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Effects of Fuelwood Collection on Children's School Attendance: Evidence from Northwest Ethiopia

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Abstract

Households in many developing countries lack readily accessible energy sources. They heavily rely on collecting environmental products, such as fuelwood, to meet their daily energy needs. A disproportionate share of the collection burden falls particularly on school-aged children, who spend many hours collecting fuelwood for cooking, diverting their time from schooling. Thus, the objective of this study is to examine the effects of fuelwood collection work on children's school attendance in Northwest Ethiopia. The study used primary data from 679 randomly chosen children aged 7 to 18 collected from 403 households. The data was analyzed using both descriptive statistics and regression models. The study findings revealed that children spend about 7 hours per week on fuelwood collection. Conversely, the results showed that around 77% of school-age children were delayed when they entered grade one. The regression model results indicated household characteristics, such as female headship, age and education level of the household head, have a positive and significant effect on children's fuelwood collection work. The intensity of fuelwood collection and children's school attendance were also influenced by child characteristics: age and sex. Besides, the results revealed that with a 5% increase in fuelwood collection intensity, the probability of children's school attendance reduces by about 25%. This means that collecting fuelwood for an extra hour per week leads to a decrease of over 2% in the likelihood of children's school attendance, suggesting that children's school attendance is affected by fuelwood collection work. Based on the findings, policies that include increasing the availability of energy-saving technologies and access to modern energy can enhance children's school attendance.

Keywords: *Bivariate Probit, Children, Endogeneity, Fuelwood Collection, Intensity. Schooling*

1. Introduction

Human capital development is crucial for poverty reduction and for laying the foundation for a better and prosperous nation (Assaad et al., 2010). This requires a significant investment in a child's education by their parents (Cuesta, 2018), as it allows for self-improvement and advancement in the future (Eigbiremolen, 2017). Investment in education, particularly child education, contributes to a more enlightened and productive society while breaking the intergenerational cycle of poverty and

deprivation (Krueger & Maleckova, 2002). In addition, investing in education can help increase economic growth, productivity and national development (Ndiritu & Nyangena, 2011). Thus, education benefits not only the individual but the entire society through various spillover effects. Recognizing the importance of human capital development in economic growth, many developing-country governments invested in education.

Despite considerable efforts to increase investment in education, millions of school-age children in Sub-Saharan African (SSA) countries are not in school, and many others leave school at a young age and often learn little while in school (Abafita & Kim, 2015). Instead, many children are involved in hidden forms of child labour, like work in the household, on the family farm, or in the family business (Webbink et al., 2012). Domestic chores, such as fuelwood collection, are often not included in employment statistics, resulting in limited knowledge about the children who perform these tasks (Levison et al., 2018).

Many households in SSA countries struggle to access reliable sources of energy (Aggarwal et al., 2001). Consequently, they heavily rely on collecting environmental products like fuelwood to meet their daily energy needs (Ndiritu & Nyangena, 2011). A disproportionate share of the collection burden falls on women and children, particularly school-aged children, who spend many hours each week collecting fuelwood for cooking (Nankhuni & Findeis, 2004). When deforestation makes fuelwood scarce, women and children are forced to travel long distances and invest significant time and labour. As reported by Cundale et al. (2017) and Beyene et al. (2014), in SSA, the time spent collecting fuelwood ranges from 4 to 15 hours per week, depending on the level of deforestation. As a result, children at prime school attendance age routinely collect fuelwood for at least as many hours as adults. Accordingly, children are more valuable than adults in fuelwood collection activities, which may increase their value (Aggarwal et al., 2001). This situation, however, reduces children's school attendance, study time, and, ultimately, their ability to learn and progress through school (Levison et al., 2018), which has detrimental effects on future human capital development.

The situation is similar in Ethiopia, where about 71% of children aged 5 to 17 years were engaged in some work supporting their households' livelihoods (ILO, 2018). Even preschool children, who are usually too young to work, participate in domestic chores (Admassie, 2003). Besides, Ethiopia has struggled to improve primary education at the national level. For instance, the government subsidizes the direct cost of primary school to alleviate the financial burden placed on low-income households in sending their children to school (Woldehanna & Araya, 2016). Despite efforts, Ethiopia still struggles to achieve universal primary education and has one of the world's lowest school enrollment rates (Haile & Haile, 2012). An additional and worrying challenge is that even where educational resources are made available, some communities do not fully value children's education. This manifests in low primary school completion rates, delayed school attendance, and gender disparities in enrolment and grade attainment (Woldehanna, 2011; Cuesta, 2018).

A large share of the Ethiopian population heavily depends on the natural environment for their livelihoods. At the same time, the environment that supports people's livelihoods and well-being is being degraded (Nyssen et al., 2004). The problem is severe in the Northwest highlands. Evidence suggests that natural forests are deforested due to a long history of settlement, rapid population growth, agricultural land expansion, the escalating demand for fuelwood, and urbanization (Wondie et al., 2011; Agidew & Singh, 2017). In addition, the depletion of forest resources can negatively impact children's school attendance as they have to spend more time

and effort collecting and transporting fuelwood (Gebru & Bezu, 2013).

Moreover, whether a child should attend school or work at home is primarily a parental decision. Hence, parental attitudes toward educational investment play a crucial role in school attendance (Admassie, 2003). However, although schooling increases future earnings, poor parents are unable to send their children to school due to a lack of financial resources to cover the direct costs of sending children to school and the opportunity cost of the children's time (Glewwe, 2002). Various authors have reported that different factors contribute to the low likelihood of children's school attendance, of which domestic chores are the most prominent (Admassie, 2002; Haile & Haile, 2012). Nevertheless, most previous studies on formal child labour and education were general and did not demonstrate the negative effect of natural resource scarcity on children's education.

Empirical studies on how hours of work spent by children in fuelwood collection work affect their likelihood of attending school have yet to be conducted in the study area. Only two studies in Ethiopia have quantified the link between natural resource scarcity and children's schooling. The first study was conducted by Gebru & Bezu (2013), who used cross-sectional data on children aged 7 to 18 to investigate the effects of natural resource scarcity on children's education in Tigray. They found that a 50% increase in resource collection intensity reduces the likelihood of a child attending school by approximately 11%. The second study was carried out by Beyene et al. (2014), who explored the effect of resource collection on child education using panel data collected in four rounds from the Amhara region. They concluded that natural resource scarcity negatively contributes to child education by increasing the work burden on children.

In the study area, many children spend substantial time collecting environmental products, like fuelwood. While attention to deforestation and fuelwood scarcity is increasing, the link between fuelwood scarcity and children's education is often overlooked. Numerous factors contribute to concerns about impediments to children's educational attendance, many of which have been studied. However, in Northwest Ethiopia, where forest resources are threatened, little attention has been given to children who collect fuelwood. The present study empirically tests the hypothesis that deteriorating fuelwood negatively affects children's schooling. Thus, the objective of this study was to examine the effects of fuelwood collection work on the school attendance of children in northwest Ethiopia. Using deforestation as an example of environmental degradation, the study attempted to shed light on the link between fuelwood collection work and children's education. In this way, the study contributes to the literature on fuelwood scarcity and fuelwood collection, as well as its effect on children's education in Ethiopia. This is because knowledge of factors that determine school attendance would undoubtedly go a long way in formulating strategies that improve school attendance and environmental recovery.

Theoretical framework

Theoretically, this study is based on Becker's (1965) seminal paper on time allocation and its extensions to household behaviour to study schooling and fuelwood collection work. A family's decision regarding child schooling, resource collection, and other activities can be analyzed using the household production model developed by Becker (1965). The model assumes that parents' utility maximization is constrained by market-purchased goods and time endowment. This model necessitates joint decisions on the number of children a family should have, as well as the pattern of time allocation among household members for schooling, market work, and household production (Gebru & Bezu, 2013). In the model's original specification, home-produced goods (e.g., collected fuelwood in this study) and market

goods (e.g., electricity) are perfect substitutes for each other. Gronau (1977) further developed the model by arguing that a household's home goods production is characterized by diminishing marginal productivity due to tiredness and limited access to local forest resources. This is also validated by Rosenzweig and Evenson's (1977) conclusion that a family's decision on children's time allocation to school and work is jointly determined. The preference of the household for schooling (S), leisure (L), home-produced goods (Z), and a composite consumption commodity (C) is specified as follows:

$$U = U (S, Z, L, C, E)$$

where U is the utility function of the family, and E is the household environment. The utility function is assumed to be concave and twice and continuously differentiable. Z refers to goods produced at home, using market-purchased goods and children's housework time, such as collecting fuelwood, taking care of younger siblings, tending animals, etc. In this model, parents maximize a utility function, subject to time and budget constraints.

2. Materials and Methods

Description of the Study Area

The study was conducted in the Semien Mountains and adjacent districts of North Gondar Zone, Northwest Ethiopia. The Semien Mountains are located at latitude 13°29'21" to 13°29'40" N and longitude 37°51'36" to 38°34'33" E. It lies within five districts, including Adiarkay, Debark, Janamora, Beyeda, and Telemet, covering an area of 241,093 hectares. The total population was estimated to be 378,929 (CSA, 2013), with an average household size of 6.01. The altitude of the study area ranges from 1,276 to 4,540 m (Debebe et al., 2023). The study area is located in one of the wettest and coldest regions of the country, with a mean annual rainfall of between 1,350 and 1,550 mm, falling in a single rainy season between June and September (Hurni & Ludi, 2000). Mean daily temperatures range from a minimum of -2.5°C to 4°C to a maximum of 11°C to 18°C (Asrat et al., 2012). The area is drained and divided into different landscape features by tributaries of the Tekeze River, such as the Ansiya, Jinbar, Belegez, and Mesheha (Yohannes et al., 2020). The dominant vegetation type in the study area comprises the Afro-montane Erica forest (Erica arborea), hypericum woodland, ericaceous heath-land and the Afro-montane grassland (Wondie et al., 2011).

Research Design, Data Sources and Methods of Data Collection

The study used a cross-sectional descriptive and explanatory research design. The descriptive study design was employed to characterize the patterns of children's education and fuelwood collection work in detail. In contrast, the explanatory study design was used to identify and test a priori hypothesis that deteriorating fuelwood negatively affects children's schooling. The study acquired data from both primary and secondary sources. First, primary data regarding school-age children were gathered from household heads using a semi-structured questionnaire. Semi-structured questionnaires were chosen since they could include quantitative and qualitative questions. Then, after an extensive literature review and a preliminary qualitative study, a survey questionnaire was developed and translated into the local language, Amharic. Finally, the questionnaire was pretested with 20 households to ensure questionnaire clarity, ordering, relevance, and interview time. The survey data comprised questions on children's involvement in education and fuelwood collection, as well as the hours they spend collecting fuelwood, collection intensity, school attendance, household demographics and socioeconomic characteristics, and sources of fuelwood. Because this study aims to understand the effect of children's participation in fuelwood collection on their education, it focused on children aged 7-18 (inclusive). Therefore, we chose seven years

as the lower limit since most children begin elementary school when they are seven or older. Similarly, the maximum age limit was selected following the 1999 International Labour Organization's (ILO) convention, which defines all persons under the age of 18 as children (ILO, 1999). In addition, to substantiate and cross-check the data collected through survey, we conducted interviews using purposively selected participants. Hence, eight key informant interviews were conducted with education experts at the zonal, district, and kebele levels, as well as with school teachers, to gain insight into children's school attendance. Furthermore, secondary data were collected from various published and unpublished sources to cross-validate the results and support the arguments.

Sampling Techniques

In this study, we used a multistage sampling technique to select the study site, districts, kebeles, and households. First, the Semien Mountains were chosen as a study site on purpose because they are one of the most environmentally degraded areas of northwest Ethiopia, suggesting that a slight change in forest resources can have far-reaching effects on the livelihoods of local communities. In the second stage, two districts surrounding the Semien Mountains, Adiarkay and Debark, were deliberately chosen to ensure variation in the characteristics of the districts, including agroecology and forest cover. In the third stage, six kebeles from the selected districts were randomly selected. Lastly, a simple random sampling technique was employed to determine sample households. The kebele administration of each kebele provided household lists. Accordingly, 420 households were chosen randomly from the sampling frame in each kebele using a systematic random sampling technique based on a formula proposed by Kothari (2004). Then, probability proportional to size (Table 1) was employed to calculate the number of households sampled from each kebele chosen. Of the 420 households surveyed, 708 children aged 7 to 18 years were considered for this study. However, due to incomplete information, 17 households were dropped, and the analysis was made based on 403 households and 679 children. It is important to note that more than one child comes from one household, given the household size.

Table 1**.** Sample distribution of surveyed households and children

Districts	Kebele	Total Households in each Kebele	Sample Households
Debark	Debir	5,209	151
	Dib-Bahir	1,212	35
	Adisge-Milgebsa	1,872	54
	Adebabay-Tsion	3,218	94
Adi-Arkay	Zarima	991	29
	Anguana Kerneja	1,953	57
Total		14,455	420

Data Analyses

The collected data were edited, coded, and classified before entering into the Statistical Package for Social Scientists (SPSS v.2020) software. The data was then cleaned and checked for errors and inconsistencies before being exported to STATA 14 for analysis. Finally, in line with the study's objective, we employed descriptive statistics like mean, standard deviation, tables, and figures to characterize children's involvement in fuelwood collection and school attendance. The decision to send children to school may be jointly determined with a decision to send children to collect fuelwood. This problem is addressed by estimating a simultaneous equation model for binary variables. Hence, a bivariate probit model was used to identify and analyze the effect of fuelwood collection work on children's school attendance. Bivariate probit regression is a method with two probit equations whose error terms are correlated. One of the binary dependent

variables becomes an endogenous regressor variable for the other dependent variable. Since children's time spent collecting fuelwood increases as forest resources decline, their likelihood of attending school may be negatively affected. Hence, school attendance may be influenced by the amount of time a child spends on fuelwood collection work (collection intensity). Interdependence arises between school attendance and fuelwood collection intensity. To address the endogeneity problems, the two-stage conditional maximum likelihood (2SCML) models are used. The 2SCML model works well if at least one endogenous and continuous explanatory variable exists in the probit model. The process of 2SCML computation involves two steps. First, a reduced form of ordinary least squares (OLS) is estimated on fuelwood collection intensity as a function of all exogenous explanatory variables and the instrumental variable (IV), and then residuals are saved. Following that, both the saved residuals and the endogenous collection intensity variables are included in the schooling probit. If the sample t-statistic for the estimated coefficient of the residual is statistically significant, it suggests that collection intensity is endogenous in the school attendance probit.

Description of Variables

In this study, the dependent variables are schooling, fuelwood collection, and the average time spent collecting fuelwood. Schooling is a binary variable indicating whether the child is enrolled in school. Fuelwood collection participation is also a binary variable that indicates whether the child participated in fuelwood collection in the last week before the survey. Finally, the intensity of fuelwood collection is measured as a continuous variable, which is determined by the number of hours spent collecting fuelwood per week. Because the objective of this study is to examine the effect of children's participation in fuelwood collection on their school attendance, the following discussion is limited to child fuelwood collection work. Moreover, several explanatory variables are hypothesized to influence children's school attendance and fuelwood collection. These could include household characteristics such as the age, sex, size, income, and education level of the household head, as well as individual child characteristics: age, sex, current school attendance, age at first class, grade-for-age and time spent in fuelwood collection.

3. Results and Discussion

Socio-economic Characteristics of Households

Table 2 shows the basic summary statistics of the variables for the sample households involved in the study. We sampled and surveyed a total of 420 households and achieved a response rate of 96%. The survey data revealed that about 75% of the households are headed by males, while 25% are female-headed. The mean age of the household head is 45.2 years, with 5.2 average years of schooling. The average household size is 5.52 persons, which is higher than the regional average of 4.3 in Amhara (CSA, 2010).

Table 2. Summary statistics of households' demographic and socioeconomic characteristics

Variables	Mean	SD
Gender (Male =1; Female= 0)	0.747	0.435
Age of the household head (years)	45.21	11.418
Schooling of the head (years)	5.17	3.381
Household Size (number of persons)	5.19	1.827
Annual income of the household (Birr)	18,123	9,966
Occupation of the household head (Farming=1; Others=0)	0.67	0.469

Children in the household (numbers)	2.51	1.284
Fuelwood as a primary source of energy (Yes=1; No=0)	0.875	0.33
Electricity connection (Yes=1; No=0)	0.365	0.482
Distance to the nearest forest (minutes)	69.12	37.69
Distance to primary school (minutes)	37.83	24.13

On average, there were approximately 2.5 children per household. Households have an average annual income of about 18,123 ETB (about US$ 470.36). During data analysis, the official exchange rate was US$1=38.53 ETB from the National Bank of Ethiopia. When it comes to occupation, nearly two-thirds of the sample households are engaged in farming, and over a third are self-employed. In addition, roughly 64% of households lack access to electricity. On average, households spend around 69 minutes travelling to access nearby forests. Many households in the study area predominantly rely on biomass fuel, particularly fuelwood.

Children's Schooling and Fuelwood Collection Work

The statistical summary in Table 3 displays the participation of school-aged children in fuelwood collection and their school attendance. The sample encompasses 679 children aged 7 to 17 who live with their parents, which is the primary focus of this study. All the children came from households that participated in the survey. Children usually begin their primary education at the age of seven and are expected to finish it by the time they turn 15 (Woldehanna & Araya, 2016). Of the 679 school-aged children, 55% (374) are males, while 45% (305) are females. The average age of children is around 12.6 years.

Table 3. Summary statistics of school-age children in the households.

Variable	Mean	SD
School attendance (Yes=1; No=0)	0.79	0.406
Fuelwood collection participation (Yes=1; No=0)	0.81	0.394
Fuelwood collection intensity per week (minutes)	406.7	172.4
Sex of the child (Male=1; Female=0)	0.55	0.498
Age of the child (years)	12.55	2.998
Ratio of children who collect fuelwood to family size	0.372	0.128
Grade of the child (years)	5.272	2.164
Grade-for-Age (enrolled at age 7=1; enrolled over age 7=0)	0.236	0.425
Absent from class (Yes=1; No=0)	0.77	0.422
Age at first class/grade (numbers)	8.60	1.196
Fuelwood collection trip (days)	2.34	0.458
Participation of children in fuelwood collection and schooling	0.64	0.756
Engaged in only fuelwood collection	0.20	0.47
Engaged in only schooling	0.13	0.35

The proportion of children in the sample who had been enrolled in school was 79% at the time of the survey, consistent with the net enrolment rate of the Amhara Region (78.5%) but lower than the national average (86.4%). The results also indicated that 21% of children are out of school while the average years of schooling were 5.3 years (Table 3). There are multiple reasons why students may not be able to attend classes during the academic year. About 32% of school-aged children are unable to attend school due to fuelwood collection work. Additionally, 28% and 22% of children cannot attend school because of farm work and lack of parental interest in education, respectively. According to key informant participants, it has been identified that one of the reasons children are not able to attend school is the financial constraints faced by

households in affording the cost of education. Apart from permitted holidays and school breaks, 77% of students were absent from school.

As the kebele education expert reported, each kebele in the study area had at least one primary school. These schools are public, and children rarely attended primary schools outside their kebele. According to education experts, on average, children spend around 30 hours per week on their schooling, which includes time spent travelling to and from school, attending class time, and completing homework. On the other hand, school-going children are engaged in fuelwood collection. The study found that 64% of school-age children were involved in both fuelwood collection and schooling, while 20% and 13% were only engaged in fuelwood collection and schooling, respectively (Table 3). This may be the manifestation of fuelwood scarcity, which may induce children to gather fuelwood for domestic use and even for market purposes.

Moreover, children make an average of 2.34 trips per week to gather fuelwood. On average, children spend nearly 407.7 minutes (6.8 hours) per week collecting fuelwood, which includes travel and collection time. This task is particularly time-consuming for them (Table 3). Spending more hours collecting fuelwood can have a negative impact on children's school attendance. Regular school attendance is crucial to achieving good grades and progressing at the right age for class. Even though the expected age for children to start school is 7, we still have students older than seven years in our dataset because some children start grade 1 later than seven years. Our results show that only 23.3% of school-aged children started grade 1 at age seven, as required by the education system in Ethiopia. Conversely, the result shows that approximately 77% of children of school age were delayed when they entered grade 1 (Table 3). The implication of delaying starting school reduces efficiency and negatively affects children's motivation for schooling (Abafita & Kim, 2015).

Furthermore, during the survey, households were asked about their fuelwood sources. About 87% of the households have identified forests as an essential source of fuelwood (Table 2). The results (Fig. 1) further show that about 54% of the households obtained fuelwood from state and community forests, followed by on-farm trees (33.3%) and purchasing from the market (12.7%).

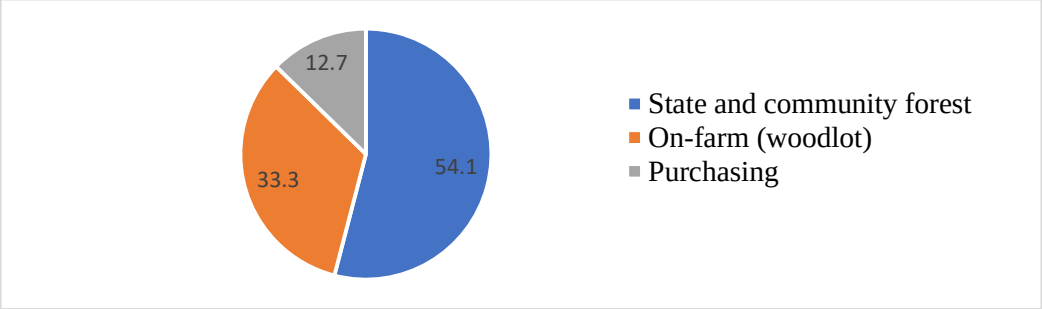

Figure 1. Sources of fuelwood for households.

Determinants of Children's Fuelwood Collection Intensity

The bivariate probit model for school attendance and fuelwood collection participation work produced a Wald test of rho = 0 (chi2 (1) = 17.22; Prob > 0.000), indicating that there is a correlation between the disturbance terms of the equations. Thus, unexplained factors that affect children's participation in fuelwood collection and schooling decisions are positively correlated. Thus, fuelwood collection participation and school attendance appear to be competing activities. The findings of this study support the joint estimation of the participation in fuelwood collection and schooling equation

and align with other similar studies (Ndiritu and Nyangena, 2011; Gebru & Bezu, 2013).

The estimated univariate probit of fuelwood collection work participation, fuelwood collection intensity (first stage regression), and the school attendance instrumental variable probit are shown in Table 4. The second column in Table 4 shows results from estimating the reduced form of the fuelwood collection intensity equation. On the other hand, the first and third columns display results from the probit model for the school attendance and fuelwood collection participation equations. Residuals from the fuelwood collection intensity equation are added as an additional regressor to the schooling model to control and test for the endogeneity of fuelwood collection intensity.

The Ordinary Least Square regression of the fuelwood collection intensity model provides an R^2 of 0.383. This indicates that 38% of the variability in fuelwood collection intensity can be explained by the explanatory variables included in the model, implying the model fits the data reasonably well. Furthermore, an F-test of the hypothesis that the ratio of the child-to-family size does not affect the other variables gives a test statistic of 10.2, suggesting a strong instrument.

The first stage estimation (the fuelwood collection intensity) in the 2SCML technique displays the ratio of the child-to-family size used as an instrument for the endogenous log (fuelwood collection work hours) variable (Table 4). The instrument used in the fuelwood collection model is significant and hence relevant. We found a negative relationship between the ratio of children (who collect fuelwood) to family size and fuelwood collection work intensity (-0.787), suggesting that the number of children and fuelwood collection intensity is negatively correlated. This indicates that households with an extra child will likely reduce the average hours spent gathering fuelwood per week by 79%, assuming all other things remain constant. Nevertheless, the negative relationship between the child-to-family size ratio and time spent collecting fuelwood is consistent with our expectations based on past empirical studies and theoretical models of household allocation (Ndiritu & Nyangena, 2011; Gebru & Bezu, 2013).

Household characteristics variables affect the likelihood of participating in fuelwood collection work and the intensity of this work. The study findings indicate that the age of the household head has a positive and significant ($p < 0.05$) effect on participation in fuelwood collection activities. This conveys that children in elderly households are more likely to be involved in fuelwood collection work by 3%. Such children are expected to increase fuelwood collection intensity by about 18% per week relative to children from young household heads, holding others constant. This result is consistent with the finding of Beyene et al. (2014), who confirmed that children in older household heads increase the probability of participating in fuelwood collection work.

In addition, the education level of the household head has a positive and significant ($p < 0.05$) effect on children's fuelwood collection intensity. The result shows, ceteris paribus, children from households with better education levels spend an average of 30% more time gathering fuelwood per week compared to children from lower education household heads. It appears to go against the expectation that better-educated parents have a better understanding of the adverse effect of child labour and hence would not involve their own children in fuelwood collection tasks. This may be explained by the fact that parents with better education are probably involved in government administration and other social issues, suggesting that they may face time constraints in collecting fuelwood and performing other domestic chores. Hence, children living with educated household heads are more likely to participate in fuelwood collection work. This finding is in line with the findings of previous studies (Gebru & Bezu, 2013).

Household size is another predictor variable influencing fuelwood collection work and intensity. The results show that the coefficient of household size has a positive and statistically significant ($p < 0.05$) effect on the intensity of fuelwood collection participation of children. The positive signs of the coefficient of household size suggest that as the number of household members increases by one, children will spend about 16% more time per week on fuelwood collection. This is perhaps explained by the increased quantity and frequency of cooking in a household with large family sizes. In addition, stiffer competition over scarce resources like fuelwood may, in turn, increase child labour in fuelwood collection tasks. This result is consistent with empirical findings conducted in Ethiopia and elsewhere in developing countries (Haile & Haile, 2012; Beyene et al., 2014).

Table 4. Estimated regression results of fuelwood collection intensity and schooling.

Variable	Fuelwood collection participation		Fuelwood collection work hours		School attendance	
	Marginal effects (S.E.)	P> |Z|	Coeff (S.E.)	P > |t|	Marginal effects (S.E.)	P > |Z|
Constant			2.308(0.200) ***	0.001		
Log_Collection intensity (hours)					-0.249 (0.132) **	0.06
Male headship	-0.012 (0.04)	0.764	-0.031(0.22)	0.149	-0.005 (0.054)	0.924
Age of the head	0.031 (0.015) **	0.072	0.177(0.101) **	0.078	0.001 (0.003)	0.82
Years of schooling of the head	0.027 (0.015) **	0.039	0.299(0.112) **	0.085	-0.035(0.018) **	0.05
Household size	0.029 (0.015) **	0.054	0.156(0.098) **	0.022	0.011 (0.029)	0.70
Occupation (farming)	-0.042 (0.039)	0.282	0.025(0.021)	0.332	-0.031 (0.047)	0.51
Number of children	0.008 (0.032)	0.800	0.017(0.027)	0.216	-0.075 (0.045) *	0.095
Log_Household income	-0.069 (0.085)	0.418	-0.015(0.043)	0.477	-0.068 (0.103)	0.51
Log_Distance to forest	0.158 (0.073) **	0.031	0.059 (0.033) *	0.088	0.060 (0.084)	0.47
Female child	0.035 (0.015) **	0.019	0.052(0.018) ***	0.003	0.073 (0.043) *	0.085
Age of child	0.012 (0.01) ***	0.081	0.078(0.039) *	0.083	0.017 (0.008) **	0.042
Child-to-Family Size Ratio			-0.787(0.083) ***	0.001		
Residuals					0.540 (0.311) *	0.082
No. of observations	603		538		538	
R^2			0.383			

*, ** and *** significant at 10%, 5% and 1%, respectively.

The availability of forests in the study area determines the intensity of fuelwood collection by the household, which is measured by the distance a household travels to collect fuelwood from these resources. The results revealed a positive and significant ($p < 0.1$) relationship between distance to the forest and participation and time spent on fuelwood collection. This implies that as the distance to the forest resources increases, the intensity of fuelwood collection also increases by 6%. Our findings on the effect of distance to the forests on the intensity of fuelwood collection agree with those reported by Beyene et al. (2014) in Ethiopia.

A closer look at the various factors considered in our analysis reveals that variables related to child characteristics play a significant role in determining the probability of a child engaging in fuelwood collection work and the intensity of their participation. As evident from the regression results (column 2), the estimated coefficient of the age of the child has a positive and significant effect ($p < 0.05$)

on the likelihood of participating in fuelwood collection work. This suggests that as the child's age increases, so does their probability of fuelwood collection intensity. Beyene et al. (2014) also concluded that older children are relatively more involved in fuelwood collection, which may result in less time in schooling. Similarly, the sex of the child is another predictor variable with significant ($p < 0.01$) and positive effects on the probability of fuelwood collection work. The positive relationship indicates that female children are more likely than males to participate in fuelwood collection. This implies that the traditional division of labour in SSA involves a higher work burden on females than males (Nankhuni & Findeis, 2004; Beyene et al., 2014).

Determinants of Children's Fuelwood Collection Work on School Attendance

Column 3 in Table 4 shows the second stage results of regressing school attendance (binary) on time spent collecting fuelwood using the residuals from the first stage. The probit model for schools shows that residuals have a statistically significant positive coefficient at a 10% level. Thus, the results suggest that the intensity of fuelwood collection is endogenous in the schooling model, which supports the use of IV in our estimation process. The results further revealed that the estimated coefficient of fuelwood collection intensity is negative and significant at 5%.

Table 4 (column 3) shows the association between fuelwood collection work and children's school attendance. Participating in fuelwood collection work reduces the likelihood of a child attending school. With a 10% increase in fuelwood collection intensity, the probability of children's school attendance reducing by about 2.5%. In other words, collecting fuelwood for an additional hour per week leads to a decrease of over 2% in the likelihood of attending school. The probable reason is that when forest resources are declined, it leads to fuelwood scarcity. Increasing fuelwood scarcity has resulted in long hours of fuelwood collection work spent by school-aged children. This will adversely affect the likelihood of not attending school through the opportunity cost of time spent on fuelwood collection. This result is in line with empirical findings in Ethiopia and elsewhere in developing countries (Ndiritu & Nyangena, 2011; Gebru & Bezu, 2013; Cuesta, 2018) that involving fuelwood collection work negatively affects the likelihood of children's school attendance.

The educational status of the household head affects children's schooling decisions because they believe that education enhances the future earning potential. Hence, exploring whether fuelwood collection work affects children's education is vital. The results show that the estimated coefficient of years of schooling of the household heads has a negative and significant effect on children's school attendance. If the education level of the household head increases by one year, there is a 3.5% probability that the attendance of children in school will decrease. The probable reason is that household heads with some education levels are more likely to be occupied by government administrative issues. The findings of a study by Haile and Haile (2012) differ from the current research. They found that children of parents with better education tend to work more within the household, negatively affecting their school attendance. Similarly, a study conducted in Tigray, Northern Ethiopia, by Gebru and Bezu (2013) reported that children with educated household heads are about 25% more likely to send their children to school. In the same vein, there is also evidence that children from better-educated parents more often attend school and stay longer in school (Ersado, 2005).

As is common in many developing countries, children are substantially involved in fuelwood collection chores. The study findings suggest that having more children has a negative and statistically significant ($p < 0.1$)

effect on their school attendance. The result also reveals that an increase in the number of children in the household by one would decrease the likelihood of sending children to school by 7.5%. This is probably because the availability of many children in the household may increase the demand for caretaking, and many school-aged children make the competition over household resources stiffer. This indicates the number of children and investment in child education trade-offs faced by parents; poor households may be constrained to cover their children's school expenses (Gebru & Bezu, 2013). In contrast, a household with many children may provide greater opportunities for school attendance and fewer work hours, especially if there is specialization among family members (O'Brien et al., 2019). Similar studies in Ethiopia show that having more children in a household results in a greater demand for work, decreasing the likelihood of school attendance (Haile & Haile, 2012).

Another variable influencing children's likelihood of attending school is age. The results show that the estimated coefficient of child age has a positive and significant ($p < 0.01$) effect on children's school attendance. The positive and highly statistically significant coefficient of the child age variable in the schooling probit model shows the probability of school attendance increases by 2%; as the child's age increases by one year, other things remain constant. Interestingly, in the first-stage regression, we found that older children are more likely to engage in intensive collection work than younger children. This result is consistent with the finding of Abafita and Kim (2015) in Tigray that child age had a positive and significant effect on the probability of school attendance. However, this finding is against the findings of Ndiritu and Nyangena (2011) in Kenya, which state that as children grow older and acquire more skills, the opportunity cost of schooling rises. Hence, they are less likely to attend school.

Moreover, the literature on child labour highlights potential gender-based disparities in fuelwood collection work participation and their effect on school attendance. Hence, the likelihood of school attendance is investigated from the gender perspective. The results show that the coefficient of child sex is positive and statistically significant ($p < 0.1$), implying that a female child is more likely not to attend school by 7.3% relative to male counterparts. This suggests a gender bias in favour of male children in schooling. A study conducted by Admassie (2002) reported similar findings where being a female child significantly narrows the probability of attending school. However, the findings are inconsistent with Gebru and Bezu's (2013) report that gender discrimination in schooling owing to fuelwood collection intensity is not evidenced in Tigray, Northern Ethiopia.

4. Conclusion and Implications

Deteriorating environmental resources, particularly forests, increases the cost of collecting environmental products like fuelwood. Fuelwood collection is part of the daily routine of many households in the study area. Most of the collection burden falls on school-age children, diverting their time from education. This type of child labour frequently leads to foregone schooling, which might affect their future human capital development. This study examines the link between fuelwood collection work and children's school attendance evidence from the Semien Mountains and adjacent districts of Northwest Ethiopia. This kind of study is crucial because it helps us understand the linkage between schooling and natural resource scarcity, and it can also make allies of education advocates and proponents of natural resource conservation. The study's main hypothesis is that as fuelwood becomes scarce, households are forced to travel long distances and invest more time and labour in collecting fuelwood, adversely affecting the children's school attendance. The study concluded that deforestation and forest degradation limit a household's access to forests, which may

negatively affect human capital formation and, consequently, an individual's potential earnings when getting older. The findings of this study have significant implications for educational and environmental policy. They highlight the need to integrate natural resource management programs with primary education programs. Besides, the availability of natural resources, such as fuelwood, may substantially improve children's school attendance. Thus, it is essential for policies to focus on assisting impoverished households in advancing up the energy ladder, as this can improve children's school attendance. Moreover, promoting fuel-efficient cookstoves may reduce the frequency of fuelwood collection and deforestation and improve children's school attendance. The most practical action would be to focus on supporting poor households relying heavily on fuelwood to progress the energy transition and improve children's school attendance.

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