j*'s education that guarantees what *m* considers a "sufficient" education, *m*'s contribution will be zero in Nash equilibrium with common consistent beliefs.

In the same way we can analyse *f*'s maximisation problem in order to find *f*'s best reply functions to *m*'s choice.

Let's we assume log-linear utility functions:

$$U^m = \alpha \ln c_1^m + \beta \ln c_2^m + \delta \ln(x_{1,m}^b + x_{1,f}^b) + \varepsilon \ln(x_{1,m}^g + x_{1,f}^g)$$

$$U^f = a\ln c_1^f + b\ln c_2^f + d\ln(x_{1,m}^b + x_{1,f}^b) + e\ln(x_{1,m}^g + x_{1,f}^g)$$

where α, β, δ, ε, a, b, d and e are all positive parameters. For reasonable values of the parameters, the best reply functions have the following slopes:

$$\frac{\partial x_{1,i}^b}{\partial x_{1,k}^b} < 0 \qquad \frac{\partial x_{1,i}^b}{\partial x_{1,k}^g} > 0$$

$$\frac{\partial x_{1,i}^g}{\partial x_{1,k}^g} < 0 \qquad \frac{\partial x_{1,i}^g}{\partial x_{1,k}^b} > 0$$

where k is i's spouse. When a parent increases her contribution to one child's schooling, the other parent augments the contribution to the other child's education.
Since preferences are concave and the budget constraint is linear i's best reply functions have a unique value for each couple of k's contributions to public goods. If both parents pay for both public goods we have an internal solution, otherwise there is a corner solution.

The Cournot-Nash equilibrium is given by the simultaneous solution of the four best reply functions. The equilibrium values for the private consumption in the two periods depend also on $\bar{x}_{1,k}^b$ and $\bar{x}_{1,k}^g$ and can be calculated after we obtain the equilibrium level of m's and f's contributions to public goods. The demand functions for consumption and children's schooling do not depend only on individual's income and prices, but also on spouse's income that conditions her contribution to public goods.

Bergstrom *et al.* (1986) showed that, in a bargaining model with public goods, best reply functions are continuous in a compact and convex set and, as a consequence, we can use the Brower Fixed Point Theorem to show that a Nash equilibrium exists. Moreover, if the public good is normal, we find a unique equilibrium. Warr (1983) showed that, in a voluntary Nash equilibrium[19] with a single public good, income redistribution among contributors that leave total income unchanged does not modify the amount of public good purchased and therefore there is income pooling, as in a unitary model. However, when there are more than one public goods, changes in individuals' incomes can modify both the single individual's contributions and the total amount of contributions because some of the contributors may stop to pay for one of the public goods. As a consequence we do not find income pooling. These results are obtained under the assumption of egoistic preferences. If individuals have caring preferences these results are true only for particular functional forms of the utility functions (see Bergstrom *et al.*, 1986).

When we obtain the equilibrium values for c_1^i , c_2^i , $x_{1,i}^b$ and $x_{1,i}^g$ we can substitute them in the i's utility function in order to find the value of the indirect utility V^i for the non-cooperative solution. This is used in the next chapter to define the threat points in the cooperative bargaining model.

[19] We have a voluntary Nash equilibrium when the contribution to public good is not compulsory.

4. *A cooperative bargaining model for gender bias in investment in education*

The model here presented follows Lundberg and Pollak (1993) approach: using a cooperative bargaining model a couple decides how to allocate resources between the consumption of private and public goods. Spouses' cooperation is based on a threat of non-cooperation and the indirect utilities corresponding to these threat points are given by V^m and V^f obtained in the previous paragraph[20].

The Nash bargaining problem consists in the maximisation of the product of each player's cooperation gain, measured by the difference between the level of utility reached by cooperating and the level of utility obtained in case of non-cooperation (threat point), and it can be written as:

$$\max \mathrm{N} = [U_1^m(c_1^m, x_1^b, x_1^g) + U_2^m(c_2^m) - V^m][U_1^f(c_1^f, x_1^b, x_1^g) + U_2^f(c_2^f) - V^f]$$

subject to the household's budget constraint

$$\begin{aligned} & p_1^m c_1^m + p_1^f c_1^f + p_2^m (1+r)^{-1} c_2^m + p_2^f (1+r)^{-1} c_2^f + p_1^b x_1^b + p_1^g x_1^g = \\ & = (1-\lambda^b)\{[\overline{w}^m (1+\eta^b \overline{x}_0^m)] + I^m\} + (1-\lambda^g)\{[\overline{w}^f (1+\eta^g \overline{x}_0^f)] + I^f\} + \\ & + (1+r)^{-1}\{\lambda^b[\overline{w}^m (1+\eta^b x_1^b) + I^b] + \lambda^g[\overline{w}^f (1+\eta^g x_1^g) + I^g]\} \end{aligned}$$

The actualised sum of parents' consumption plus the total expenses for children education must be equal to the present value of household's resources. These are given by parents' incomes in period 1 plus the sum of the transfers that parents receive in period 2 from their adult children.

If there are not liquidity constraints and *r=0* (for simplicity), the first order conditions for to $x_{1,i}^b$ and $x_{1,i}^g$ are given by:

$$\frac{\partial U_1^m}{\partial x_1^b}(U_1^f + U_2^f - V^f) + \frac{\partial U_1^f}{\partial x_1^b}(U_1^m + U_2^m - V^m) - \upsilon[p_1^b - \lambda^b \overline{w}^m \eta^b] = 0 \qquad (1)$$

$$\frac{\partial U_1^m}{\partial x_1^g}(U_1^f + U_2^f - V^f) + \frac{\partial U_1^f}{\partial x_1^g}(U_1^m + U_2^m - V^m) - \upsilon[p_1^g - \lambda^g \overline{w}^f \eta^g] = 0 \qquad (2)$$

where υ is the Lagrangian multiplier. These conditions are both sufficient and necessary because we assumed strictly quasi-concave utility functions.

When we solve the full set of first order conditions, we obtain the optimal level of consumption for both private and public goods. As in the non-cooperative equilibrium, there is not income pooling and father's and mother's incomes enter separately in the demand functions.

If we assume again log-linear utility functions, conditions (1) and (2) become:

[20] Most of the bargaining models (Manser and Brown, 1980; McElroy and Horney, 1981; McElroy, 1990) use as threat points the indirect utility that each spouse can obtain outside the marriage. This threat seems to be too "strong" in day-to-day marriage and therefore Lundberg and Pollak (1993) proposed to use the non-cooperative outcomes as threat points. This Cournot-Nash equilibrium gives inefficiently low contributions to public goods.

$$\frac{\delta}{x_1^b}(U_1^f + U_2^f - V^f) + \frac{d}{x_1^b}(U_1^m + U_2^m - V^m) + \upsilon[p_1^b - \lambda^b \overline{w}^m \eta^b] = 0$$

$$\frac{\varepsilon}{x_1^g}(U_1^f + U_2^f - V^f) + \frac{e}{x_1^g}(U_1^m + U_2^m - V^m) + \upsilon[p_1^g - \lambda^g \overline{w}^f \eta^g] = 0$$

and therefore:

$$\frac{x_1^g}{x_1^b} = \frac{p_1^b - \lambda^b \overline{w}^m \eta^b}{p_1^g - \lambda^g \overline{w}^f \eta^g} \cdot \frac{\varepsilon(U_1^f + U_2^f - V^f) + e(U_1^m + U_2^m - V^m)}{\delta(U_1^f + U_2^f - V^f) + d(U_1^m + U_2^m - V^m)} \qquad (3)$$

The ratio between girl's and boy's years of education (equation 3) can be analysed by considering separately the two terms

$$\frac{p_1^b - \lambda^b \overline{w}^m \eta^b}{p_1^g - \lambda^g \overline{w}^f \eta^g} \qquad (4)$$

and

$$\frac{\varepsilon(U_1^f + U_2^f - V^f) + e(U_1^m + U_2^m - V^m)}{\delta(U_1^f + U_2^f - V^f) + d(U_1^m + U_2^m - V^m)} \qquad (5)$$

The first term (4) is the ratio between the net benefits for the parents of investing in one year of son's and daughter's education.

The second term (5) shows how preferences interact with the values of the indirect utility associated to the threat points in affecting parents' decision on children education. $(U_1^i + U_2^i - V^i)$ represents, in fact, the gain from cooperation that, *ceteris paribus*, decreases as the utility of the threat point increases. Therefore V^i can be considered as a measure of *i*'s decision power within the family.

ε, *e*, δ and *d* are the parameters representing the weights that parents' give to boy and girl education in their utility functions.

Equation (3) allows considering four different hypotheses on parents' preferences:

1. *m* and *f* have the same preferences on children's education and there is not gender bias: parents give the same weights in their utility functions to girl and boy education;
2. there is not gender bias in preferences, but the mother gives more importance to children's education;
3. the mother cares more about children's education and she has a preference for the daughter; on the contrary, the father prefers the son;
4. both parents are equally interested in children's education, and they both prefer the boy.

In the following paragraph the effects of these different assumptions on preferences are presented.

5. *Decision powers, preferences and gender bias in education*

Hypothesis 1: when parents give the same weight in their utility functions to both children's education we have $\delta = d = \varepsilon = e$ and (3) becomes:

$$\frac{x_1^g}{x_1^b} = \frac{p_1^b - \lambda^b \overline{w}^m \eta^b}{p_1^g - \lambda^g \overline{w}^f \eta^g} \qquad (6)$$

We find gender bias in education ($x_1^g < x_1^b$) only when $p_1^b - \lambda^b \overline{w}^m \eta^b < p_1^g - \lambda^g \overline{w}^f \eta^g$. In poor countries this is likely to happen because of three different facts. First, the opportunity cost of education is higher for girls than for boys because daughters help more their parents in the domestic activities, while boys start to work later in the household productive activities (Pitt *et al.*, 1990; Appelton *et al.*, 1995). Sometimes also the direct cost of educating a girl is higher because female schools are less abundant and frequently far away from house. This increases transport costs (Gould, 1993). As a consequence $p_1^b < p_1^g$.
Second, returns to education are lower for women because of discriminations in the labour market and therefore $\eta^b > \eta^g$. Echevarria and Merlo (1995) attributed this to the reproductive role of women, while Appleton (1996) showed that one of the reasons for the low level of girls education in Ivory Coast is the low expected return to female education. Women are in fact less likely than men to work in the formal sector and parents under-evaluate the positive effect of education on household activities and child rearing. Moreover, labour market discriminations determines also $\overline{w}^m > \overline{w}^f$.
Finally, the contribution to old parents' consumption (λ^j) is usually greater for males, because when a woman gets married, she leaves her family and she becomes a member of the husband's household. Therefore she contributes less than her brothers to old parents' consumption (Horton, 1988; Appleton, 1996) and we have $\lambda^b > \lambda^g$.

The joint effect of these circumstances produce gender bias in education in many LDCs. This model can be applied also to rich countries where, in most of the cases, women's education is still lower than men's education. If in developed countries the cost of educating a girl is equal to the cost of educating a boy, there are still discriminations in the labour market that make returns to female education lower than returns to male education.

Hypothesis 2: there is not gender bias in parents' preferences, but the mother cares more then the father about children's education and therefore $d > \delta$, $e > \varepsilon$, but $d = e$ and $\delta = \varepsilon$. Thomas (1990) and Patton (1993) showed in fact that mothers tend to spend a greater income share in goods for their children. As in the previous case, (3) becomes equal to (6) and we obtain the same results as before.

Hypothesis 3: the mother not only gives more importance to children's education, but she also has a preference for the daughter, while the father prefers the son. This means that $\delta > \varepsilon$ and $d < e$, but $\delta < d$ and $\varepsilon < e$. The assumption that mothers prefer girls seems confirmed by Tansel (1997) for Ivory Coast and Ghana, and by Thomas (1994) that analysed the impact of mother's and father's education on children health in United States, Brazil and Ghana. In particular, he found that an increase in mother's education (and/or income) has a greater impact on girls than on boys health conditions.

In this case equation (3) can not be simplified and we have to analyse the effects of changes in the values of the threat points.
For LDCs, if all the assumptions made in Hypothesis 1 on parameters are true, we obtain the following comparative statics results (proofs in the Appendix):

$$\frac{\partial\left(\frac{x_1^g}{x_1^b}\right)}{\partial V^f} > 0 \qquad \text{and} \qquad \frac{\partial\left(\frac{x_1^g}{x_1^b}\right)}{\partial V^m} < 0 \qquad (7)$$

Improvements in the value of mother's threat point decreases gender bias in education. On the contrary an increase in the value of father's threat point increases the difference between x_1^g and x_1^b.

Hypothesis 4: if it is true that mothers tend to favour their daughters in food distribution because healthier girls can help more in the domestic tasks (as in Thomas, 1990, and in Svedberg, 1990 and 1996), when we analyse education the opposite can be true: school reduces the time girls may spend helping their mothers and it is possible that mothers prefer keep them away from school in order to receive more help. This means that both the mother and the father want to spend an higher share of their income on boy education[21], and therefore $\delta > \varepsilon$ and $d > e$. Moreover, if both parents give the same weight in their utility function to the children of the same gender, we have that $\delta = d$ and $\varepsilon = e$. Equation (3) becomes:

$$\frac{x_1^g}{x_1^b} = \frac{p_1^b - \lambda^b \overline{w}^m \eta^b}{p_1^g - \lambda^g \overline{w}^f \eta^g} \frac{\varepsilon}{\delta}$$

and, as a consequence of the assumption made on costs and returns to boys and girls education, we obtain a greater difference between x_1^g and x_1^b. The effect of market is in fact reinforced by gender bias in parents' preferences (Kingdon, 1998).

In the model presented, the sources of gender bias in education are related not only to the different costs and returns of schooling for boys and girls, but also to the different parents' preferences and decision powers[22]. To better understand the relative importance of these different causes, I simulated the model and the results are presented in the following paragraph.

[21] Gachukia (1994b) for Africa and Dasgupta (1993) for Asia argued the existence of a parental preference for male children.

[22] The model can be extended to include an household domestic production function in which the home produced goods are made using inputs bought on the market and time devoted by *m* and *f* to domestic activities. In this way it is also possible to introduce a time constraint for parents and to obtain a general equilibrium model for household decision making that also considers labour supply decision, assumed fixed in the model presented (Pasqua, 1997).

6. *Simulation of the model and policy conclusions*

The objective of this calibration is to obtain an explicit solution for the model and to evaluate the effects of different policies. In particular it is important to examine how parents' preferences interact with market characteristics and with traditional households' attitudes to produce gender bias in education.

Calibration allows to study the behaviour of some variables in a context defined *a priori* by the choice of the values for the exogenous variables and for the parameters. Therefore it is not a statistical method, but, following Canova (1993), a "sophisticated method to do economic theory". The objective of the simulation is not to demonstrate that the theoretical model is "correct", but to better understand how the model works when the solution of the model is complex and the introduction of simplifying assumptions may compromise the realism of the model.
Calibration has been often used for economic policy purposes, in order to give quantitative answers to precise questions. The results depend obviously on the choice of the values for the parameters and for the exogenous variables. Thus this choice is usually done in order to obtain the observed values of the endogenous variables or using estimates obtained in other studies. The crucial point is, therefore, to select a set of coherent values and evaluate the results in the limited area defined by the set of parameters chosen.

In this work, the values for the exogenous variables are taken from previous studies using the World Bank Living Standard Measuring Study (LSMS) data set for Ivory Coast for the years 1985-1986. This data set contains information about household composition, earnings and consumption of almost 9,000 families in different areas of the country.

Ivory Coast, as almost all Sub-Saharan countries, has very low level of education, in particular for women: according to the survey, girls between 12 and 16 in the survey received on average 3.31 years of schooling, while boys 4.75; between 17 and 19 years girls have on average 3.53 years of education while boys 5.7 (Tansel, 1993).

In simulating the model, I assumed that female non-skilled worker wage is 96.5% of male non-skilled worker wage. I assumed that the mother has 0.47 years of schooling while the father 1.55[23] and I used the rates of return to education estimated by Schultz (1993) for Ivory Coast that are 10.9% for women and 14% for men[24]. Using these values I obtained a female labour income equal to 83.4% of the male labour income at the average levels of education, and this is consistent with the results obtained by Appleton *et al.* (1995) and Tansel (1993) for Ivory Coast. Moreover I assumed that non-labour income is less that 10% of the total income earned by the individual. The cost of educating a girl is supposed 20% higher than the cost of educating a boy, and this reflects mainly the difference in the indirect costs. Finally, I assumed that men transfer 20% of their income to their old parents, while women transfer only 10%. The values of the parameters in the parents' utility functions are chosen in order to obtain an income share spent in children education close to 5%. According to Gootaert and Kanbur (1995), in fact, expenses for

[23] These are the average education received by the parents of children between 17 and 19 years calculated by Tansel (1993) for the Ivory Coast LSMS data set.
[24] The difference between women's and men's returns to primary education are similar to those of secondary education.

children education in Ivory Coast are 5.75% of the total expenses in Abidjan, 5.4% in other urban areas, 4.5% in rural areas and only 2.5% in the poorest areas of the country.

Using these values, I calculated the investment in education (expressed in years of education) in the four different hypotheses. The results are presented both for cooperative and non-cooperative behaviour. In poor countries, in fact, often households' members do not pool their incomes and spouses have separate economic spheres (Lundber and Pollak, 1993; Smith, 1994; Doss, 1996)

Hypothesis 1: in this hypothesis parents have the same utility function and there is not gender bias in their preferences, and therefore :

$\alpha = a = 0.52$ $\beta = b = 0.42$ $\delta = d = \varepsilon = e = 0.03$

The results of the simulation are showed in table 3: in the non-cooperative case the father pays equally for both girl and boy education, while the mother, who has a lower income, pays only for the boy. Here, gender bias in education is the result of an efficient investment strategy that favours less costly and more productive children (*i.e.* boys).
In the cooperative case the demand for both public goods increases. However, also gender gap in education grows and in fact the son receives three times more schooling than the daughter. This is again the result of the efficient parents' strategy. We can finally observe that, under the cooperative behaviour, both parents reach an higher level of utility (V^m and V^m) and this means that it is "convenient" for them to cooperate.

Table 3

Simulation – Hypothesis 1

	NON COOPERATIVE	***COOPERATIVE***
Father's consumption in t=1	18.74	17.97
Father's consumption in t=2	15.13	14.52
Mother's consumption in t=1	18.74	17.97
Mother's consumption in t=2	15.13	14.52
Boy's years of education	1.56	7.20
	[0.96 (m) / 0.6 (f)]	
Girl's years of education	0.96 (*m*)	2.13
Father's indirect utility	2.677	2.708
Mother's indirect utility	2.677	2.708

Hypothesis 2 : in this hypothesis there is not gender bias in parents' preferences, but the mother cares more than the father about children and their education. Tansel (1997) argued that in Ivory Coast (and in Ghana) parents have different preferences for sons' and daughters' education. The values for the parameters in the utility functions are:

$\alpha = 0.52$	$\beta = 0.42$	$\delta = 0.03$	$\varepsilon = 0.03$
$a = 0.50$	$b = 0.40$	$d = 0.05$	$e = 0.05$

Table 4 shows the results obtained under this assumption.

Table 4

Simulation – Hypothesis 2

	NON COOPERATIVE	*COOPERATIVE*
Father's consumption in t=1	19.84	19.16
Father's consumption in t=2	16.02	15.47
Mother's consumption in t=1	17.53	16.14
Mother's consumption in t=2	14.02	12.91
Boy's years of education	2.53 (*f*)	9.44
Girl's years of education	1.02 (*m*)	2.79
Father's indirect utility	2.747	2.784
Mother's indirect utility	2.535	2.577

In both case we obtain higher level of schooling for both children compared with the results of Hypothesis 1. In the non-cooperative case the mother pays for son's education while the father pays a lower amount for the daughter's education. In the cooperative case we have a greater difference in the level of education between children in absolute value.

Hypothesis 3 : in this hypothesis the mother cares more than the father about children and she has a preference for the girl, while the father prefers the boy. The values for the parameters of the utility functions are given by:

$\alpha = 0.535$	$\beta = 0.43$	$\delta = 0.025$	$\varepsilon = 0.01$
$a = 0.52$	$b = 0.41$	$d = 0.03$	$e = 0.04$

In table 5 we can observe how the non-cooperative case produces a lower gender bias in education. The mother pays completely for girl schooling and a fraction of boy education, while the father pays only for the boy. In the cooperative case we obtain a decrease in both children's schooling with respect to previous cases. The difference in parents' decision powers, in fact, produces a resources' allocation closer to the preferences of the parent with the higher value of threat point. In this case the allocation is closer to father's preferences and we therefore have both gender bias and less years of education because father is not very interested in children education.

Table 5

Simulation – Hypothesis 3

	NON COOPERATIVE	*COOPERATIVE*
Father's consumption in t=1	19.78	19.17
Father's consumption in t=2	15.89	15.40
Mother's consumption in t=1	18.31	17.31
Mother's consumption in t=2	14.44	13.65
Boy's years of education	1.52 [1.33 (m) / 0.19 (f)]	6.58
Girl's years of education	1.25 (*f*)	1.73
Father's indirect utility	2.804	2.809
Mother's indirect utility	2.628	2.633

Hypothesis 4 : in this last hypothesis gender bias in education is increased by gender bias in parents' preferences: the mother and the father have the same utility function and they both prefer the son. The values for the parameters are:

$\alpha = a = 0.52 \qquad \beta = b = 0.42 \qquad \delta = d = 0.04 \qquad \varepsilon = e = 0.02$

In table 6 we can see that in the non-cooperative case the father (the richer parent) pays for boy education while the mother pays for girl schooling. When we consider the cooperative case, the difference between girl and boy education reaches its maximum both in absolute and in relative value because preferences bias and market factors work in the same direction.

Table 6

Simulation – Hypothesis 4

	NON COOPERATIVE	***COOPERATIVE***
Father's consumption in t=1	18.82	18.00
Father's consumption in t=2	15.20	14.54
Mother's consumption in t=1	18.74	17.93
Mother's consumption in t=2	15.14	14.49
Boy's years of education	2.09 (*m*)	9.60
Girl's years of education	0.64 (*f*)	1.42
Father's indirect utility	2.690	2.725
Mother's indirect utility	2.686	2.721

7. *Which policy to reduce gender bias in education?*

In order to reduce gender bias in education in poor countries two different types of policies are considered:

- *Cost Reduction*: policies that reduce costs (direct and/or indirect) of educating a girl, such as public investment in those services that reduce the importance of girls' work for their families (like waterworks), building more schools, even in small villages, and giving grants to parents who decide to educate their daughters. In the model this means to set the cost of one year of education equal for boy and girl ($p_1^b = p_1^g$);
- *Return Increase*: policies that increase returns to women's schooling, by eliminating gender discriminations in the labour market. In the model this means to set both the unskilled worker wage and the returns to education equal for men and women ($\overline{w}^m = \overline{w}^f$ and $\eta^b = \eta^g$).

The simulation allows to evaluate which policy is the more effective in the context identified by the assumptions made. Each policy is simulated at the beginning separately and after jointly for the four different hypotheses on parents' preferences.

Hypothesis 1: as we can see in table 7, reducing costs is more effective than increasing returns to women's education if parents behave cooperatively. However, even when both costs and returns are the same for boys and girls, gender bias in education remains because of the different transfer that men and women make to their old parents. This can be considered the effect of traditional values and gender roles.

Table 7

Simulation of policies– Hypothesis 1

TYPE OF POLICY		NON COOPERATIVE	COOPERATIVE
Costs' reduction	Δ in boy education	+ 0.02	-
	Δ in girl education	+ 0.02	+ 0.47
Returns' increase	Δ in boy education	+ 0.03	+ 0.15
	Δ in girl education	+ 0.07	+ 0.29
Both	Δ in boy education	+ 0.03	+ 0.15
	Δ in girl education	+ 0.27	+ 0.92

Hypothesis 2: when the mother prefers to invest more in children's education and there is not gender bias in preferences, the level of schooling of the girl increases more when we introduce costs' reducing policies (table 8). An higher level of both children schooling can be obtained by increasing female returns to education. In fact, if mother's labour income increases, her bargaining power increases too and investment in children's education reflects more her preferences.

Table 8

Simulation of policies– Hypothesis 2

TYPE OF POLICY		NON COOPERATIVE	COOPERATIVE
Costs' reduction	Δ in boy education	-	-
	Δ in girl education	+ 0.19	+ 0.63
Returns' increase	Δ in boy education	+ 0.10	+ 0.24
	Δ in girl education	+ 0.05	+ 0.40
Both	Δ in boy education	+ 0.10	+ 0.24
	Δ in girl education	+ 0.26	+ 1.23

Hypothesis 3: also in this case costs' reduction is more effective than returns' increase in augmenting investment in girls education (table 9). In the non-cooperative case, when both policies are introduced at the same time, the girl receives even more education than the boy, because the increase in returns to women's education augments also the mother's bargaining power and, under this assumption, mother has a preference for the daughter.

Table 9

Simulation of policies– Hypothesis 3

TYPE OF POLICY		NON COOPERATIVE	COOPERATIVE
Costs' reduction	Δ in boy education	-	-
	Δ in girl education	+ 0.24	+ 0.39
Returns' increase	Δ in boy education	+ 0.06	+ 0.14
	Δ in girl education	+ 0.11	+ 0.26
Both	Δ in boy education	+ 0.06	+ 0.14
	Δ in girl education	+ 0.38	+ 0.77

Hypothesis 4: when we have gender bias in parents' preferences, policies have a very limited effect on girls education (see table 10). Policy interventions can in fact do very little when gender bias is the result of practice and social values that want women linked to a traditional role within the household. However, the simulation does not considers long terms effects; increasing today girls education may generate positive effects on next generations, because better educated women want better educated children, and in particular are more willing to educate their daughters.

Policies measures can slowly modify the traditional role of women in poor countries and give them a new power in economic, social and political life. This is not only fair, but it is a guarantee for a sustainable development.

Table 10

Simulation of policies– Hypothesis 4

TYPE OF POLICY		NON COOPERATIVE	COOPERATIVE
Costs' reduction	Δ in boy education	-	-
	Δ in girl education	+ 0.12	+ 0.32
Returns' increase	Δ in boy education	+ 0.04	+ 0.20
	Δ in girl education	+ 0.04	+ 0.20
Both	Δ in boy education	+ 0.04	+ 0.20
	Δ in girl education	+ 0.18	+ 0.61

Conclusions

In almost all poor countries children go to school only for few years because of their important role in helping parents both in the domestic and in the productive activities. Moreover, the *Human Development Reports* show that gender bias in education persists in many poor countries, especially in South Asia and in Sub-Saharan Africa.
What policy can be accomplished to increase investment in girls education?

In order to answer this question we need to consider those factors affecting parents' decision on children education. In paragraph 4 and 5 a bargaining model for household decision-making has been developed. In this model children education depends not only on costs and returns to schooling, but also on parents' preferences and decision powers, different for mothers and fathers.

Therefore, it becomes important to analyse how different hypotheses on parents' preferences interact with market factors in causing gender bias in education. Market factors determine both direct and indirect costs of children schooling and returns to education, that are not always equal for men and women.
Gender bias in education is, hence, the result of a household investment strategy that tends to devote more resources to the less expensive and more productive child (usually the boy). Moreover, the traditional women role and parents' preference for sons may contribute to increase the difference in the level of education between boys and girls.

According to the simulation of the model, introducing policies for reducing the costs of girls education is more effective in increasing female education than augmenting

returns to female schooling. However very little can be done in the short run when traditional social values are strong and parents have a preference for boys.

The importance of reducing gender bias in education in poor countries has been recognised from the UN Beijing Conference in 1995: better educated women have more access to economic resources, can earn higher wages, are more productive in domestic activities and child care, and tend to have less children. As a consequence, investing in women's education have high social returns in terms of fertility reduction, better children health conditions and more equal distribution of resources within the family. Unfortunately, the lack of public resources in many LDCs do not allow governments to invest in education as it is necessary to reach the objectives of universal primary education (objective that UNESCO targeted for the year 2000) and gender bias reduction.

Appendix

In this appendix the proof of result (5) is presented. Let's consider equation (3)

$$\frac{x_1^g}{x_1^b} = \frac{p_1^b - \lambda^b \overline{w}^m \eta^b}{p_1^g - \lambda^g \overline{w}^f \eta^g} \frac{\varepsilon(U_1^f + U_2^f - V^f) + e(U_1^m + U_2^m - V^m)}{\delta(U_1^f + U_2^f - V^f) + d(U_1^m + U_2^m - V^m)}$$

If we want to calculate the effect of a change in mother's threat point on the ratio between years of girl and boy education, we must calculate the partial derivative of x_1^g / x_1^b with respect to V^f that is equal to:

$$\frac{\partial\left(\frac{x_1^g}{x_1^b}\right)}{\partial V^f} = \frac{p_1^b - \lambda^b \overline{w}^m \eta^b}{p_1^g - \lambda^g \overline{w}^f \eta^g} \frac{(\delta e - \varepsilon d)(U_1^m + U_2^m - V^m)}{[\delta(U_1^f + U_2^f - V^f) + d(U_1^m + U_2^m - V^m)]^2}$$

The first fraction is constant and its value is between 0 and 1. The second fraction has always a positive denominator. Also $(U_1^m + U_2^m - V^m)$ is positive, because it is *m*'s gain from cooperating with *f*. The sign of the partial derivative therefore depends on the sign of $(\delta e - \varepsilon d)$ that, in hypothesis 3, is positive and therefore:

$$\frac{\partial\left(\frac{x_1^g}{x_1^b}\right)}{\partial V^f} > 0$$

In the same way, we have that:

$$\frac{\partial\left(\frac{x_1^g}{x_1^b}\right)}{\partial V^m} = \frac{p_1^b - \lambda^b \overline{w}^m \eta^b}{p_1^g - \lambda^g \overline{w}^f \eta^g} \frac{(\varepsilon d - \delta e)(U_1^f + U_2^f - V^f)}{[\delta(U_1^f + U_2^f - V^f) + d(U_1^m + U_2^m - V^m)]^2}$$

As before the sign of the partial derivative depends only on the sign of $(\varepsilon d - \delta e)$. Given the assumption on parents' preferences, this expression has a negative value and therefore:

$$\frac{\partial\left(\frac{x_1^g}{x_1^b}\right)}{\partial V^m} < 0 \qquad (11)$$

When mother gives more weight than father to children education and both parents have a preference for the boy, the sign of the two partial derivatives depends on the value of the parameters.

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