Abstract

Research on educational attainments amongst other things is centered on the debate between the relative importance of school and family characteristics. Origins of this debate go far back to the Coleman Report (Coleman et.al 1966) for the United States and the Plowden Report (Peaker 1971) for Great Britain. Both these reports concluded that family characteristics were more important compared to school characteristics for educational outcomes[1]. Myriad of factors influence school participation in developing countries and an overwhelmingly vast majority of the studies, regardless of the focus of their research and their exact empirical specifications, do take into account a mix of school, household, individual-child, and community level characteristics when analyzing school participation (Hanushek 1995).

One household level factor that has been however been neglected both in the broader research on developing countries as well as a country specific study is household access to infrastructure as it relates to energy use. There are studies that include presence of electricity in school as a measure of school input and there is also, albeit limited research that examines effect of village electrification on enrollment (see Hannum 2003 on relationship between village electrification and enrollment in China). However, there is none that considers availability of electricity at the household level or the use of modern cooking fuels such as LPG[2]. The reason for lack of such research is probably that household income is considered a good proxy for existence (or non existence) of amenities such as electricity, LPG and water. While such a correlation between (household) income and infrastructure is reasonable, it can nevertheless be not taken for granted. Access to electricity may also be a function of exogenous factors such as the government's electrification program, public subsidies associated with the supply of electricity. In addition, an independent link between household electrification and school participation can arise through the greater amount of time that students get to spend studying in case of access to electricity. There is research that shows that presence of electricity alters the work patterns and time allocation of children between the various activities such as paid labor, school related and housework (Ilahi 2001; DeGraff at.al 1993) and also affects schooling by allowing more time to study (Brenneman and Kerf 2002).

Energy plays an important role in people's lives. Despite energy being central to most aspect of human welfare, millions of households in developing countries still lack access to modern energy and pay a high price for poor quality substitutes. In developing countries traditional fuels are cheap and easy to collect, and therefore a large majority of households in developing countries rely on it for cooking and heating. This has a twofold impact on education. One is that women

[1]Duncan's (1967) research on the United States presents mixed findings in the sense that though all the four family characteristics that are considered (family type, family head's education and occupation and the number of siblings) together explained not more than three-tenth of the variance in attainment but each on of them independently did have an effect. Mare (1979, 1980, and 1981) in his study on the impact of parental socioeconomic status on school transitions again on the United Sates shows that though the effects of the former declines at higher levels of education, there are significant departures from such declines depending on the gender of the parent and the child's level of education.

[2] Presence of electricity in a household is argued to be positively associated with the achievement of the child health outcomes, namely, infant mortality rate, child mortality rate and prevalence of malnutrition related to the World Bank's Millennium Development Goals (Leipziger et.al 2003).

have to spend longer time in collecting traditional fuel and in household chores like cooking. This prevents them from spending enough time with their children. The second is the widespread dependence on kerosene for lighting in rural areas without electricity, and this limits the possibility of reading by family members including children in school. This might possibly lead to poor school performance. Girls just might not be able to spend enough time on school work.

This paper focuses on the relationship between educational participation in India and access to modern fuels[3] after controlling for other important household characteristics. Education is measured by enrollment rates and reading and arithmetic skills of children aged 8-11 years. The overall impact of modern fuels on these educational outcomes is analyzed for over 10,000 children in rural and urban India. In particular we seek to address the following questions:

- Do Modern Fuels have an impact on primary, middle and secondary school enrollments in India?
- Do Modern Fuels affect the quality of education measured by reading and arithmetic skill levels of children aged 8-11 years
- Does this relationship differ for girls and boys after we control for energy and other socio-economic factors?

This study uses data from the India Human Development Survey (IHDS). The IHDS is a nationally representative sample of 41,554 urban and rural households. It covers all major states and union territories of India, with the exception of Andaman/Nicobar and Lakshadweep. These households are spread across 33 states and union territories, 384 districts, 1503 villages and 971 urban blocks located in 276 towns and cities. One of the unique things about this survey is that it conducted short assessments of reading, writing and arithmetic skills for children aged 8-11. The survey design incorporated simple tests to measure whether a child is not able to read at all, or is able to read letters, words, sentences, paragraphs or stories. Simple addition, subtraction, multiplication and division problems were also developed. Children were asked to write simple sentences and were considered able to write if they could write a simple sentence such as "I like blue color" with zero or one mistakes. In all we have 42,356 students between the age of 6 and 18 enrolled in school. Out of these approximately 11,000 children aged 8-11 years took the reading and arithmetic skills test.

The survey contains unique child assessment data as well as a wealth of household socioeconomic information. Children are classified according to their ability to read in one of the five categories: (1) Can not read at all; (2) Can read letters but not form words; (3) Can put letters together to read words but not read whole sentences; (4) Can read a short paragraph for 2-3 sentences but not fluent enough to read a whole page; (5) Can read a one page short story.

[3] In this paper, the terms *traditional energy* and *modern energy* are used to distinguish ways of using energy rather than a type of fuel. Some generally accepted ways of using these terms in the energy research literature can sometimes lead to confusion, so we define them in this paper. The use of biomass energy in inefficient or open stoves is considered a traditional way of cooking. For lighting, the inefficient use of open fires, candles, and kerosene, typical of developing countries, is also considered a traditional way of using energy. On the other hand, gas, LPG, kerosene, electricity, and biomass energy used in efficient or less polluting stoves are considered modern ways of cooking. The use of electric lamps is both efficient and produces a high-quality light; thus, it is considered a modern way of lighting. Other examples could be used, but the general idea is that traditional ways of using energy are typically inefficient and somewhat polluting, while the opposite is true of modern energy use.

Children's mathematical skills are classified in four categories: (1) Can not read numbers above 10; (2) Can read numbers between 10 & 99 but not able to do more complex number manipulation; (3) Can subtract a two digit number from another; (4) Can divide a number between 100 and 999 by another number between 1 and 9[4].

We use the following dependent variables for our analysis:
a. Probability of school enrollment at primary (age 6-10), middle (age 11-13) and high (secondary) (age 14 – 17) school. The dependent variables thus are namely; a) likelihood of enrollment at ages 6-10 and b) likelihood of enrollment at ages 11-13 and c) likelihood of enrollment at ages 14 – 17. The three variables are thus measured as;
1 = currently enrolled in school at ages 6-10 or 11-13 or 14 – 17, 0 = otherwise
b. Measure of the quality of education proxied by Math Scores and Reading Skills Scores taken by children aged 8-11 years old.

Ordinal models are best suited for our study because the test scores may contain measurement errors. While the interviewers were trained to distinguish between students of varying levels of reading and mathematical ability, interviewers may nonetheless make errors in classifying the students into various categories. Thus the outcome variable should be classified as a propensity to read rather than a specific skill level. Observed reading levels were tied to the following latent variable by the measurement model:

y_i = *1 (does not read)* *if* $\theta_0 = -\infty \leq y_i^* < \theta_1$
y_i = *2 (letter)* *if* $\theta_1 \leq y_i^* < \theta_2$
y_i = *3 (word)* *if* $\theta_2 \leq y_i^* < \theta_3$
y_i = *4 (paragraph)* *if* $\theta_3 \leq y_i^* < \theta_4$
y_i = *5 (story)* *if* $\theta_4 \leq y_i^* < \theta_5 = \infty$

Due to the ordinal nature of the outcome variables (Math and Reading Test scores) we use ordinal logit regressions which take the following form:
$y_i^* = x_i\beta + \varepsilon_i$
$y_i = m$ if $\theta_{m-1} \leq y_i^* < \theta_m$ for m = 1 to j

Table 1 presents the means of the independent variables for children living in households that with and without electricity or LPG. Results show for almost all variables, households which have access to electricity or LPG do better. For example, reading and math scores for these households are higher on average compared to those who do not have access to electricity. The mean level of female adult education is much higher for households with access to modern fuels compared to those with no access. Women and girls spend almost half to one-third time collecting fuels if they have access to electricity or LPG vs. no access. Women have greater empowerment and mobility in households that have electricity and can spend more time helping out the child with their homework.

[4] Note that we focus on 2 digit numbers to avoid calculations on fingertips and to get a better estimate of true understanding of subtraction and division. Also, given the Indian system of expecting children to memorize multiplication tables from 1 to 20, we chose to test children on division rather than multiplication skills.

Table 1: Means by Fuel type used

Independent Variables	Without Electricity	With Electricity	Without LPG	With LPG
Reading Test Scores	2.06	2.83	2.36	3.19
Math Test Scores	1.18	1.73	1.35	2.07
Age	11.12	11.52	11.32	11.63
Currently Enrolled	0.84	0.90	0.85	0.94
Literate adult in the household	0.90	4.64	5.10	7.10
Firewood	0.90	0.71	0.91	0.45
Dung	0.65	0.38	0.56	0.22
Crop	0.25	0.12	0.19	0.06
LPG	0.02	0.44	0	1
Coal	0.03	0.05	0.05	0.03
Electricity	0	1	0.63	0.98
Government School	0.54	0.51	0.57	0.42
Private School	0.08	0.24	0.10	0.40
Other School	0.02	0.05	0.03	0.07
Urban	0.08	0.38	0.16	0.60
Log of Income	10.01	10.65	10.21	11.06
Homework help	0.22	0.39	0.27	0.50
Fuel collection	208.57	129.06	195.92	54.46
Empowerment Index	4.11	4.17	4.13	4.22
Primary Index	1.32	1.44	1.36	1.50

While these descriptive statistics are of interest in themselves, they do not control for factors such as type or residence, type of fuel used in the household, state of residence etc. Hence the next step is to look at multivariate analyses. We will first analyze the effect of covariates of interest enrollment rates by gender for each level of school (primary, middle and secondary). Probit models will be used for this analysis. We will also look at the impact on enrollment rates for each level of school separately and also by region of residence (urban or rural). Finally using ordinal logistic models we will analyze the impact of these covariates on reading and math scores of children who are enrolled in school and are aged 8-11 years.

In conclusion, the paper considers the extent to which the family context is influenced by the use of modern fuels for lighting and cooking in India, and how this in turn has an impact on the school performance of children, and in particular girls. Not only do the children have no time for reading, school work is often dependent on daylight hours as the commonly used kerosene lamps provide very poor quality lighting. Thus the opportunity cost of poor access to domestic energy not only has profound effects on women but also on the education of children. This paper analyzes the impact of using modern fuels (like electricity and LPG) on the primary education of children in both rural and urban areas