Environmental Goods Collection and Children's Schooling

Evidence from Kenya

Simon Wagura Ndiritu and Wilfred Nyangena

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Abstract

This paper presents an empirical study of schooling attendance and collection of environmental resources using cross-sectional data from the Kiambu District of Kenya. Because the decision to collect environmental resources and attend school is jointly determined, we used a bivariate probit method to model the decisions. In addition, we corrected for the possible endogeneity of resource collection work in the school attendance equation by using instrumental variable probit estimation. One of the key findings is that being involved in resource collection reduces the likelihood of a child attending school. The result supports the hypothesis of a negative relationship between children working to collect resources and the likelihood that they will attend school. The results further show that a child's mother's involvement in resource collection increases school attendance. In addition, there is no school attendance discrimination against girls, but they are overburdened by resource collection work. The study recommends immediate policy interventions focusing on the provision of public amenities, such as water and fuelwood.

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Environmental Goods Collection and Children's Schooling: Evidence from Kenya

Simon Wagura Ndiritu and Wilfred Nyangena*

Introduction

The formation of human capital is vital for the economic growth of any country. This is largely done by investing in education for children. Investment in education can help foster economic growth, enhance productivity, and contribute to national development. A low level of human capital is considered a major impediment to the eradication of poverty in developing countries. Educational investment in children enhances their productive skills and earning capacity, in addition to conferring other benefits, such as health status and ability to acquire new information. These benefits are not confined only to the individual, but also extend to parents and society at large. Hence, primary-level education particularly is given high priority toward achieving universal primary education and meeting the Millennium Development Goals (MDG) by the year 2015. In developing countries and especially sub-Saharan Africa, fundamental changes are required if primary school attendance is to increase enough to achieve the MDG target for primary education (MDG 2, target number 3).

Recognition of the importance of human capital development in economic growth has driven many governments to invest heavily in the provision of education. In 2003, the Kenya government introduced free primary education, with a primary objective of encouraging enrollment from poor households. However, given an estimated net primary school enrollment rate of 79 percent, Kenya is far from achieving universal primary education by 2015. The education sector is still fraught with problems, including declining enrollment, low primary-school completion rates, gender disparities in enrollment and grade attainment, among others.

The fact that the rural poor are heavily dependent on natural resources, and that availability of these resources can affect schooling, is the empirical puzzle that motivates this paper. Many poor people eke out a living from products obtained directly from their local environment. Much labor is needed even for simple tasks. Many households do not have ready access to the sources of domestic energy available, nor do they have tap water. In semi-arid and arid regions, the water supply is often not close at hand, and when forests recede, finding fuelwood requires more time and travel. In addition to cultivating crops, caring for livestock, and producing simple marketable products, members of a household may have to spend long hours a day fetching water and collecting fodder. These are complementary but time-consuming activities that have to be undertaken on a routine or daily basis if the household is to survive. Labor productivity is low, not only because capital is scarce but also because environmental resources are scarce.

Kenya, like other developing countries, is natural-resource dependent; the availability of these resources can play a major role in shaping educational attainment. Given this dependence, one would ask how these households respond to the perceived degradation of natural resources. From about the age six, children from poor households in poor countries fetch water, mind domestic animals and their siblings, and collect fuelwood. Children at prime school-attendance age have routinely been observed to work at least as many hours as adults. As natural resources are depleted, more hands are needed to gather fuel and water for daily use. Children have a comparative advantage relative to adults in resource-collection activities. As resources grow more scarce and households have to travel larger distances and spend more time in these collection activities, this may increase the demand for children. When this happens, poverty—manifested by low educational attendance and attainment, fertility, and environmental degradation, which reinforce one another—becomes an escalating spiral (Cleaver and Schreiber 1994).

There is a plethora of economic studies which show evidence of costs and gender bias, among others, as determinants of schooling. For instance, some studies with an exclusive focus on gender bias have attempted to demonstrate intrahousehold bias in schooling (e.g., Behrman et al. 1997; Rose 2000; Pasqua 2005). Similarly, Case et al. (2004) showed that the probability of school enrollment is inversely proportional to the degree of relatedness of the child to the household head. The literature is scanty on links between environmental goods collection and school attendance. With the exception of Nankhuni and Findeis (2004), existing studies have largely ignored the role played by environmental factors in determining schooling and attendance. Much of the analysis takes for granted that children will attend school if it is free.

The depletion and degradation of natural resources thus pose serious challenges to the achievement of the Millennium Development Goals, especially education. Yet, the links between natural resources and education have remained largely unexamined in the Kenyan context. There is also no study which addresses the issue of what happens to school attendance following the decline and changes in natural resource availability in Kenya. For this paper, we used unique data from Kiambu District that contains detailed information on education and environmental goods collection times. There is also information on gender; households' socioeconomic characteristics, such as income and age; time taken to collect fuelwood and water; and children's school attendance and participation in resource collection. We used an instrumental variable estimation approach to address the potential endogeneity problems involved in our estimation, in addition to alternative, more robust estimation procedures. We have extended the literature on school enrollment by including natural resource collection work as a determinant of schooling decisions.

The contributions of the study are threefold. First, the study presents empirical evidence of the links between school attendance and collection of fuelwood and water. Specifically, the empirical analysis uses Kenyan data to examine how households respond to changes in availability of fuelwood and water. Second, the findings not only specifically contribute to the understanding of links between school attendance and environmental collection of goods but also add in general to the literature. Knowledge of factors that determine schooling attendance, as well as how households react to scarcity of environmental goods, would no doubt go a long way in the formulation of strategies to improve school attendance. More crucially, this knowledge takes on an added significance in the light of increasing environmental degradation in Kenya. Last, because the country is natural resource dependent, these resources can play a major role in shaping the country's educational policy. Natural resources command a great deal of policy attention and could be the focus of many interventions, such as fertility, public provision of electricity, and piped water. The result supports the hypothesis of a negative relationship between children working to collect resources and the likelihood that they will attend school.

The rest of the paper is structured as follows. Sections 1 and 2 present the methodology and the model specification. In section 3, we discuss the variables, data, and descriptive statistics. The econometric results are in section 4, and section 5 concludes.

1. Methodology

We followed the model structure used by Becker (1965) and Rosenzweig and Evenson (1977) to study schooling and environmental goods. A family's decision regarding child

schooling, resource collection, and other activities can be analyzed with the household production developed by Becker (1965) and employed by Rosenzweig and Evenson (1977) and others. This model has been widely used to analyze choice of hours worked, and later was extended by Gronau (1977) to include home production and leisure. Recent empirical work on time allocation in developing countries follows the work of Gronau (1977), and Singh et al. (1986). However, these studies fail to take into account the realities of home production and household structure in developing countries. (See Rosenzweig and Evenson [1977]. Their approach has been used to capture the time allocation in the context of a developing country by other studies, such as Nankhuni and Findeis (2004) who looked at resource collection and schooling in Malawi.)

The family's preference for schooling (S), leisure (L) of their children, home produced goods (Z), and a composite consumption commodity (C) is expressed as:

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

where U is the family utility function and E is the household environment. The utility function is assumed to be twice and continuously differentiable and concave. Z refers to a class of goods, such as fetching water, collecting fuelwood, taking care of younger siblings, tending animals etc., that is produced at home, using market-purchased goods and children's housework time. In this model, parents maximize a utility function, subject to a set of constraints, such as time and budget constraints. The comparative static properties of the model generate a number of interesting hypotheses. For instance, an exogenous increase in nonlabor income would increase schooling and reduce the child's market and housework time. A rise in the cost of resource collection would reduce schooling and increase child work.

2. Model Specification and Estimation Issues

School attendance is potentially endogenous and this may lead to biased and inconsistent results. One possible channel of endogeneity is that school attendance and resource collection can be jointly determined through labor supply decisions. The decision to send children to school may be jointly determined with a decision to send children to collect fuelwood, water, and fodder. Another avenue for endogeneity is that parents who value the education of their children may work harder to keep their children in school (Kingdon 2005). We addressed this problem by estimating a simultaneous equations model for binary variables. Following Greene (1998; 2008) and Nankhuni and Findeis (2004), we adopted the following bivariate probit model:

$$\eta_{i1} = x'_{i1}\beta_1 + \varepsilon_{i1},\, y_{i1} = 1,\, \text{if } \eta_{i1} > 0,\ y_{i1} = 0,\, \text{otherwise} \tag{1}$$

$$\eta_{i2} = x'_{i2}\beta_2 + \varepsilon_{i2},\, y_{i2} = 1,\, \text{if } \eta_{i2} > 0,\ y_{i2} = 0,\, \text{otherwise} \tag{2}$$

$[\varepsilon_{i1}, \varepsilon_{i2}, \rho] \sim$ Bivariate normal (BVN).

Where individual observations of y_1 and y_2 are available for all i, the y_{i1} and y_{i2} are the choices of school attendance and participation in resource collection work observed in the data, respectively; η_{i1} and η_{i2} are the latent variables from which the decisions to participate in these two choices are defined; X_1 and X_2 are the independent variables (household characteristics, environmental variables, regional dummies, demographic variables, and child characteristic variables) in the school attendance model and the resource-collection work model, respectively; and ε_{i1} and ε_{i2} are the error terms, which may be correlated; otherwise, the univariate binary probit model is appropriate (see Greene 2008).

Given the relationship between school attendance and resource collection, there are reasons to suspect the recursive simultaneous equation model. School attendance may be affected by the amount of time that a child spends on resource collection. Therefore, school attendance may be sensitive to the time that a child spends collecting firewood or water. Hence, the resource collection work intensity is treated as an endogenous explanatory variable in the schooling equation:

$$y_1 = X_{i1}\beta_{i1} + \tau y_2 + \varepsilon_1 \tag{3}$$

$$y_2 = X_{i2}\beta_{i2} + \varepsilon_2 \tag{4}$$

In this model, interdependence arises between y_1 (school attendance) and y_2 (resource collection work intensity) because y_2 appears on the right hand side of equation (3). We addressed this problem by using the Rivers and Vuong (1988) procedure to correct for endogeneity. The procedure is done in two stages. In the first stage, a reduced form regression is done on exogenous variables, including instruments, and residuals are predicted. In the second stage, the predicted residuals are included in the probit, including the endogenous variable. A simple t-test of the coefficient residual tests the null hypothesis of exogeneity. This procedure was implemented using the IV probit command in Stata.

To motivate the need to use instrumental variables, we considered the following structural form equation for schooling and reduced form equation for resource collection:

$$y_1 = \beta x_i + \tau y_2 + \varepsilon_1 \text{, and} \tag{5}$$

$$y_2 = \alpha x_i + \delta z + \varepsilon_2, \tag{6}$$

where the structural equation of school attendance, variable y_1, is given by equation (5), while the reduced form equation of the resource work intensity, variable y_2, is given by equation (6). The resource intensity dummy was constructed to represent time spent by children that exceeded the two-hour threshold time to collect resources after school in the evening. The common exogenous covariates which belong in both equations are given by the vector X. The instrumental variables *z*, such as distance to the resource and scarce variables, are included in the reduced form equation, but excluded from the structural form. Unlike Nankhuni and Findeis (2004), who used wood and water scarcity variables and an own-piped water access dummy variable as valid instruments, we proposed alternative instruments.

We used exogenous variation in the household energy fuel expenditure and ratio of children (who collect resources in a household) to family size[1] as instrumental variables for resource work intensity in order to estimate the effects of participation in resource work on school attendance. These are plausible instruments for several reasons. In comparison to a single child, the higher the ratio of children to the family size the lesser the burden to collect resources that can directly affect the children's resource collection participation decision. Consequently, this may also indirectly affect their school attendance. Similarly, higher household expenditure on close substitutes of firewood, such as kerosene, charcoal, or even firewood purchased in the market, has a direct effect on parents' decisions to send children to collect resources and an indirect effect on their school attendance. We found that fuel energy expenditure and the ratio of children (who collect resources) to the family size are in fact closely related to resource collection work (in the first stage regression).

One may ask whether each of the equations in the system is identified. The challenge in estimating the causal impact of resource collection work intensity on education outcome is the possibility that unobserved characteristics of households may influence their decision to collect resources and also play a role in their school decisions for their children. For example, parents who care more about the education of their children may not involve their children in intensive

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[1] We thank an anonymous reviewer for suggesting this instrument variable.

resource collection activities, despite the fact that there is resource scarcity.[2] Moreover, a household with many children who are out of school may reduce the burden of resource collection for those who are in school.

3. Data and Descriptives

The data for this study is mainly cross-sectional primary data, collected from 200 rural households in Kiambu District[3] during the months of April and May 2007. The 200 households were drawn from 20 villages: 9 in Lari division, 6 in Kikuyu division, and 5 in Ndeiya division. The data collected was limited to the three divisions (Lari, Kikuyu, and Ndeiya), due to the continued deforestation of the upland forest, which has contributed to firewood and water scarcity problems.

The study sample was generated using the sampling framework provided by the Kenya National Bureau of Statistics. To ensure equal representation, all the three divisions were sampled using the proportion of enumeration areas (EAs), created for the 1999 census. Multistage sampling was then used to select the sample villages (EAs), and households. In the first stage, the three divisions were selected (Kikuyu, Lari, and Ndeiya). Following the EAs information, the study proportionately sampled 9 of 102 EAs (Lari), 6 of 68 EAs (Kikuyu), and 5 of 47 EAs (Ndeiya). From each village, 10 households were randomly selected and interviewed by trained enumerators. This is considered to be fairly representative of the village (the national household surveys use about 10 households per EA-village). The authors visited the firewood markets to collect firewood prices and conducted focus group discussions with the firewood traders.

The data collected included information on whether children are currently participating in schooling or resource collection; socioeconomic characteristics of households; household sources of income; sources of resources, mainly for fuel, wood, and water; and main energy sources and uses. Of the 200 households surveyed with 1,154 individuals, 609 children aged 5–

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[2] They may also work very hard in order to buy substitutes and also take their children to the best schools.

[3] Kiambu is one of seven districts in the Central Province of Kenya, as of 2002. It is located in the south of the province and borders Nairobi City. It has a total area of 1,323.9 km[2,] with the population of 802,625,000 (per the 1999 census), and has a projected growth rate of 2.56 percent per annum. Kiambu is divided into seven administrative divisions, Kiambaa, Githunguri, Limuru, Kikuyu, Ndeiya, Lari, and Kiambu Municipality. Lari is the largest, and Kiambaa is the smallest (Government of Kenya 2002).

18 years were considered in the analysis and we gathered full information on our variables of interest. (Details of the variables are provided in the descriptive statistics section.) It is important to note that several children come from one family, given the household size and their ages. The survey collected more specific information on children's activities, such as time allocation for domestic responsibilities and resource collection, and time spent on school work. In addition, the dataset included information on the children's school progress, child labor, and the effects of the collection activities on their schooling activities.

In the dry season, the nearest potable water is on average 7 km away in Ndeiya division. Child labor is a severe problem in this district: children between 10 and 18 years of age are estimated to be working at agriculture-related activities and other household chores (Government of Kenya 2002).

3.1. Descriptive Statistics

Table 1 provides the socioeconomic characteristics of the 200 sampled households. From the data, it is evident that few households are female headed. In the sample, only 13 percent of all households have female heads. The results also indicate a low average terminal level of education for the household head, suggesting that on average most household head have only a primary education (8 years of schooling). This also supports the education attainment dummies, which indicate that only 38 percent of all household heads completed post-primary education, compared to 60 percent who completed primary education.

The age categorization indicates that 45 percent of the sampled age groups are school-aged children (6–18 years old). Moreover, the household size, on average, has six members and an average of four children. One would suspect that households with many children out of school are likely to participate in resource collection, which reduces the burden of resource collection to those children who go to school. There is evidence that households' heads diversify income sources. The main income sources are wage labor (47 percent), agriculture (37 percent), and family business (16 percent). Not all households derive income from each of the main sources shown in table 1, but have at least one income source or combination of agriculture with wage labor or family business. The average household income from various sources is KES 8,518 (about US$ 112.15) [4] per month with a variation of KES 6,501 ($85.60). The minimum

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[4] KES = Kenyan shilling. Currently, 1 KES = US$ 0.0131666 (or US$ 1 = KES 75.95).

income in the sampled households is KES 1,000 ($13.12), while the maximum income is KES 50,000 ($658.33).

Table 1. Household Socioeconomic Characteristics

Variable	*Mean*	*Std. dev.*	*Min.*	*Max.*
Male household head	0.87	0.34	0	1
Age of household head	42.48	9.49	22	83
Years of school of household head	8.68	2.81	0	16
No education (household head)	0.02	0.12	0	1
Primary education (household head)	0.60	0.49	0	1
Post-primary education (household head)	0.38	0.48	0	1
Household size	6.16	1.54	3	11
Number of children in household	4.10	1.59	0	9
Number of children who collect resources in a household	2.58	1.36	0	6
Children < 6 years	0.12	0.32	0	1
Children 6–14 years	0.33	0.47	0	1
Children 15–18 years	0.12	0.32	0	1
Young adults 19–24 years	0.08	0.27	0	1
Adults > 25 years	0.35	0.48	0	1
Household head main occupation				
Family Business	0.16	0.37	0	1
Agriculture	0.37	0.48	0	1
Wage labor	0.47	0.50	0	1
Household monthly income (in KES)	8517.54	6501.14	1000	50000

Note: 1 KES = US$ 0.0131666

Source: Field survey data, 2007.

3.2 Children's Schooling and Resource Collection Work

The sample has 609 children, aged 5–18 years old, who are the main focus of pre-school, primary, and post-primary levels of education in Kenya.[5] These children on average started

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[5] In Kenya, pre-unit is preschool or nursery school. Primary school is divided into lower primary (standard, or grades, 1–3) and upper primary (standard, or grades, 4–8). Post-primary, or secondary, school is Forms 1–4. Post secondary means university- or polytechnic-level education.

nursery school at an average age of 5 years and joined standard 1 at the age of 6 or 7 years, depending on the number of years they spent in preschool. Of the 609 children between 5 and 18 years, for whom there was information about their education and who were included in the sample, 51 percent attained a level of upper primary education, 23 percent and 4 percent were in lower primary school and preschool, respectively. The post-secondary level had 21 percent of the children, who were either in secondary school, polytechnic school, or university, or had just completed ordinary level studies. The school attendance data is summarized using the four major categories in figure 1 below.

Figure 1. School Attendance in Primary and Post-Primary School, 2007
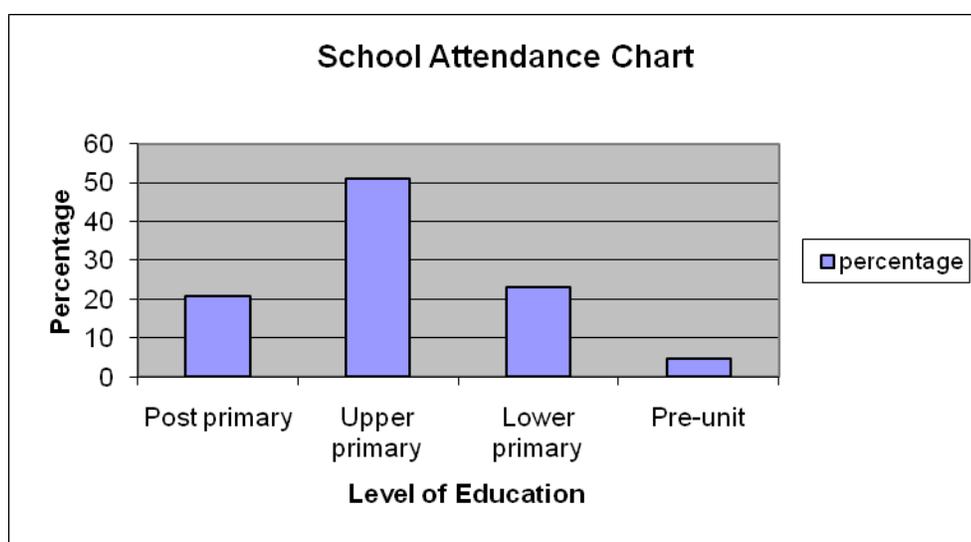
Notes: Post primary means secondary school (grades 9–12). Primary school is eight years;
            upper primary is grades 4–8; lower primary is grades 1–3. Pre-unit is nursery or preschool.

Source: Field survey data, 2007.

Of the 609 children, 19 percent are out of school, while 81 percent are still in school. Ten percent of the sampled children are out of school due to lack of school fees. The pie chart in figure 2 below shows the percentage of school progress in the sampled children. Those in the sample who have ever attended school were also asked question about repetition of classes. The results for this question show that 24 percent of children sampled have repeated at least one class, while 76 percent had not repeated any class. The drop-out rate in the sample is about 50 percent of those children who should go on to secondary school.

Figure 2. Grade Progressions in Primary and Post-Primary School
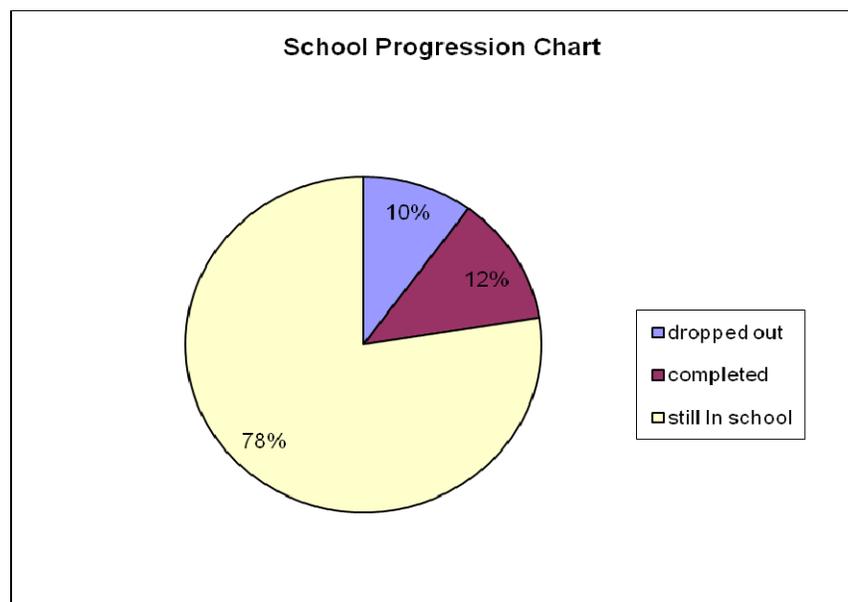
Table 2 below describes children's schooling and resource collection activities. The schooling variables reveal that 79 percent of children in the sample attended school in the previous term[6], while the rest either withdrew from school to perform domestic work (including resource collection) or dropped out of school. We observed that 83 percent of children attended public school, while 17 percent went to private school. This indicates that majority of rural population benefits from Kenya's free primary education. On average, children spend 8 hours in school and 1 hour collecting resources (mainly water) after school. Children spend on average 1 hour and 45 minutes for private studies. Of the children involved in resource collection activities, 9 percent reported that resource collection work affected their work, as reflected by their inability to complete homework. This was also confirmed by the progress reports for these children. Focus group discussions with teachers confirmed that the resource collection work affected performance.

Table 2 also presents the children's time allocation for resource collection and domestic activities. On average, 63 percent of children in school collected water, while 41 percent

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[6] Kenya has three school terms in a year. The first term usually runs from January to March, then a one-month break in April. The second term follows, May to July, and August is the second holiday. Last, September to November makes up the third term, with December as the holiday.

collected firewood. Interestingly, 60 percent of the sampled children in school participated in either collection of water or firewood or both. We generated the resource work intensity dummy = 1 if time spent >120minutes, 0 otherwise. We found that the number of children who collect resources beyond this threshold of two hours reduced by almost half, at 35 percent. Children spent on average four hours collecting resources. Specifically, the greatest share is spent on firewood collection, which takes three hours, while water collection takes one hour.

For water collection, the time spent excludes queuing at water sources and takes 40 minutes plus travel time of 20 minutes. As expected, women spend an average of 3 hours and 26 minutes on both firewood and water collection per day. The survey showed that children's participation in domestic responsibilities, such as agricultural activities, cooking, cleaning, laundry, and child care, is on average 21 hours per week. In addition, 12 percent of children who do not attend school are involved in child labor. On weekends, children spend another two hours on average collecting resources.

Table 2. Descriptive Statistics for Children's Resource Collection Activities and Schooling

Variables	Mean	Std. dev.	Min.	Max.
School attendance	0.79	0.41	0	1
Resource work participation	0.60	0.49	0	1
Resource work intensity dummy = 1 if time spent >120 minutes, 0 otherwise	0.35	0.48	0	1
Water collection participation	0.63	0.48	0	1
Firewood collection participation	0.41	0.49	0	1
Travel time for firewood collection	98.61	91.2	0	360
Collection time for firewood	66.37	51.44	0	300
Travel time for water collection	22.68	22.37	2	150
Collection and queuing time for water	38.71	42.18	3	240
Firewood collection total time	168.23	116.82	10	480
Water collection total time	61.48	60.62	5	390
Children who collect resources as ratio of family size	0.41	0.20	0	0.83
Household fuel expenditure	936.60	582.78	100	3750
Child labor	0.12	0.32	0	1
Children's domestic responsibilities (hours per week)	21.14	20.91	0	104
Female child	0.43	0.50	0	1
Mother resource work, in minutes	196.14	144.86	0	660

Average number of children in a household	4.30	1.51	1	9
Kikuyu dummy	0.25	0.43	0	1
Lari dummy	0.51	0.50	0	1
Ndeiya dummy	0.24	0.43	0	1
Age child began school (standard 1)	6.25	0.65	4	8
Resource work hours of children on weekdays	0.58	0.53	0	4
Hours children work on weekends	2.07	1.76	0	7
Evening study hours	1.77	0.84	0	5
School type dummy = 1 if public school, 0 otherwise	0.83	0.37	0	1

Source: Field survey data 2007

3.3 Fuelwood Collection Descriptive Statistics

Households were asked about their sources of fuelwood. These results are reported in table 3. About 25 percent of households obtain fuelwood from the market, while another 18 percent combines buying fuelwood and collecting it from the commons. This indicates the presence of a well-defined market of fuelwood in Kiambu District. The price of fuelwood varies, depending on the source and the perceived scarcity by the dwellers. For instance, fuelwood prices in Karai (in Kikuyu division) were determined by the major distributor of fuelwood, which had a well-organized fuelwood business. In Ndeiya division, fuelwood was bought from households who collect fuelwood to sell and either deliver the fuelwood to their customers or let customers buy the fuelwood at the collectors' homes**.**

In Lari division, 48 percent of households collect fuelwood from the forest and pay a monthly fee of KES 45 (US$ 0.59) to the Kenya Forest Service, which allows fuelwood collection once a day from the forest. The monthly rental rate is quite low and hence could not be used to proxy for resource scarcity (Gardner and Barry 1978). Those households that collected fuelwood for sale collected on average 57 pieces of bamboo, approximately 1 meter long, which were sold at an average cost of KES 135 ($ 1.78).

A measure of resource scarcity is time per trip, as suggested by Filmer and Pritchett (1996). Households were asked if the supply of fuelwood was a problem, which is normally indicated by travel time and distance to source of fuelwood. The average travel time of a round trip, plus collection time, to collect fuelwood depends on the source of the fuelwood. Collecting fuelwood from the forest takes the greatest amount of time (4 hours and 30 minutes) and buying in the market takes the least (25 minutes), as shown in table 4. This results in a substitution effect

between family income and time spent on fuelwood collection.[7] Collection from the common follows the time spent in forest collection closely in all three divisions under study.

Table 3. Sources of Fuelwood for Households

Source of fuelwood	Percentage use
Forest	26
Fallow land	13
Market	25
Home garden	15
Other (combines fuelwood purchase and collection from the commons)	18
Does not use fuel-wood	3

Source: Field survey data, 2007.

Table 4. Mean Time from Household to Source of Fuelwood (in minutes)

Source	Karai	Lari	Ndeiya
Fallow land	228.75	240	168.57
Forest	254	269.5	195
Home garden	57.27	102.92	80.18
Market	25.26	27	28.22

Source: Field survey data, 2007.

3.4 Market for Fuelwood

Those who collect fuelwood from the market buy it from dealers, which operate a fuelwood business, where various fuelwood pieces have different prices. Table 5 shows the different pieces and the price per piece. Table 5 indicates that the price of fuelwood varies considerably with the different volumes of fuelwood pieces that customers select from the categories provided by the fuelwood dealers. Households buy the pieces they prefer, depending on the amount of money they have and their consumption of fuelwood per day. They pay a range of KES 20 to KES 150 (US\$ 0.26–\$1.97) for single bundles. The fuelwood dealers obtain the

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[7] We thank an anonymous reviewer for suggesting this point.

fuelwood they sell from different sources, which includes growing it on their own farm, buying trees from farmers, and collecting from the fallow land and forest. The price of trees bought from other farmers depends on the thickness of the tree and its location.

Table 5. Fuelwood Price per Cubic Meter

Price per piece of wood	Volume of a fuelwood piece in cubic meters
KES 1.50	0.0029
KES 2.00	0.0035
KES 2.50	0.0042
KES 3.00	0.0048
KES 5.00	0.0064
KES 7.00	0.0096

Note: KES 1 = US$ 0.0131666

Source: Field survey data, 2007.

Households indicated that they substituted three main fuel sources: fuelwood, charcoal, and kerosene. Fuelwood and charcoal are mainly used for cooking and heating, while kerosene is used for lighting and cooking. Table 6 shows the sampled households' expenditure on the three main fuel types. Fuelwood had the lowest mean of KES 249 (US$ 3.28) and also the maximum cost of KES 3,150 ($41.45). This indicates that there is evidence that some households combine fuelwood collection and purchase, while others obtain their entire fuelwood supply from the market. The study also revealed that charcoal is a close substitute for fuelwood.

Table 6. Cost of Fuel per Month

Fuel type	Mean cost	Std. dev.	Min.	Max.	Avg. quantity
Kerosene	330.07	164.15	0	680	2 liters
Fuelwood	249.17	391.62	0	3150	50 pieces
Charcoal	345.08	324.58	0	2000	1 bag

Source: Field survey data 2007

3.5 Household Water Collection

Table 7 presents information on household water collection by source. We observed that households collect water from different sources in the area. In Karai (in Kikuyu division) and Ndeiya division, households mainly obtain their water from the village tap (approximately 35 percent of the water source in the sampled areas) and some from their own tap (21 percent), where water is supplied three times a week. During the dry season, tap water is scarcely supplied and all households are forced to collect water from the village tap. In Lari Division, households obtain water from shallow boreholes, although a few obtain water from the river.

Table 8 reports the water collection and queuing times that include the round trip travel time. We observed that households in either Ndeiya or Karai collect water from boreholes or rivers. In Lari, a majority of households also obtain their water from boreholes and few from rivers. Village taps are key points for water collection in these three areas. Households in Karai recorded the greatest mean time of 129 minutes (2 hours, 9 minutes), which is largely spent queuing, due to water scarcity (especially during the dry season).

Table 7. Household Sources of Water

Source of water	Percentage use by households
Borehole	21
Neighbor's tap	13
Own tap	22
River	4
Village tap	36
Village tap and own tap	5
Village tap and neighbor's tap	1

Source: Field survey data, 2007.

Table 8. Mean Time Spent Collecting Water from Source (in minutes)

Source	Karai	Lari	Ndeiya
Borehole	-	26.42	-
Neighbor's tap	30	31.11	25
Own tap	12.56	9.5	10.5
River	-	70	-
Village tap	128.52	102.35	107.95

Source: Field survey data 2007

4. Econometric Results

The descriptive statistics show that schooling, however measured, is worsened by collection of resources. We pursued this matter further by testing the hypothesis whether or not children currently attend school or whether they collect resources. As these are binary joint outcomes, we estimated a bivariate probit model. A likelihood ratio test of the null hypothesis that the correlation coefficient (ρ statistics of 0.07) equals zero against the alternative that ρ does not equal zero was carried out. The chi-squared statistic obtained from this test was 0.18, with a p-value of 0.68, so the null hypothesis is not rejected at any conventional statistical level. Thus, resource work participation and school attendance appear to be noncompeting activities. It is plausible that children combine both activities. Therefore, the two decisions become competitive when the resource work intensity exceeds the threshold level of combining schooling and resource collection work. Hence, the intensity of resource collection work merits attention in the instrumental variable estimation. The results of the estimated univariate binary probit of resource collection work participation, resource work intensity (first stage regression), and the school attendance IV probit are presented in table 9.

In the first stage estimation, we found that the two instruments used in the resource intensity model are significant; hence, they are relevant. Fuel expenditure has the expected sign, meaning that greater household spending on energy leads to less resource collection by children. However, the ratio of children (who collect resources) to family size is positively related to intensity of resource collection work. This shows that number of children and resource collection work intensity is positively correlated, meaning that household's collect resources beyond the two-hour threshold when there are more children to collect. It is also possible that children have a tendency to work together in a family, meaning they go together to collect the resources when it takes a longer time to accomplish.

The IV probit output includes a test of the null hypothesis of exogeneity; in other words, there is no correlation between the errors in the schooling equation and the resource work intensity equation. The significant Wald test for exogeneity indicates that we reject the null hypothesis. The positive estimated rho coefficient (0.45) indicates that the error terms of school attendance and resource work intensity are positively correlated. Those unmeasured factors that make it more likely for a child to collect resources beyond the two-hour threshold also make it more likely that the child will attend school, conditional on other regressors included in the equation. Hence, the use of IV probit is supported by this result.

The school attendance is negatively affected by resource collection work, as indicated by the negative significant resource collection intensity marginal effects. Being involved in resource collection beyond the two-hour collection work threshold reduces the likelihood of a child attending school by 21 percentage points on average. These results resonate with previous findings by Nankhuni and Findeis (2004) that resource collection work negatively influences child schooling decisions. As is common in developing countries, children are substantially involved in domestic work. Although its coefficient is negative as expected, there is no evidence of domestic work affecting school attendance. A more interesting finding is that child labor reduces children's participation in resource collection. Perhaps, children who participate in child labor have no time left to assist their household in resource collection. The child labor variable was dropped, since it perfectly predicted failure in the IV probit estimation because no children who attend school participate in child labor.

In all the estimated models, wealth (proxy by family income) appears to have no impact on child resource collection and schooling decisions, thus providing neither support nor evidence against the notion that poverty drives children to collect resources. There are no surprises that household wealth does not affect schooling decision in Kenya because of the free primary education policy. Although household income negatively correlates with resource collection intensity, there is no evidence of substitution effect between family income and time spending on resource collection. Although the years of schooling of the household head is not significant, it has the expected signs; that is, the education of the household head positively affects children's school attendance and negatively affects their resource collection work.

With the presence of a female child in a household, signs for resource collection are positive and statistically significant. The implication is that being a girl increases the likelihood of resource collection by 9 percentage points, relative to boys. This confirms the widely accepted traditions that girls are more likely than boys to be involved in resource collection in sub-Saharan Africa. Apparently, from the results, there is no discrimination for schooling for girls in

the study area; this is because the marginal effect of the female children is positive and statistically significant in the schooling model. Being a girl increases the likelihood of attending school by 3.6 percentage points on average, relative to boys, implying that girls are more likely to attend school than boys. However, female children are overburdened by resource collection work. The results further show that children from Lari division are more likely to participate in both resource collection and schooling, relative to children from Ndeiya division. These results suggest that children from Lari division combine schooling and resource collection. There is no evidence that children from Kikuyu division are likely to attend school and collect resources relative to children from Ndeiya division. Hence, we cannot conclude which division has the most severe resource scarcity from these results.

The high positive marginal effects of the age category of 6–14 years suggest that this is when children are most likely to attend school, as compared to ages 15–18, which has a low marginal effect. One can argue that as children grow older and acquire more skills, the opportunity cost of schooling rises. Interestingly, we find in the first stage estimation that those aged 15–18 are more likely to work in intensive resource collection, as compared to ages 6–14, whose coefficient was not significant. The involvement of women in resource collection is negatively, though not statistically significantly, correlated with the incidence of children collecting resources in the resource participation equation. However in the IV probit model, the involvement of women in resource collection has positive, statistically significant predictive power on the likelihood of a child's attending school. Similar evidence was found by Nankhuni and Findeis (2004).

Finally, we found that family size negatively affects both resource collection and school attendance. In large households, those who do not participate in school reduce the collection burden of those in school, which thus negatively affects child resource collection. The negative signs on the coefficients of family size and school attendance suggest that, as the number of household members increases, the more the household wealth base is constrained. One more family member reduces the children's resource collection burden by 3.1 percentage points on average. On the other hand, an extra individual in a family reduces the likelihood of not attending school by 1.6 percentage points. Hence, family size reduces children resource collection burden more than reduction of the likelihood of not attending school.

Table 9. Probit and IV Probit Results

	Resource work participation		Resource work intensity (first stage estimation)		School attendance	
	Marginal effects	*Robust std. err.*	*Coeffi-cients*	*Robust std. err.*	*Marginal effects*	*Robust std. err.*
Resource work intensity dummy	-	-	-	-	-0.211**	0.107
Child labor	-0.253***	0.095	*dropped*		*dropped*	
Household income (in logs)	0.036	0.041	-0.014	0.032	-0.017	0.017
Domestic work (in hours)	-0.001	0.001	0.001	0.001	-0.001	0.001
Female child	0.093**	0.046	0.026	0.037	0.036*	0.022
Mother resource work (in minutes)	-0.005	0.016	0.062***	0.014	0.023**	0.010
Children aged 6–14 years	0.534***	0.064	0.049	0.058	0.375***	0.051
Children aged 15–18 years	0.570***	0.039	0.243***	0.068	0.087***	0.030
Family size	-0.031**	0.015	0.005	0.012	-0.016**	0.007
Years of schooling of household head	-0.008	0.009	-0.009	0.006	0.004	0.004
Lari division dummy	0.112**	0.054	0.050	0.047	0.056*	0.030
Kikuyu division dummy	-0.094	0.070	-0.056	0.053	0.010	0.026
Child ratio			0.814***	0.080		
Energy expenditure (in logs)			-0.094***	0.028		
Constant	-	-	0.392	0.389	-	-
/athrho			0.479**	0.217		
/lnsigma			-0.870***	0.022		
rho			0.445	0.174		
sigma			0.419	0.009		
Number of observations	609		532		532	
Log pseudo likelihood	-316.217		-405.873		-405.873	

Notes: *Dropped* indicates child labor was dropped; 68 observations were not used since it perfectly predicted failure in the IV probit; Wald test of exogeneity (/athrho = 0): chi2(1) = 4.86 Prob > chi2 = 0.0275;

* Significant at 10%; ** significant at 5%; *** significant at 1%.

5. Conclusion

This paper provides new insights into the debate on the interlinking of resource scarcity and human capital development. In particular, the study examines the links between natural resource-collection work and children's schooling in Kiambu District in Kenya. The study was motivated by the growing concern about the anticipated negative effect of environmental degradation on human capital development. The main study hypothesis is that, as resources become scarcer, households will invest more time in collecting them and this will adversely affect the children's school attendance. Since the decisions to collect resources and allow children to attend school are jointly determined, we estimated a bivariate probit model. The instrumental variable probit was also estimated to correct for endogeneity of the schooling and resource collection work intensity equations.

The main empirical findings are as follows. Resource work participation and school attendance appear to be rather noncompeting activities in the bivariate probit model. When we take care of resource work intensity, we find that children's school attendance is negatively affected by scarcity of natural resources and the increased hours of collection work that result. Being involved in resource collection beyond the two-hour collection work threshold reduces the likelihood of a child attending school by 21 percentage points on average. Involvement by the child's mother in resource collection increases school attendance. This implies that parents should be encouraged to help their children in household responsibilities to enable them concentrate on academic work. In addition, there is no discrimination against girls' schooling, but they are overburdened by resource collection work.

The implications of this research are potentially important from an educational policy perspective and argue for integrating local natural-resources enhancement programs with the free primary-education program. Our findings are in line with those of Nankhuni and Findeis (2004). We find that mere participation in resource collection is not necessarily in competition with schooling decision, but rather the intensity of resource collection work negatively affects school attendance in Kenya. Public provision of natural resources, such water and fuelwood, may substantially improve school attendance.

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