Student Paper

Young Lives
An International Study of Childhood Poverty

Gender Bias in the Allocation of Education Expenditure: Evidence from Andhra Pradesh, India

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Thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Economics for Development at the Oxford Department of International Development (ODID), University of Oxford, UK.

The data used come from Young Lives, a longitudinal study of childhood poverty that is tracking the lives of 12,000 children in Ethiopia, India (Andhra Pradesh), Peru and Vietnam over a 15-year period. **www.younglives.org.uk**

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ABSTRACT
This study examines the existence and extent of gender bias favouring boys in the allocation of education expenditure in households using data from Andhra Pradesh in India collected by the Young Lives study in 2009/10. It attempts to identify the changing degree of gender bias with age. The estimation uses Engle curve demand analysis and a hurdle model, which separately considers gender bias in the decision of whether to incur education expenditure and the expenditure level conditional on investing in education. The study finds gender bias in school enrolment among children aged ten upward. In terms of expenditure, evidence of a pro-male bias is found in the decision of whether to invest in education and the level of expenditure on school fees and extra tuition. It is found that the degree of gender bias increases with age. The study also examines the existence of gender bias within households by incorporating household fixed effects and finds that there is significant gender bias in the intra-household allocation of education expenditure. Gender bias is also found to manifest itself via differential school choice with the probability of being enrolled in private schools being significantly higher for boys than for girls at all ages.

1. INTRODUCTION

India has historically been characterised by a high level of inequality; despite rapid economic growth in the past two decades, stark inequalities remain. Unequal sharing in the benefits of progress has resulted in women remaining disadvantaged.

This study explores the extant level of gender bias in investment in education using data collected in 2009-10 for the Indian state of Andhra Pradesh from the Young Lives (YL) study. A comparison of the priority given to the education of males and females is made by examining the difference in the probability of school enrolment, the expenditure on education and the type of school boys and girls attend. The study aims to examine the changing degree of gender bias in education expenditure with age.

A persistent gender bias in investment in human capital is both socially and economically undesirable. From a human rights perspective gender equality is intrinsically necessary as a development goal in its own right.

Another important argument for gender equality in education is the instrumental approach drawn from the human capital theory. Under the assumption that boys and girls have a similar distribution of innate ability and those at the upper end of both distributions are more likely to receive education, gender inequality will cause less able boys than girls to be educated. Consequently, the average ability of the educated and average level of human capital is lower (Abu-Ghaida & Klasen, 2004). This may then result is a slower pace of growth (Benavot, 1989). Hill & King (1995) found a low female-male enrolment ratio to be associated with lower GDP per capita.

Further, female schooling has been found to impact welfare through externalities including a fall in fertility and child morality (Schultz, 1994, 1997; Murthi et al. 1995; Drèze & Murthi, 2001; Klasen & Abu-Ghaida, 2004), and an improvement in child health (Pal, 1999). Female disadvantage in education is then detrimental to society as a whole which makes an improvement in the level of education attained by women crucial not only in the interest of equity but also for economic and social progress.

Given that over 35% of India's population is under the age of eighteen (UNICEF, 2010), the country is faced with an opportunity to develop a large skilled labour force. Adequate investment in the human capital of its young population could accelerate the development process of the country. Delays in this regard could be harmful as the demographic advantage that the country enjoys may turn into a burden. In particular, given the benefits associated with female education, gender inequality in the accumulation of human capital may prove to be one of the chief obstacles to development. There is therefore an urgent need for the country to increase access to education and, in particular, achieve gender equality.

Public policy can function as a catalyst to improve female education. The Indian government has identified education as a priority and there have been numerous national and state level initiatives in recent years to improve the status of education (discussed in Section 2). These, along with rapid privatisation in the education sector, have led to radical shifts in schooling patterns. However, in order to execute effective policies it is crucial that there be accurate knowledge of the nature of the problem. The question addressed in this paper is important in this respect.

Kingdon (2005), Himaz (2009) and Kingdon & Azam (2011) explore gender bias in education expenditure in India, and this paper builds on that literature. However, considering the dynamic changes that the education sector has undergone in recent years it is important to re-examine the extent of gender bias in education allocation.

The study attempts to detect the existence of gender bias in education expenditure by first estimating an Engle curve and then a hurdle model, which examines gender bias in the decision of whether to invest in education and the level of education expenditure conditional on investment in education. Himaz (2009) estimates gender bias in education expenditure in a similar manner using data from Young Lives collected in 2006-07. This study uses data from the following round of the survey and can therefore help identify if there have been any changes and whether they have been desirable and satisfactory.

It is found that although there is no gender bias in enrolment at the primary school level, there is a significant difference in the probability of parents investing in education as well as the amount spent on education even from the age of five. At subsequent ages, there is pro-boy bias in enrolment and the degree of gender bias in expenditure increases with age. Since accessing formal sector labour market opportunities is generally contingent on having completed secondary schooling, gender bias at this level could imply large differences in the type of jobs that are accessible to males and females.

The next section reviews the existing literature. Section 3 provides an overview of the changes in the education sector in India. Section 4 describes the methodology used.

Section 5 introduces the data. The results are explained in Section 6. Section 7 provides a discussion of the results and the final section concludes.

2. LITERATURE REVIEW

A concern for the gross gender inequality in India and the acknowledged importance of female schooling has occasioned studies to estimate the manifestation of gender inequality in the allocation of resources towards education. Subramanian & Deaton (1991) examined gender bias in intra-household allocation by fitting Engle curves that included variables capturing the demographic composition of households. Using data from 1983 for Maharashtra, India they found evidence of a pro-boy gender bias in education expenditure only in rural households for children between the ages of 10 and 14, but none in urban households. This was surprising as the 1991 census reported a significant difference in literacy rates (86% against 52%).

Deaton (1997) stated that the Engle curve seemed to fail to detect gender bias even when it was known to exist. Kingdon (2005) attributed this to the averaging of the bias over two channels: a difference in the probability of investing in education for boys and girls and the expenditure level conditional on incurring some expenditure. If the bias persisted in only one channel, or if it exerted itself in opposite directions for the two decisions, then averaging may lead to the conclusion of no gender bias even when it exists.

Kingdon (2005) attempted to overcome this problem by estimating a hurdle or two-tiered model to separately consider bias in these two decisions. Using data for sixteen major Indian states in 1994, it was found that the basic discriminatory mechanism was differential enrolment rates, i.e. a large part of the inequality stemmed from lower levels of enrolment for girls.

The education sector changed radically over the next decade. There is an indication that the mechanism through which gender bias works is changing: rather than just differential enrolment rates, recent research has indicated that there is significant bias in terms of the expenditure incurred on education. Therefore, the question of interest is no longer simply whether girls are enrolled at schools but whether they receive the same expenditure and quality of education.

Kingdon & Azam (2011) found that in 2005 gender bias in enrolment was increasing with age. However, they also found evidence of bias in expenditure. Once households had decided to invest in education, they detected gender bias at the middle school level. However, at subsequent ages corresponding with secondary schooling they found little gender bias.

Himaz (2009) used data from 2006-07 from the Young Lives study for a sample of 11-12 year old children and derived similar results. There was a pro-boy bias in school enrolment for children in upper primary and secondary school ages. Gender bias in expenditure conditional on enrolment was detected for children aged between 10 and 14 years driven mainly by extra tuition fees, which disappeared at the secondary school level. The paper reported that a roughly equal proportion of boys and girls were sent to private school.

However, the private schooling sector has been expanding significantly in recent years. The growing demand for private schools in India can be attributed to the failure of public schools to meet the expectations of parents (Venkatanarayana, 2004). Tooley, Dixon & Gomathi (2007) found private schools to be a significant provider for the poor and to be superior on a wide range of indicators including pupil-teacher ratio, teaching activity, teacher absenteeism, and classroom and school inputs.

If there is segmentation in access or "hierarchies of access" (Ramachandran, 2002) to education girls may be enrolled in non-formal schools while boys attend government schools, or girls attend government schools and boys private schools. Recent research (Kingdon & Azam, 2011; Maitra, Pal & Sharma, 2011) has found that boys are more likely to be enrolled at fee-charging private schools. In fact, Maitra, Pal & Sharma (2011) report that the extent of gender bias in private school enrolment is double that in school enrolment in 2004-05. It is therefore important to consider differential school choice decisions as a potential source of gender bias.

3. BACKGROUND: THE INDIAN EDUCATION SECTOR

The first post-independence census of India in 1951 reported literacy rates of only 9% for females and 27% for males. Progress in this regard was slow until 1991 when the corresponding rates were 39.3% and 64.1%. However, since then there has been increased public attention on the benefits of schooling and government policies have been introduced to improve the supply side and incentivise households to enrol children in school; consequently dramatic changes have occurred. Significant efforts have been made to promote female schooling which has reduced the gender differential in literacy rates, though it remains pronounced.

The Midday Meal Scheme that provides children at the primary level a cooked meal on every school day was executed nationwide by 2003 and extended to include children in the upper primary in 3479 Educationally Backwards Blocks in 2007. As a result, enrolment rates, especially for females, rose.

Sarva Shiksha Abhiyan (Education for All), the flagship education programme, implemented in 2002, has specific provisions to boost female participation via changes in the education system as well as societal attitudes. The proportion of out of school children fell from 6.6% in 2005 to 3.5% in 2010 for children between the ages of 6 and 14 in rural India (Pratham, 2005; 2010).

Further, in recognition of education as a national priority, government investment in education has increased considerably in recent years. For instance, the state governments of the four large states of Uttar Pradesh, Bihar, Rajasthan and Andhra Pradesh nearly doubled their elementary education budget between 2006-07 and 2009-10[1] (Pratham, 2010). However, there remains an acute shortfall in terms of quality in government schools which necessitates action by the government to improve education infrastructure in India (Venkatanarayana, 2004; Muralidharan & Kremer, 2007).

One way in which the supply side has improved has been through rapid growth in the private schooling sector in recent years. Enrolment in private schools for rural children aged 6 to 14 increased from 16.3% in 2005 to 24.3% in 2010 (Pratham, 2010). Private schools are considered to be more efficient than government schools. Muralidharan & Kremer (2007) report that since private schools pay teachers around one-fifth of government schools, they are able to hire more teachers, and thereby reduce multi-grade teaching and improve pupil-teacher ratios. They found private unaided schools to have lower teacher absence, higher student attendance and better student performance.

Apart from this private schools often have English as the medium of instruction, which is associated with a 15-25% wage premium (Munshi & Rosenzweig, 2006; Chakraborty & Kapur, 2008; Azam, Chin & Prakash, 2010). Given the preference for English language skills in the labour market, systematic enrolment of boys over girls in private schools with

[1] This is significant as state governments contribute a major share of India's education budget. In the financial year 2009-10, state governments accounted for 74% of the national total education spending.

English as the language of instruction implies unequal future labour market returns to education.

The increase in private schooling, which entails payment of higher fees, reflects a conscious investment in education by households. It is therefore informative to consider differential school choice as a possible channel through which gender bias persists.

4. EMPIRICAL STRATEGY AND SPECIFICATION

This paper employs a strategy similar to that used by Kingdon (2005), Himaz (2009) and Kingdon & Azam (2011). It first utilises household level data and then uses individual expenditure data to examine gender bias by estimating an Engle curve and a hurdle model. It then proceeds to estimate a household fixed effects model to account for household unobserved heterogeneity. Finally, it explores differential school choice as a source of gender bias.

4.1 Household data

4.1.1 Engle curve

The Young Lives dataset provides information on the total expenditure on education by households but is not disaggregated to the amount spent on each child. In the absence of individual level data differences in education expenditure are often estimated indirectly by an Engle curve incorporating variables that capture household demographic composition. Rather than including a single gender dummy variable, gender bias is detected at different ages through the difference in the expenditure share of education based on the presence of individuals of similar ages but different sexes in a household.

The Engle curve is estimated by OLS using the Working-Lesser Engle form for demand analysis which assumes a linear relationship between the budget share a good (education in this case) and the natural log of per capita expenditure.

The following equation is estimated:

$$w_{jg} = \alpha + \beta \ln\left(\frac{X_{jg}}{n_{jg}}\right) + \delta \ln\left(n_{jg}\right) + \left[\sum_{k=1}^{K-1} \theta_k \left(\frac{n_{kjg}}{n_{jg}}\right)\right] + \gamma z_{jg} + x_g + u_{jg} \ldots (1)$$

where w_{jg} is the share of the household budget devoted to the good under consideration (education) by household j in sentinel site g calculated as pq_{jg}/X_{jg}, with p and q denoting the price and quantity of the good and X_{jg} total household expenditure; n_{jg} is the household size and n_{kjg} is the number of members in the age-sex category k in household j; z_{jg} is a vector of other household characteristics that determine educational expenditure such as caste, years of formal education attained by parents and location; x_g is an unobserved cluster effect, and u_{jg} is the stochastic error term such that $v_{ig} = x_g + u_{ig}$ is the composite error term. The standard errors are clustered at the sentinel site level.

The variables denoting the household demographic composition express the proportion of household members in the various age-sex categories. The age-sex categories considered are for ages 0-4, 5-9, 10-14, 15-19, 20-24, 25-54 and 55 onward. Since these add to unity and inclusion of all results in perfect collinearity, the proportion of females over 55 years is excluded which acts as a base group and the remaining thirteen groups are considered.

The ages between five and nineteen are the main schooling years where gender bias is explored. The limits at which the groups are divided typically correspond to particular stages of education and are therefore of significance. Children are officially to be enrolled in school at the age of six (though this is not strictly enforced). The 5 to 9 age group roughly corresponds to children in primary education, 10 to14 to those in upper primary, and 15 to 19 to secondary school. There are key examinations (national or state level board exams) at grades ten and twelve during secondary schooling.

Gender bias in the allocation of education expenditure is estimated by conducting an F-test to check for the equality of the coefficients for the groups corresponding to males and females for each age category. It therefore tests $\theta_{mk} = \theta_{fk}$ where m and f represent the variables for males and females in the age group k.

4.1.2 Hurdle Model

The Engle curve is fitted on all households in the dataset regardless of whether they incur any education expenditure. A hurdle model unpacks the gender bias from two stages, i.e. it examines gender bias stemming from the decision of whether to invest in education and the expenditure incurred conditional on positive education spending. This allows the processes that determine whether any education expenditure is incurred and the level of expenditure conditional on its being positive to affect the dependent variable differently (Wooldridge, 2002).

The following equations are estimated:

$$P(w_{jg} = 0|a) = 1 - \Phi(a\delta) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$\ln(w_{jg})\,|(a, w_{jg} > 0) = \lambda x_{jg} + c_g + u_{ig} \ldots\ldots\ldots (3)$$

where w_{jg} is the budget share of education, a is a vector of explanatory variables consisting those considered in the Engle curve estimation, δ and λ are parameters to be estimated, and $v_{ig} = c_g + u_{ig}$ is the composite error term.

The first equation is the hurdle or first tier which estimates the probability of education expenditure share being positive. This is done by estimating a probit for whether education expenditure is incurred (w>0 versus w=0) as a binary response. It examines whether households differentiate between boys and girls in choosing whether to invest in education.

The second equation is estimated for those observations that cross the hurdle i.e. for that subsample that has positive w_{jg}. The OLS of the natural log of expenditure share on education is estimated using the previously considered explanatory variables.

Gender bias in the two decisions-- whether to invest in education and the level of expenditure conditional on positive expenditure-- is evaluated as in the Engle curve case, via an F-test for the equality of the coefficients for the demographic variables of age-sex groups for individuals of opposite sexes in similar ages[2].

4.2 Individual level data

Young Lives data do not provide information on total education expenditure on each child. However data are available on the amount incurred on school fees and extra tuition for the index child and his/her siblings between the ages of five and eighteen. Data are also available on school enrolment and the type of school that enrolled children attend.

Individual level analysis allows for the examination of gender bias in education expenditure by considering expenditure for each child in the household rather than inferring it based on total expenditure and household composition. It is more sensitive to detecting bias since aggregation may make it difficult to identify gender differences in education spending. For instance, Kingdon & Azam (2011) found a pro-male bias among

[2] Kingdon & Azam (2011) estimate the combined marginal effects over the two mechanisms in maximum likelihood, which is not done in the current study due to time and programming constraints.

children aged 10 to 14 in only four states using household data but in thirteen states with individual level data.

The individual level estimations in this study employ similar controls as household level regressions, though they differ in some key respects. First, the variables that capture the household demographic composition variables are replaced by a dummy variable for gender (Male). This is the coefficient of interest and gender bias is inferred if this coefficient is significant. The specification also has age and the square of age[3] as explanatory variables in addition to the previously used control variables of household characteristics that determine education expenditure.

The model is specified as:

$$y_{ij} = \delta_o + \delta_1 \ln \frac{X_j}{n_j} + \delta_2 \ln(n_j) + \delta_3 (Male_{ij}) + \delta_4 (Age_{ij}) + \delta_5 (Age_{ij}^2) + \delta_6 \, z_g + v_j$$

where the dependent variable y_{ij} varies as explained

The first estimation using individual level data considers the school enrolment decision and is estimated using a maximum likelihood probit estimation. The factors that determine investment in education are assumed to explain enrolment decisions in the household.

The study then considers a gender differential in the amount spent on school fees and extra tuition, which reflects conscious investment by households in the enrichment of children's human capital. The equation for unconditional expenditure (analogous to the Engle curve in the household level estimation) has the total expenditure on fees and extra tuition as the dependent variable instead of its proportion in total expenditure.

In the case of the hurdle model, the first stage probit uses a binary dependent variable for whether there is any expenditure. The second stage, conditional expenditure, has the natural log of the expenditure on fees and extra tuition as the dependent variable.

The regressions are then estimated using the same model for subsamples consisting of children in the three relevant age groups separately to examine the changing nature of gender bias at the different levels of schooling.

[3] This allows for a non-linear relationship between education expenditure and age.

4.3 Household Fixed Effects

It is possible that household-specific unobservable factors that determine education spending are correlated with the explanatory variables. Failure to control for these variables would result in omitted variable bias. For instance, Jensen (2002) argued that in the absence of any explicit bias in households there could be inequalities in outcomes due to "son preferring, differential stopping behaviour" where parents continue having children until they have a son (or the desired number of sons). Consequently girls, on average, have more siblings and belong to larger families and, for a given household income, the per capita income and expenditure would be lower for girls. This would bias the estimates upwards. Similarly, Subramaiam (1996) argued that the extent of gender bias may be overestimated as households with more girls could be poorer and adjust expenditure accordingly. The correlation of the household gender structure with an omitted wealth effect could result in biased and inconsistent estimates.

An effective way to control for unobserved household variables is through household fixed effects estimation which permits the examination of the difference in education expenditure on males and females within a household and generates consistent estimates in the presence of substantial unobservable heterogeneity.

Although data constraints do not allow some individual-specific characteristics such as intelligence and motivation to be controlled for, Behrman and Deolalikar (1993) suggest that such unobserved factors that influence expenditure decisions vary more across households than within households and fixed effects estimation helps reduce the problem of omitted variables to some extent. However, as long as they determine investment decisions the estimates will still have some omitted variable bias.

Further, using household fixed effects aids in limiting or even eliminates selectivity bias that may arise from the education expenditure being censored at zero[4] (Pitt & Rozenweig, 1990; Behrman & Deolalikar, 1993).

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[4] The residuals can be considered to be the sum of residuals with mean zero and a term that adjusts for the truncation of the dependent variable and is proportional to the Mills ratio. When household member equations are differenced the adjustment terms vanishes and a household-specific term adjusts for the truncation (Pitt & Rozenweig, 1990).

The following model is estimated:

$$y_{ij} = \beta X_{ij} + z_j + e_{ij}$$

where y_{ij} is the dependent variable 'i' in household 'j'; X_{ij} is a vector of child-specific characteristics[5]; z_j represents observed and unobserved characteristics that are the identical for children belonging to the same household which the fixed effects model controls for; and e_{ij} is the idiosyncratic error term.

The household fixed effects estimation is conducted on a subsample of children that belong to households that have at least one child of both sexes of school-going age. To compare the fixed effects results with OLS both estimations are conducted on this subsample.

Three equations are estimated as in the previous sections. The first uses expenditure as the dependent variable; the second, a linear probability model (LPM), considers bias in the decision of whether to incur education expenditure; and the third uses expenditure for those observations that have positive expenditure. On incorporating fixed effects the study uses an LPM for the hurdle instead of probit, as done by Kingdon & Azam (2011). This is because the maximum likelihood coefficient estimates for probit using fixed effects may suffer from an incidental parameters problem due to the allowance for household-specific intercepts that may bias the estimates (Neyman & Scott, 1948; Greene, 2002, 2004).

4.4 School Choice

There are three main types of schools in India: government schools, private aided schools and private unaided schools. Private aided schools are privately managed but have little control over their fee level as they are heavily regulated and financed almost entirely by the government. On the other hand, private unaided schools are self-financed and enjoy substantial autonomy in functioning. Since private aided schools are similar to government schools for most practical purposes they have been pooled together for the sake of this study. The sample also has a few schools run by charitable trusts, non-governmental organisations and religious organisations; these are also included in the public school category as they involve similar expenditure. Therefore, when school choice in considered, the term private school refers to a fee-charging private unaided school.

[5] The fixed effects model controls for age, the square of age and gender.

A possible explanation for differences in expenditure on school fees and extra tuition could be differential school choice by households opting to send boys to fee-charging private schools and girls to free government or government-subsidised schools. The extent of gender bias in school choice is explored by a probit to examine the difference in the probability of attending a private school (conditional on enrolment) for males and females after controlling for observed household factors. The specification used includes the same controls as in the hurdle model using individual level data. However, data on school type are only available for the index child; therefore this estimation uses a smaller sample. This is then estimated on samples of children in the three age groups separately.

5. DATA

5.1 Data Description

Young Lives is a long term international research study that follows two groups of children, 2000 born in 2001-02 and 1000 born in 1994-95, to examine the changing nature of childhood poverty. Data are to be collected over 15 years for four developing countries– Ethiopia, India (for the state of Andhra Pradesh), Peru and Vietnam. Though it is a longitudinal dataset, this study uses a cross section of data from the most recent round of data collection (2009-10) for Andhra Pradesh, the fifth largest state in India.

The data follow index children aged 7 to 8 years old (younger cohort) and 14 to 15 years old (older cohort) and also contain information about their households. This study pools the two cohorts together for estimation. This is advantageous as it increases the sample size and variation in the data. Since gender bias at all school going ages is being estimated, considering both cohorts makes the data richer and may allow for more efficient estimation. The sample contains data on education spending for children aged between 5 and 18 years in the surveyed households.

The data were collected from 20 sentinel sites (mandals) that were chosen from districts such that all three chief agro-climatic regions of Andhra Pradesh were equally represented, a pro-poor bias was maintained and other criteria that met the objective of the study were satisfied. However, the households surveyed within the sites were randomly selected.

Given the size and enormous diversity of India it would be inappropriate to generalise these results to the country as a whole. Indeed these data may not be entirely representative of Andhra Pradesh.

As YL is a cohort study, given the ages of the children, the parents' ages are also likely to lie within a certain age range. This may affect household decisions regarding educational investments. In this regard it might be inappropriate to generalise the results for the entire population. However, they remain valid for the age range we observe these households in.

Since Young Lives focuses on childhood poverty, the surveyed sites belong over proportionally to poorer areas. The sites chosen also contain a balanced representation of the three regions of the state as well as urban and rural areas, which does not reflect the true population weights of the state. Kumra (2008) compares the indicators from the Demographic and Health Survey (1998/99) for Andhra Pradesh with YL Round 2 (2006) data and finds that YL caregivers are less educated than the state average but YL families possess more assets; however some of the differences found could be attributed to the time lag between the surveys.

However, the data contain exogenous sample selection i.e. selection not based on education expenditure but rather dependent on the independent variables. In such a case, provided there is sufficient variation in the independent variables in the sub-population, the OLS estimates remain unbiased and consistent. Therefore, despite the above mentioned issues, this is a good dataset for the study at hand as it contains a wide variation in demographic, social and economic variables that may affect education expenditure and will allow for a study of the factors influencing education allocation using a rich sample.

5.2 Descriptive Statistics

School enrolment rates vary with age and gender: in the primary school age group (5 to 9 years) 92.53% of males and 92.83% of females were enrolled; the corresponding rates for children in the upper primary ages (10 to 14 years) were 93.14% and 90.09%. Subsequent enrolment rates drop with 72.48% of males and 65.72% females between 15 and 18 years (secondary schooling) enrolled in school. Figure 1 compares enrolment rates for males and females.

In terms of education expenditure, 96.8% of households incur some expenditure on education. On average, 4.88% of household consumption expenditure is spent on education, with households spending a mean of rupees 2265.98 on male children and rupees 1360.09 on female children annually on fees for school and extra tuition. The average spending increases with age for both males and females; however, the extent of bias also increases as can be seen in Table 1.

There is a divergence in the amount spent on education for children attending private schools and those attending government schools, as illustrated in Figure 2. On considering the level of private school enrolment, 47.51% of male index children and 35.08% of female index children are enrolled in private schools. Figure 3 shows the difference between male and female enrolment rates in private schools for the age groups under consideration.

The average level of parents' education was 3.38 years for mothers and 5.21 years for fathers[6]. The logarithm of per capita expenditure and the log of household size have also been included as control variables[7]. The average household size for girls is 7.2 while that for boys is 7.0. Tables 2 and 3 contain summary statistics of the data used.

6. EMPIRICAL RESULTS

6.1 Household level

The key results for the household level regressions are presented in Table 4. The bottom of the table reports the difference in marginal effects (DME) between males and females for the school-going ages of interest. It is calculated as the difference between the marginal effect for the male variable and the female variable for each age group[8].

The results of the Engle curve are in Column 1. Gender bias in education expenditure is detected in the 10 to 14 as well as 15 to 19 age groups, i.e. for children that typically in upper primary and secondary school.

The hurdle model is more informative in that it sheds light on the channel through which gender bias occurs. The first stage probit (Column 2) examines bias in the household decision of whether to incur any education expenditure. It is found that gender bias is not significant until ages corresponding to secondary schooling, the 15 to 19 year age group, at which stage it is significant at the 5% level of significance.

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[6] Parents that have attained adult literacy have been put on par with primary education and imputed a value of 5 years

[7] The correlation between the log of household size and the log of per capita expenditure is weak (-0.35) and both can be used as controls without encountering collinearity problems

[8] DME=$\theta_{mk} - \theta_{fk}$ for age group k.

However, the second stage (Column 3) which represents conditional expenditure detects statistically significant bias for all age groups at the 5% level. There is bias favouring boys in education expenditure at all ages, but the extent of bias appears to reduce with age.

It is possible that girls that survive school past the primary level are a select group selected on the basis of ability, motivation or wealth, etc. It is then likely that dynamic selection causes the expenditure difference between boys and girls conditional on schooling to narrow with the duration of their survival in school.

6.2 Individual level

The results using individual level data are displayed in Table 5. Gender bias is examined via the coefficient on the male dummy variable. Since the specifications used are different from those in the household level analysis it would be inappropriate to compare the household level regressions' differences in marginal effects with the marginal effect of the male dummy variable in the individual analysis.

All estimations using individual level data were first conducted on the entire sample and then for subsamples of the three relevant age groups separately. The marginal effect of the male dummy for each age category has been listed at the bottom of Table 5 for each specification.

Column 1 contains the marginal effects of the probit for school enrolment. Males are 2.1 percentage points more likely to be enrolled in school ceretis paribus at the mean of all explanatory variables, which is significant only at the 10% level. However, the regressions for the subsamples of children in different levels of schooling are quite revealing. Though there is no gender bias in enrolment at the primary level, a pro-boy bias is found in the 10 to 14 group with boys 2.4 percentage points more likely to be enrolled. This bias increases substantially for ages 15 to 18 (secondary school) as boys are 10.1 percentage points more likely to be enrolled.

Gender bias is then estimated in the expenditure incurred on fees for school and extra tuition. Column 2 contains the results for the unconditional expenditure regression (equivalent with the Engle curve). The annual expenditure on males is rupees 805.40 greater than that for females, which is statistically significant at 1%. This is also practically large as it is 44.5% of average expenditure for the sample. Separate estimations detect bias in expenditure for all three groups under consideration at the 1% level. The extent of bias increases dramatically with age: from rupees 437.5 (24.2% of mean expenditure) at the primary school ages, to rupees 841.70 (46.5% of mean expenditure) for upper primary, and further, to rupees 1745 (96.4% of mean expenditure) at the secondary school age group.

The hurdle model results are in Columns 3 and 4. The first stage finds evidence of gender bias to the extent that households are 8.3 percentage points more likely incur education expenditure on boys[9]. On decomposition the bias in the participation decision is found to reduce with age. The probability of investing in education is 11.45 percentage points greater for boys at the primary level, 6.72 percentage points greater at the upper primary level. Gender bias at the secondary school level is not statistically significant.

The gender bias in the decision of whether to incur expenditure is understandable for the younger ages. The Right to Education Act 2009 guarantees free education for children up to the age of fourteen. The bias may therefore occur by households sending girls to receive free schooling and either investing in fee-charging private schools for boys or, if they attend a government school, enrolling them in extra tuition classes. This is supported by the finding that there is no bias in enrolment at primary school going ages, and a low level of bias at the ages corresponding to upper primary.

The conditional expenditure regression reports that expenditure on boys is 54% greater than that on girls, which is statistically significant at the 1% level. When estimated separately for the three groups there is evidence of bias favouring boys for all levels of schooling. Analogous to unconditional expenditure, the magnitude of gender bias increases with age from spending on boys being 40% more at the primary school ages, 55% more at the upper primary and 74% more at the secondary school level.

6.3 Household fixed effects

The household fixed effects model estimated addresses concerns about household specific unobserved heterogeneity. In order to compare the fixed effects results with the previous estimation, OLS is also conducted on the subsample of households that have at least one boy and one girl in the ages of interest. The results are reported in Table 6.

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[9] The binary dependent variable indicates whether expenditure is incurred on school fees or extra tuition and does not include uniforms, stationery, or transport. The household regressions include all education expenditure and to that extent are not directly comparable with the individual level analysis.

In the case of unconditional expenditure, both the OLS (Column 1) and fixed effects (Column 2) detect gender bias in education expenditure favouring males to the extent of rupeer 811 and rupees 831 respectively, both of which are statistically very significant.

While the results of the fixed effects estimation are consistent, OLS is preferred if it is consistent on account of greater efficiency properties. It is therefore important to compare the results of the household fixed effects and OLS models. This is done using the Hausman test[10] under the null hypothesis that the efficient OLS estimates are not systematically different from the consistent fixed effects estimates. The null is strongly rejected (chi-square 19.54, with p-value 0.0002), indicating that fixed effects are significant.

The results of the decision to incur education expenditure are found in Columns 3 and 4. The LPM finds that the probability of spending on fees or extra tuition is 7.25 percentage points greater for males than females. When including household fixed effects, the extent of gender bias is estimated to be lower, with the probability of incurring education expenditure on boys 5.75 percentage points greater, but the result is still statistically very significant.

In the case of conditional expenditure presented in Columns 5 and 6, OLS reports that, conditional on positive expenditure, education expenditure on boys is 54.2% greater than that on girls. On including household fixed effects the pro-boy bias finds spending on males to be 37.6% greater than that on girls. This bias is not only statistically significant at 1%, but also economically large.

Here the null hypothesis of the Hausman test is rejected at 1% (chi-square 14.98 with p-value 0.00); the OLS estimates are biased upwards. The omitted variables seem to be positively correlated with the explanatory variables so that the extent of gender bias is overestimated, for instance due to an omitted wealth effect as discussed in Section 4.3. However, even on controlling for household fixed effects, evidence of gender bias persists. This demonstrates that there is significant bias favouring boys within households in education spending.

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[10] Hausman statistic $H = (\beta_0 - \beta_1)' (Var(\beta_0) - Var(\beta_1))^{-1} (\beta_0 - \beta_1)$ follows an asymptotic chi-squared distribution (degrees of freedom = rank of $(Var(\beta_0) - Var(\beta_1))$ matrix); variances are for the covariance matrices of the parameter estimates; β_0 refers to OLS estimate and to the β_1 consistent fixed effects estimate.

This differential allocation within households could be attributed to an investment motive on the part of parents who account a lower private return to female education since they do not consider the earnings of daughters after they are married. Sons, on the other hand, are likely to live with the parents in adulthood and are perceived as an old-age security (Miller, 1981; Das 1984). It can also be explained by lower returns to education for women owing to labour market discrimination (Kingdon, 1998). There may be a host of other social or cultural reasons due to which parents treat sons differently, which is beyond the scope of this study.

6.4 School Choice

The results of the marginal effects of the probit for the school choice regressions are in Column 5 of Table 5. The bottom of the table reports the marginal effect of the gender dummy variable separately for each age category.

The probit for the sample of index children estimates a statistically significant gender bias in private school enrolment, with males 16 percentage points more likely to attend private school conditional on being enrolled in school at the mean of all variables. Conducting the estimation separately for the three age groups finds evidence of very significant pro-male bias in private school enrolment with males 16.1 percentage points more likely to be enrolled at a private school at primary school going ages and 18.9 percentage points for upper primary at the mean of all variables under consideration. The degree of bias is slightly lower for secondary school, amounting to 14.8 percentage points.

7. DISCUSSION

Despite substantial efforts, there is still a large difference in the education opportunities enjoyed by boys and girls in India. At the primary school level no gender bias is found in enrolment. It is possible that programmes such as the mid-day meal scheme have served as an incentive to enrol girls in school (Jayaraman & Simroth, 2011; Afridi, 2011).

However, a resource constrained household is still unwilling to invest in girls' education to the same extent that it is in boys'. This is evidenced by the fact that household level analysis suggests that there is bias in the level of expenditure for children at ages corresponding to primary schooling; this finding is validated by individual level analysis which detects pro-boy bias in the decision of whether to incur any expenditure as well as in the level of education spending.

In the case of children in the ages corresponding to upper primary schooling a pro-male gender bias is detected in school enrolment, the probability of incurring expenditure on education as well as the conditional amount spent on fees and extra tuition.

For secondary schooling there is a much larger gender bias favouring boys in enrolment. While individual analysis does not detect bias in the probability of incurring expenditure, there is a substantial difference in the conditional expenditure on males and females. Gender bias in enrolment and expenditure for children at the secondary schooling age is especially significant due to recent findings of increasing returns to education up to the secondary school level (Duraisamy, 2002; Agrawal, 2011). It is therefore crucial that female education be promoted at the secondary school level to enable women to command a higher wage in the labour market.

Kingdon (2005) found that the bias in education occurs via differential enrolment rates and, once the decision to enrol a child is made, there was no bias in conditional expenditure in 1994. Kingdon & Azam (2011) found that there was bias in the decision of whether to invest in education only from the age of ten in Andhra Pradesh in 2005. Further, even in the case of conditional expenditure, they did not find bias for children in secondary schooling ages.

This study considers expenditure incurred on school fees and extra tuition for individual analysis and finds that this bias exists even for children aged in the primary school going age group. This may be attributed to the proliferation of private schools that command differential expenditure and have therefore occasioned the bias to occur via differential investment in education.

The accumulation of the required knowledge and skillset to build up the level of human capital requires the schooling received by children to be of a certain minimum standard. It is therefore important not to consider equality in gross enrolment rates as a milestone in achieving gender parity in education; bias in terms of schooling expenditure reflects the lower priority given to female schooling at all ages.

For children up to the age of fourteen it seems that there is little gender bias in enrolment. However, it is crucial that policy considerations look beyond simple enrolment rates and consider the quality of education received by males and females. On considering bias in private school enrolment, boys are on average 16 percentage points more likely to be enrolled in private schools. Given the finding that girls are significantly less likely to be enrolled in private schools, it is vital that the quality of education provided by government schools be improved to aid female learning outcomes.

The Supreme Court of India passed a judgement that mandated all private schools to reserve 25% of their seats for students from disadvantaged sections under the Right to Education Act 2009. While this may play a positive role in improving the achievement level of socially disadvantaged sections, given the fact that there is a high degree of gender bias in access to quality education, such an education policy has the potential to play a key role in ensuring that girls are able to access better quality education.

8. CONCLUSION

There have been marked changes in the education sector in recent years in terms of enrolment and schooling expenditure. This study re-examines the problem of gender bias in education expenditure using 2009/10 data from the Young Lives study for the Indian state of Andhra Pradesh. It is found that there is substantial pro-boy bias in the decision to invest in education as well as the amount spent conditional on incurring expenditure. The biases in the two decisions reinforce each other. Consequently, the Engle curve, which in previous studies was weak to detect gender bias, unambiguously finds gender bias. Notably the extent of gender bias in education expenditure increases with age. In light of these findings it is essential that the promotion of female education remain a priority.

9. FIGURES AND TABLES

Figure 1: School enrolment by age and gender

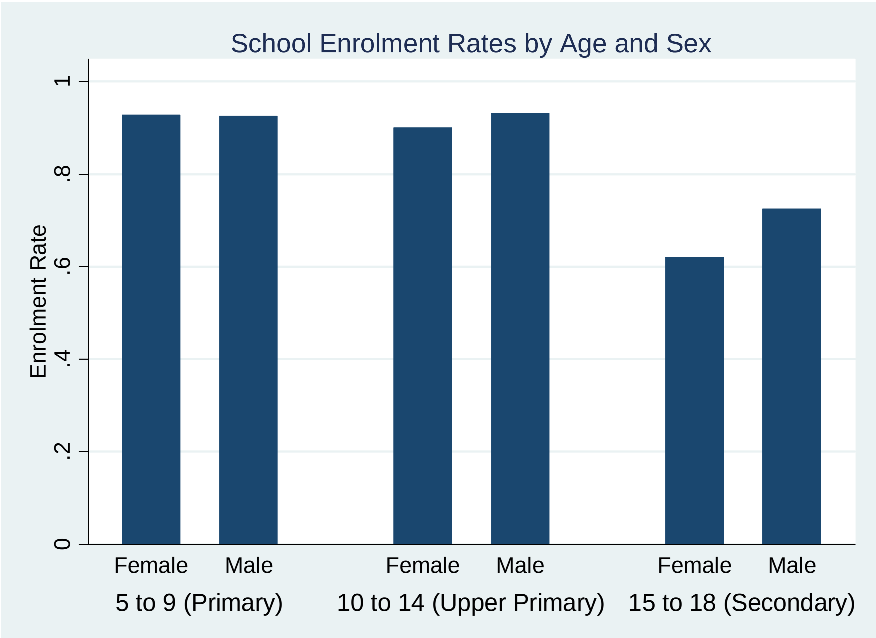

Figure 2: Expenditure on school fees and extra tuition by age, gender and school type

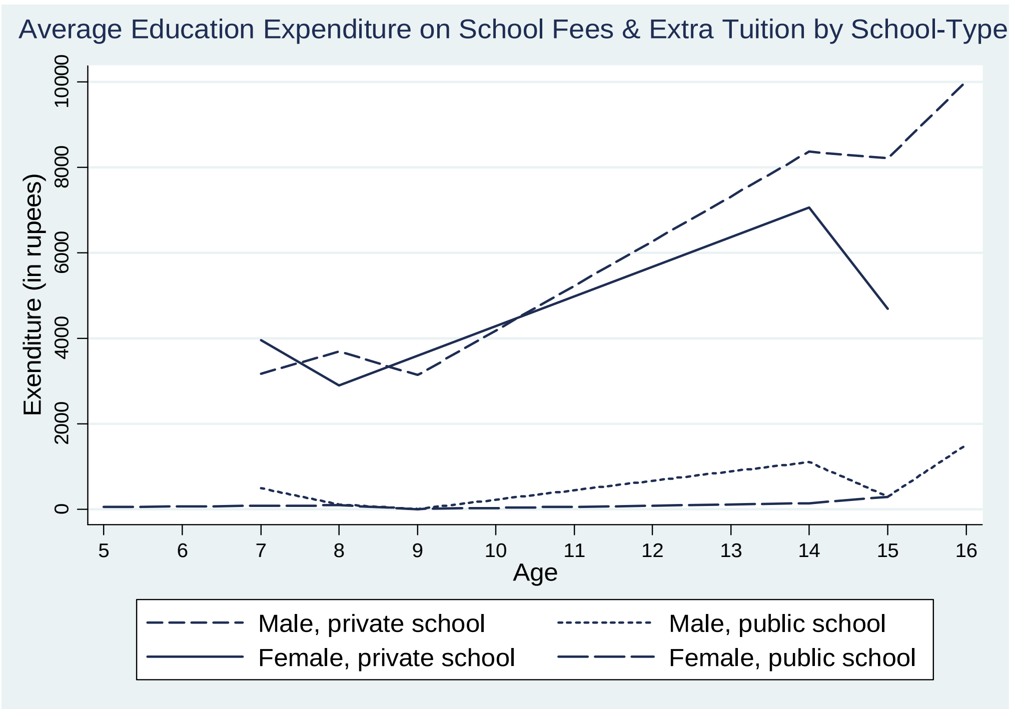

Figure 3: Private school enrolment (conditional on enrolment) by age and gender

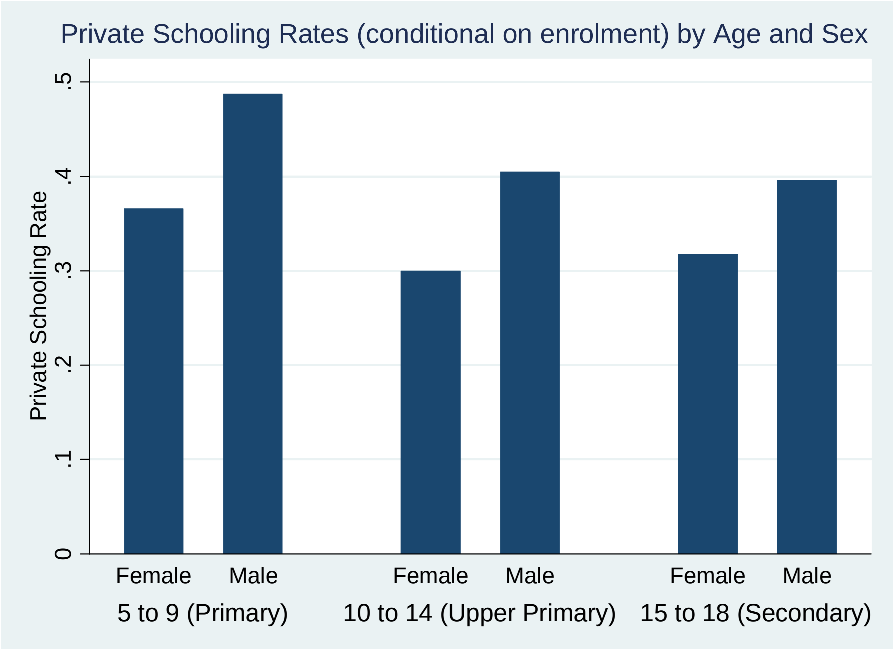

Table1: Mean expenditure on fees and extra tuition (in rupees) by age and gender

Age Group (in years)	Male	Female	Difference
5 to 9	1724.49	1164.06	560.43
10 to 14	2227.27	1305.53	921.74
15 to 18	3866.47	1952.54	1913.93

Table 2: Summary Statistics of Selected Variables (household data)

Variable	Mean	Std. Dev.
Monthly Per Capita Consumption (rupees)	1084.12	824.53
Household Size	6.61	2.91
Education Consumption Share	4.88%	0.05
Proportion Scheduled Caste	19.43%	
Proportion Scheduled Tribe	11.77%	
Proportion Backward Castes	50.45%	
Proportion Other Castes	18.35%	
Proportion in Urban Areas	25.99%	
Father's Education (in years)	5.13	4.82
Mother's Education (in years)	3.32	4.22
Total	2795	

Table 3: Summary Statistics of Selected Variables by Gender (individual data)

Variable	Male		Female	
	Mean	Std. Dev.	Mean	Std. Dev.
Monthly Per Capital Expenditure (in rupees)	1080.22	778.48	1051.43	766.39
Household Size	7.02	3.40	7.20	3.48
Enrolment rate	88.9%	0.32	85.3%	0.35
Annual expenditure on school fees and extra tuition (in rupees)	2265.98	4860.31	1360.09	3318.07

Table 4: Household level regressions

	(1)	(2)	(3)
Variables	Engle Curve	Hurdle Model	
	Education Expenditure Share	Any Expenditure	Log of Expenditure Share
Ln per capita consumption	0.000625 (0.00)	0.00728** (0.00)	-0.0569 (0.05)
Ln household size	-0.000898 (0.00)	0.00681* (0.00)	0.031 (0.07)
M0to4	-0.0183 (0.02)	-0.0427** (0.02)	-0.829 (0.55)
F0to4	-0.0218 (0.02)	-0.0436** (0.02)	-1.072** (0.50)
M5to9	0.0379** (0.02)	0.0708*** (0.02)	0.603 (0.36)
F5to9	0.015 (0.02)	0.0511*** (0.02)	-0.204 (0.38)
M10to14	0.0817*** (0.02)	0.00346 (0.02)	1.598*** (0.41)
F10to14	0.0367** (0.02)	0.0226* (0.01)	0.870** (0.37)
M15to19	0.0691*** (0.02)	-0.00722 (0.01)	1.246*** (0.38)
F15to19	0.023 (0.01)	-0.0244* (0.01)	0.524 (0.37)
M20to24	-0.014 (0.02)	-0.0450** (0.02)	-0.454 (0.58)
F20to24	0.00451 (0.02)	-0.00314 (0.01)	-0.263 (0.44)
M25to54	0.0137 (0.02)	-0.0152 (0.02)	-0.109 (0.46)
F25to54	-0.0145 (0.02)	-0.0109 (0.02)	-0.318 (0.39)

M55+	0.00856 (0.02)	-0.0231 (0.02)	-0.315 (0.49)
Scheduled Caste	-0.0116* (0.01)	-0.00165 (0.00)	-0.288** (0.13)
Scheduled Tribe	-0.0197*** (0.01)	-0.00438 (0.01)	-0.702*** (0.19)
Backward Castes	0.000123 (0.01)	-0.00523 (0.00)	0.011 (0.10)
Urban	0.0068 (0.01)	-0.00659 (0.00)	0.181 (0.11)
Mother's education in years	0.00131*** (0.00)	0.000554 (0.00)	0.0328*** (0.01)
Father's education in years	0.00147*** (0.00)	0.000941*** (0.00)	0.0401*** (0.01)
Constant	0.0214 (0.02)		-3.560*** (0.51)
Observations	2,690	2,690	2,604
R-squared	0.123		0.183
DME: 5to9	0.0229* (3.57)	0.0197* (2.81)	0.807** (6.25)
DME:10to14	0.045** (5.76)	-0.01914 (2.71)	0.728** (5.74)
DME: 15to19	0.0461*** (8.11)	0.01718** (4.75)	0.722** (4.73)

Robust standard errors in parentheses (clustered at the sentinel site); F values for DME

*** p<0.01, ** p<0.05, * p<0.1

Notes: 1. Column 1 reports results for the OLS with the expenditure share on education; Column 2 presents the marginal effects of the probit for whether any education expenditure is incurred; Column 3 has the OLS estimates for the log of education budget share on those households that incur some education expenditure.
2. M0to4 represents the proportion of household members that are male and between the ages of 0 and 4. F0to4, M5to9, etc. similarly represent the proportions in those age-sex type.
3. Dummy variables for scheduled caste, scheduled tribe, backward castes are included with other castes as the base group.
4. The differences in marginal effects (DME) reported at the bottom of the table represent the difference between the male and female coefficients for each age category.

Table 5: Individual level regressions (including private schooling)

Variable	(1)	(2)	(3)	(4)	(5)
		Engle curve	Hurdle Model		
	Enrolment	Unconditional Expenditure	Any Expenditure	Conditional Expenditure	Private Schooling
Ln per capita consumption	0.00819 (0.00996)	1,233*** (141.7)	0.137*** (0.018)	0.722*** (0.101)	0.235*** (0.0386)
Ln household size	-0.0448*** (0.0105)	210.9 (157.2)	0.0676*** (0.0227)	0.0203 (0.142)	0.111*** (0.0382)
Male	0.0210* (0.012)	805.4*** (111)	0.0832*** (0.0147)	0.545*** (0.0788)	0.160*** (0.0242)
Age	0.125*** (0.015)	-473.6** (198.5)	-0.0198 (0.0176)	-0.306*** (0.0985)	-0.0358 (0.115)
Square of age	-0.0062*** (0.00068)	29.61*** (9.933)	0.00174** (0.00077)	0.0147*** (0.00424)	0.000804 (0.00526)
Mother's education	0.00676*** (0.0016)	144.9*** (28.71)	0.0119*** (0.00352)	0.0675*** (0.0167)	0.0180*** (0.0048)
Father's education	0.00599*** (0.00134)	99.26*** (19.05)	0.00953*** (0.00273)	0.0641*** (0.012)	0.0210*** (0.00338)
Scheduled Caste	-0.019 (0.0151)	-1,027*** (265.1)	-0.075 (0.0483)	-0.975*** (0.191)	-0.215*** (0.0317)
Scheduled Tribe	-0.0404 (0.0335)	-470 (308)	-0.125 (0.0839)	-0.633** (0.225)	-0.199*** (0.0581)
Backward Castes	-0.0237 (0.0152)	-495.1 (294.2)	-0.0208 (0.0304)	-0.336* (0.171)	-0.108*** (0.036)
Urban	0.00343 (0.0143)	638.4** (234.4)	0.168*** (0.0413)	0.695*** (0.224)	0.294*** (0.067)
Constant		-6,721*** (1,157)		2.152** (1.021)	
Observations	5,911	5,130	5,911	3,162	2,453
5 to 9	-0.00918 (0.0117)	437.5*** (104.7)	0.115*** (0.0229)	0.401*** (0.13)	0.161*** (0.0289)
10 to 14	0.0238** (0.0107)	841.7*** (203.6)	0.0647*** (0.0194)	0.546*** (0.113)	0.189*** (0.0658)
15 to 18	0.101*** (0.0269)	1,745*** (319.2)	0.0462 (0.0323)	0.739*** (0.153)	0.148*** (0.041)
Robust standard errors in parentheses (clustered at the sentinel site)					
*** p<0.01, ** p<0.05, * p<0.1					
Notes: Column 1 reports marginal effects of the probit for enrolment; Column 2 reports OLS estimates for unconditional expenditure; Column 3 reports marginal effects of the probit for whether expenditure was incurred; Column 4 has OLS estimates for the log of education expenditure for children that have expenditure; Column 5 has marginal effects of the probit for private school enrolment. 2. The bottom of the table contains the marginal effects for the male dummy variable when the regression was estimated for each age group separately.					

Table 6: Household fixed effects results

Variables	(1) Without Fixed Effects	(2) Household Fixed Effects	(3) Without Fixed Effects	(4) Household Fixed Effects	(5) Without Fixed Effects	(6) Household Fixed Effects
	Engle Curve		Hurdle Model			
	Unconditional Expenditure		Any Expenditure		Conditional Expenditure (Log of Expenditure)	
Male	810.6***	831.0***	0.0725***	0.057***	0.524***	0.376***
	(107.4)	(119.0)	(0.0119)	(0.0108)	(0.0605)	(0.0526)
Age	-501.5***	-320.0**	-0.0201	-0.00448	-0.312***	-0.0924*
	(118.1)	(125.9)	(0.0123)	(0.0109)	(0.0678)	(0.0561)
Square of Age	31.38***	22.45***	0.00163***	0.0008	0.0152***	0.00842***
	(5.365)	(5.749)	(0.00056)	(0.00049)	(0.00305)	(0.00257)
Observations	4,749	4,749	5,474	5,624	2,930	2,930
R-squared	0.200	0.041	0.137	0.733	0.337	0.084
No. of Households		2,078				1,502

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: 1. The model without fixed effects controls for log of per capita expenditure, log of household size, caste, parents' education levels, and a location dummy (urban).
2. The estimation for whether there is any expenditure is made using a linear probability model.

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