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Original Paper

Effects of Child Poverty on Child's Learning Outcomes and Hours in Ghana: The Role of Ecological Zones

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Abstract

Purpose- *This paper investigates the relationship between child poverty, child's learning outcomes and hours in Ghana, emphasizing the moderating role of ecological zones in this relationship.*

Methodology*- A cross-sectional descriptive research design is employed using secondary data from the Ghana Living Standards Survey (GLSS 6 and 7). The FosterGreer-Thorbecke (FGT) poverty measures and logistic and quantile regression techniques analyze the relationship between poverty, learning hours, and outcomes across ecological zones.*

Findings*- The study finds that child poverty negatively influences learning hours and outcomes. Ecological zones moderate this relationship, with forest and savannah zones exhibiting more severe negative effects compared to coastal areas.*

Implications*- These findings highlight the need for region-specific educational policies and interventions to mitigate the adverse effects of poverty. The study underscores the importance of addressing disparities in infrastructure, resource allocation, and educational access across ecological zones.*

Originality*- This study uniquely models the moderating role of ecological zones, contributing to the literature on poverty and education. It offers empirical insights to inform targeted interventions and improve educational equity in Ghana.*

Keywords

child poverty, ecological zones, learning outcomes, learning hours, Foster–Greer–Thorbecke (FGT), logistic regression, quantile regression

1. Introduction

The study investigates the effects of child poverty on children's learning outcomes and hours in Ghana, focusing on the moderating influence of ecological zones. Poverty, defined as the lack of resources to meet basic needs, disproportionately affects children, leading to impaired cognitive development, reduced learning outcomes, and educational disparities (World Bank, 2021; Berger et al., 2018). Globally, child poverty is yet to become the ultimate barrier, severely limiting a child's possibility of development and future success. The projected current scenario states that more than 330 million children worldwide are living in extreme poverty, subsisting on less than $2.15 a day (World Bank & UNICEF, 2022).

In 2022, about 829 million children lived below the $3.65 poverty line, and 1.4 billion below $6.85. Although extreme poverty fell from 20.7% (2013) to 15.9% (2022), progress stalled, returning to pre-pandemic levels. Children (31% of the population) face higher poverty risks, limiting their access to basic needs (UNICEF, 2023; World Bank, 2022).

In Sub-Saharan Africa the challenge is even graver. Over 50% of the extremely poor children in the world are found within this region where the population lives on less than $1.90s per day (more than 60% at this figure) (Glewwe & Kremer, 2006). The situation is equally concerning in Ghana. For example, a report by Ghana Statistical Service (GSS, 2023) indicates that about 38% of children under age 17 are poor, while over 25% find themselves in extreme poverty. Poverty prevalence among the general population stands at 42%, depicting deprivations in terms of education, health, housing, and sanitation.

There is a wide variance in the outcome across the country in terms of child poverty. Ghana's four ecological zones Coastal, Forest, Savannah, and Greater Accra Metropolitan Area (GAMA) display disparities in these zones concerning child welfare. Savannah has the highest child poverty rates of more than 60% with the Forest and the Coastal zones following closely where 35% to 45% of children live in poverty. GAMA reports the least around 15% in terms of child poverty level but this doesn't mean that such poverty is free of overcrowding and lack of educational infrastructure (GSS, 2022; UNICEF Ghana, 2021).

The inequalities are mirrored in these educational outcomes. Approximately 13% of Ghanaian children of primary school age are out of school (UNESCO, 2019) with children from the poorer households more likely to drop out or perform poorly in school. By 2022, only 23% of students in Primary 6 had attained minimum competence in English while 17% met the benchmark in mathematics, with performance heavily interlinked to household income (GNEA, 2022). Studies confirm that the higher the household income, the better the educational outcome, thereby reinforcing the causal relationship between poverty and learning (Cooper & Stewart, 2013, 2017).

Nevertheless, significant knowledge gaps still exist, one neglected factor is the moderating effect of the ecological zones. Different zones pose special challenges flooding in Coastal areas, very long distances to school in the Forest zone, and child labor due to drought in the Savannah. Even here in urban

GAMA, schools in the slums face extreme overcrowding and very poor infrastructure (Brown et al., 2021). Spatial dynamics alter how poverty affects learning, but most studies overlook this, limiting understanding across Ghana's diverse contexts.

The study's objectives are to describe the nature of child poverty and learning outcomes, determine the role of ecological zones in the relationship between child poverty and learning outcomes and assess their effects on learning hours. Using data from the Ghana Living Standards Surveys, it will provide empirical insights to inform targeted interventions. By addressing these gaps, the research aims to guide policymakers in developing region-specific strategies to enhance educational equity and improve outcomes for children in poverty.

The rest of the paper is organized as follows: The next section explores the related empirical literature. The third section looks at the theoretical framework and methodology while the fourth and fifth sections present the results and conclusion respectively.

1.1 Literature Review

The interest in modelling the determinants of child learning outcomes and hours in developing countries has considerably increased recently. Empirically, child poverty has emerged as one of the key-named variables in influencing child learning outcomes and hours in several regions worldwide, where poverty negatively accounts for children's learning outcomes, thereby influencing academic achievements, cognitive development, health, and their entire well-being (Smith et al., 2018; Garcia et al., 2019; Johnson et al., 2017; Patel et al., 2017).

Management of resources and conservation of biodiversity, as influenced by climate, vegetation, and soil, describe ecological zones. Child learning outcomes are often influenced by ecological zones, such as forested areas, savannas, and coastal zones, owing to the factors of infrastructure, environmental hazards, and access to education. In conjunction with geographic context, these are significant indicators of academic performance (Gupta et al., 2017; Choudhury et al., 2018; Kumar et al., 2019).

In the discussion of child poverty and learning outcomes in this article, three main theories are highlighted: Human Capital Theory, which stresses the importance of education and skills for economic success; Education Production Function, which stresses the influence of socioeconomic factors on the learning output; and Environmental Determinism, which describes how ecological zones affect learning opportunities and levels of poverty.

1.2 Theoretical Analysis and Hypothesis

Different pathways through which mechanisms of poverty influence the learning hours and outcomes of children with particular emphasis on poor households include the following: lack of resources is among the common educational disabilities for children going to school not to have textbooks, school supplies, and internet access for after-school learning (Smith & Johnson, 2023). The above mechanisms hit very hard on educational achievement under poverty, thus requiring wide-based interventions to take care of both the material and psychological demands of children within low-income households. The study hypothesized that:

Hypothesis 1: Poverty has a negative association with children's learning hours, thus declining learning hours and outcome.

Hypothesis 2: Poverty has a negative association with children's cognitive development and study routine, thus making both lose in learning outcome and hours.

Eco-zone per se mediates the relationship between poverty and educational outcomes. In coastal eco-zones, opportunities such as tourism and fishing provide income that may weaken poverty and encourage schooling. Violence and ill-timing from all various sources of seasonal activity tourism and over-fishing plus flooding can raise havoc against all of these, effecting school withdrawal of children entirely. (Beine & Noël, 2018; Nicholls & Cazenave, 2010).

Hypothesis 1: In coastal zones, opportunities from tourism and fishing have positive effects on child learning hours and outcomes, while unstable income, environmental degradation, and flooding have negative impacts on these outcomes.

For forest zones, sustainable resource usage and improvements in infrastructure increase household incomes thereby ameliorating poverty. On the contrary, resource degradation, inadequate infrastructure, and ignorance of agroforestry aggravate poverty thus affecting education (Chaudhuri et al., 2017; UNESCO, 2018).

Hypothesis 2: In forest zones, sustainable management of natural resources and improvements in infrastructure positively influence child learning hours and outcomes, while environmental degradation and lack of access to essential services negatively impact these outcomes.

In savannah zones, the adoption of modern farming practices and irrigation augment agricultural production and household income thus weakening poverty and allowing families to invest in child's education (Mellor, 2017). On the other hand, rain-fed agriculture makes households vulnerable to drought, depleting their incomes and forcing children out of school (Ngigi et al., 2018).

Hypothesis 3: In savannah zones, adoption of modern farming techniques and irrigation positively impact child learning hours and outcomes, while rainfed farming and drought conditions negatively impact these.

In urban centers like the Greater Accra Metropolitan Area (GAMA), great access to standard education and technology can improve student learning outcomes immensely. However, the overcrowding of schools, inadequate resources, and poor toilet facilities serve to widen the gap and stifle educational growth for low-income families (Hanushek & Woessmann, 2015; Brunello & Rocco, 2018).

Hypothesis 4: In GAMA, access to quality education and technology positively influences child learning hours and outcomes, whereas overcrowding and lack of technology hinder these outcomes.

The overall consequence on poverty and education is such as whether or not the good outweigh the bad. Provided the opportunities do manifest for the common good, with the support of interested governmental policies, poverty would thus erode and make way for the greater educational achievement of children. Otherwise, if the crossroads would have prevailed, poverty would only set in further, snatching all educational opportunities from children, thereby fostering a vicious cycle of poverty. "The conceptual framework (See Figure 1) visually explains the pathways through which child poverty, ecological zones, and learning outcomes interact.

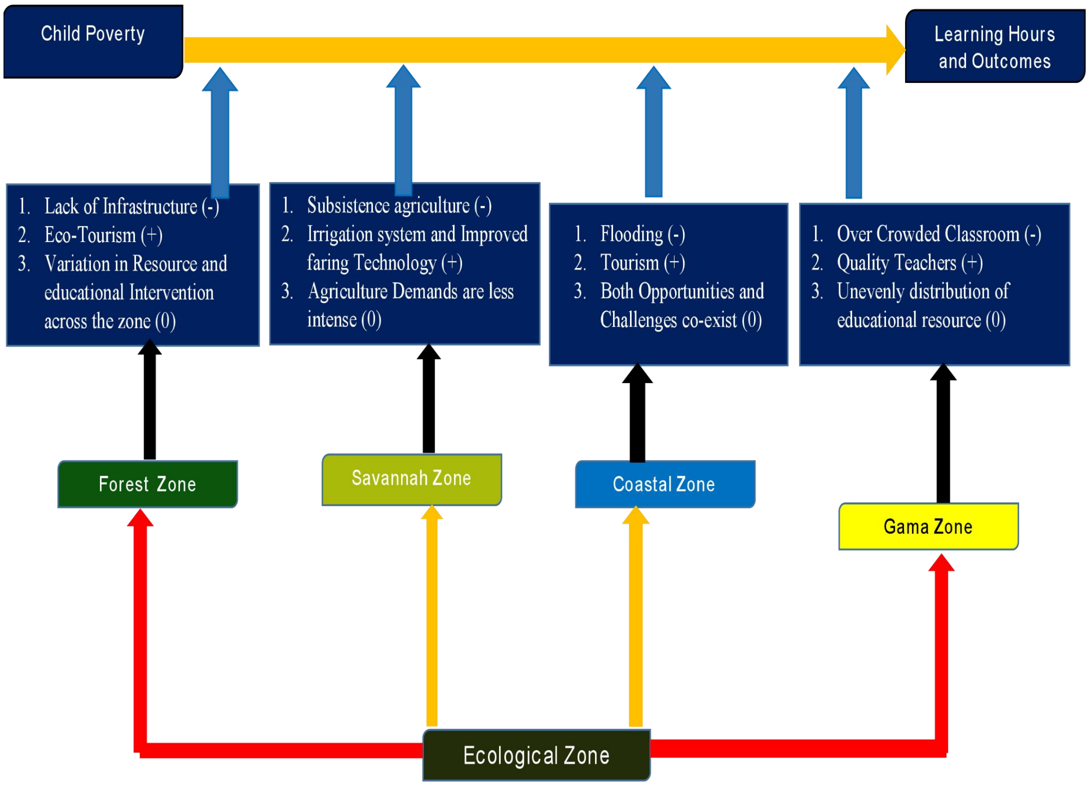

Figure 1. Conceptual Framework

Source: Author's own illustration

2. Methodology

The present study conducted quantitative research that reflected positivist philosophical assumptions. A cross-sectional descriptive research design was utilized.

2.1 Data Analysis

Objective one: To examine the nature of poverty and learning outcomes and hours among children in Ghana.

To describe this objective, the study computed three poverty indices for the various group of interest. The respective formula for poverty and the various indices is provided below

$$\text{Poverty rate} = \frac{\text{Number of Individuals or Households Below Poverty Line}}{\textit{Total population}} \times 100$$

$$\text{Poverty Gap} = \frac{\sum_{i=1}^{n}(\text{poverty line} - \text{income})}{\textit{Total population}}$$

Poverty indices

Headcount ratio (H) = $\frac{\sum_{i=1}^{n} pi}{n}$ **1a**

Average normalizes poverty gap (A)= $\frac{1}{q}\sum_{i=1}^{q} pi$ **1b**

Square Average normalizes poverty gap (M)= HA **1c**

2.2 Analytical Models

The model for skill formation production among children.

Objective two: To determine the role of ecological zones in the relationship between child poverty and child leaning outcomes.

The study relies on the production function of skills formation. Following the works by Boardman and Murnane (1979), Todd and Wolpin (2007) and Almanza and Sahn (2008) on education production function, the study builds a skills formation production.

The production function for children skills formation is thus expressed as:

$$Sf_{it} = Sf_{it}^{p} \ (Ps_{it},\ Cu_{it},\ \ddot{O}_{it},\ \varepsilon_{it},) \qquad \textbf{(2a)}$$

Where i denotes individuals, Sf_{it} is a children skills formation for period t and the superscript p signifies that the identity is a production function. Ps_{it} denotes a vector of school investment variables, Cu_{it} signifies a vector of after- school investment factors. $\ddot{O}_{it}$ denotes abilities while ε_{it} is the error term taking care of unobserved inputs and measurement error.

Introducing the principal variable of interest into the equation (2a), we have:

$$Sf_{it} = Sf_{it}^{p} \ (CPs_{it},\ Ps_{it},\ Cu_{it},\ \ddot{O}_{it},\ CPs_{it}{*}\ X_{it},\ \varepsilon_{it},) \qquad \textbf{(2b)}$$

Where CPs_{it} is the key explanatory variable "child poverty" which is measured as binary choice variable? and the role ecological zones. The theoretical model allows for investments made in the past to influence current skills formations.

The empirical econometric model based on equation (2b) is expressed as:

$$\text{Logit}(P(Z_{ij}=1/x))=\beta_0+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4x_4+\beta_5x_5+\beta_6x_6+\beta_7x_7+\ \beta_8x_8+\ \beta_9x_9+\beta_{10}x_{10}+\ \beta_{11}(x_1 * \ x_i)+\varepsilon_i \qquad \textbf{(3a)}$$

Where j =1 – 3, that is calculate, read and write.

$P($ $=1/x)$ represents the probability that child*i* achieves a certain learning outcome (coded as 1) given the predictors *Xi.Logit*(.) is the log-odds transformation.

2.2.1 Choice of Estimation Technique and Justification

This study uses a **Logit model** because the outcome variables—children's ability in reading, writing, and numeracy—are measured in binary form (1 = able, 0 = unable). Unlike the linear probability model, the Logit approach keeps predicted probabilities within the valid 0–1 range, captures the non-linear link between predictors and outcomes, and makes it possible to estimate how factors such as poverty or child health change the likelihood of positive learning outcomes (Wooldridge, 2010). The model also allows the inclusion of interaction terms, making it suitable for examining how ecological zones and child health shape the relationship between poverty and learning outcomes (Long & Freese, 2014). Overall, the Logit model is the most appropriate choice for this research.

2.3 The Model for Learning Hours Consumption among Children

Objective three: To determine the role of ecological zones in the relationship between child poverty and child leaning hours.

Becker (1964) human capital model is the main theoretical framework under which this objective is conducted. We follow closely the work of Mani et al. (2009) in outlining our model for the determinants of child schooling as shown below: We assumed that households desire to maximize their utility, U (4.1) subject to an income constraint (4.2a) and a schooling production function (4.2b).

$$U = u(C_t,\ S_t,\ L_t, D_t) \qquad \textbf{4.1}$$

$$P_t{}^C\ C_t + P_t{}^m\ M_t = w_t(T_t, -\ L_t) + \pi_t \qquad \textbf{4.2a}$$

$$S_t = f(M_t,\ I_t,\ M_t,\ ф_t,\ ф_{ct},\ U_\cap,\ U_{\cap t}) \qquad \textbf{4.2b}$$

Where: C_t represents both food and non-food consumption goods; $_t$, represents leisure enjoyed by the household; S_t, represents child schooling;

M_t represents schooling inputs; $P_t{}^C$, depicts a vector of the price of food and and nonfood consumption goods; $P_t{}^m$ represents a vector of price of schooling inputs; wt, is the wage rate; T_t, is parents total time endowment; π_t, captures profit income from farm and non-farm activities and all other sources of non-labour income; and D_t **r**epresents time-varying household demographic characteristics.

S_t has been modeled here as a pure consumption good from which the household derives utility. The utility function is affected by time-varying household demographic characteristics D_t such as age of the head of the household capturing household experience and life-cycle position. The schooling production function specified in (4.2b) follows the health production function specified in Sahn and Fedorov (2005), Strauss and Thomas (1995, 2008), Mani (2007) and Mani et al. (2009). The schooling production function S_t is written as a function of schooling inputs, resources, child characteristics and household characteristics.

Schooling hours, S_t here measures child school learning hours demand. Schooling inputs M_t include books, school uniform, and other home inputs. Environmental factors I_t, capture overall resource availability in the community and include factors such as school availability, access to electricity and other community infrastructure that affects schooling hours. In addition, $ф_t$, $ф_{ct}$ include child specific characteristics such as child's sex and age capturing age and gender specific differences in schooling. $U_\cap$, $U_{\cap t}$ capture household demographic characteristics and other time-invariant and time varying rearing and caring practices, all of which affect child schooling hours. Using the first-order conditions, the optimal amount of schooling input is given as;

$$M_t{}^* = f(P_t{}^C,\ P_t{}^m,\ w_t,\ I_t,\ \pi_t,\ D_t,\ \ ф_t,\ ф_{ct},\ U_\cap,\ U_{\cap t}) \qquad 4.3$$

By substituting equation (4.3) in to equation (4.2b), we obtain the static conditional schooling demand function as;

$$S_t^* = f(P_t^C,\ P_t^m,\ w_t,\ I_t,\ \pi_t,\ D_t,\ \phi_t,\ \phi_{ct},\ U_{\cap},\ U_{\cap t}) \qquad \textbf{4.4}$$

Equation (4.4) implies that household demand for schooling for their children crucially depends on the price of food and non-food consumption goods, the price of school inputs, the income level, environmental factors, household and child specific characteristics. The dependent variable in equation (4.4) is a continuous variable which measures number of hours learned. For the purpose of our empirical estimation, we would estimate functionally the following equation.

The empirical econometric model based on equation (4.4) is expressed as:

$$Q\tau\ (Yi \mid Xi) = \beta 0(\tau) + \beta 1(\tau)X1 + \beta 2(\tau)X2 + \beta 3(\tau)X3 + \beta 4(\tau)(X1 \times X2) + \beta 5(\tau)(X1 \times X3) + \ldots\ldots + \beta p(\tau)Xp \qquad \textbf{4.5}$$

Where:

$Q\tau\ (Yi \mid Xi)$ is the conditional quantile function of the child learning outcome Yi at the quantile τ. τ represents the quantile level ranging from 0 to 1. $\beta 0(\tau)$, $\beta 1(\tau)$, $\beta 2(\tau)$, $\beta 3(\tau)$ are the quantile-specific coefficients. $\beta 4(\tau)$ captures the quantile-specific direct effect of poverty on child learning outcomes. Xp represents a vector of control variables. $\beta p(\tau)$are coefficients associated with the control variables. The goal of quantile regression is to estimate the quantile-specific coefficients $\beta 0(\tau)$, $\beta 1(\tau)$, $\beta 2(\tau)$, $\beta \mathrm{p}(\tau)$ for different quantiles of interest (e.g., $\tau=0.25, 0.50, 0.75$).

2.3.1 Choice of Estimation Technique and Justification

Quantile regression estimates the conditional quantiles of a response variable, offering a broader perspective than Ordinary Least Squares (OLS), which focuses on the conditional mean (Koenker & Bassett, 1978). It is preferred over OLS for its robustness to outliers, as it minimizes absolute residuals rather than squared residuals. Additionally, it accommodates heteroscedastic data and reveals how predictors influence different points of the response distribution, providing detailed insights (Koenker, 2005). Unlike OLS, it also captures asymmetric effects of predictors, making it particularly valuable for understanding variations across the distribution of the response variable.

2.4 Data Source and Description

The present work uses secondary data from the sixth (2012/2013) and seventh (2016/2017) rounds of the Ghana Living Standards Survey (GLSS). These rounds provide nationally and regionally representative data on various welfare indicators in Ghana, such as education, health, employment, housing, and migration. The GLSS6 involved a two-stage stratified sampling design with 1,200 primary sampling units (PSUs) and 18,000 households selected. The GLSS7 followed a similar methodology with 1,000 PSUs and 15,000 households. The present study's final dataset comprises 82,107 observations after merging and cleaning data.

3. Results

The summary statistics of the continuous variables used in the study are presented below. The average age of children in the sample is approximately 12.93 years with a standard deviation of 1.39. Household income varies widely, reflecting the disparities across different ecological zones.

Table 1. Summary Statistics of Continuous Variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
Age of child (11-15)	7,293	12.93199	1.398625	11	15
Child_learning hours(week)	7,293	47.07378	34.11496	1	99
HH wage Income	7,293	4386.147	13763.68	0	624000
HHsize	7,293	6.824901	3.262669	1	27
Absolute Poverty Line	7,293	1621.891	206.8616	1314	1760.855
Books _and _Supplies	7,293	59.40307	104.0207	0	2100

Source: Author's own computation using GLSS 6 & GLSS 7.

The socio-demographic profile in Table 2 below presents that 38.41% of children come from urban settings whereas 61.59% of rural places, both pointing out how rural Ghana is (GSS, 2014). The girls are 70.64% compared to the boys who are 29.36%, which indicates some sort of difference in some sampling or more female enrollment than male enrollment. The majority of the children live in forest areas (37.23%) mostly followed by those living in savannah (29.27%), coastal areas (24.22%) as well as in Accra (9.28%), all of which are homogeneous to the ecological zones of Ghana as set out by GSS (2014).

Encouraging literacy outcomes, for example, reading proficiency is at 72.97% while writing is at 75.28% and an impressive 82.26% are competent in some calculations. High literacy levels correspond to higher levels of academic performance (UNICEF, 2020). About 64.97% of poor children are from total households against those of 35.03% who are classified as non-poor, and these reflect differences in socio-economic aspects that may lead to inconsistencies in schooling (World Bank, 2021).

Levels of education are generally low for parents. For example, 60.29% of fathers have little or no formal education, while 75.84% of mothers have little or no formal education, which could affect academic support in the home (Kainuwa & Yusuf, 2013). Fathers are the biggest single providers of educational expenses (50.83%), followed closely by relatives (15.99%) and both parents jointly (15.14%).

Finally, 61.22% of parents are married, suggesting that the household structures are stable and may have a positive effect on the children's educational qualifications (GSS, 2014).

Table 2. Summary Statistics of Categorical Variables

Variable	Categories	Frequency	Percentage
Location	Urban	2,801	38.41
	Rural	4,492	61.59
Gender of child	Male	2,141	29.36
	Female	5,152	70.64

Ecological_Zone	Coastal	1,766	24.22
	Forest	2,715	37.23
	Savannah.	2,135	29.27
	Accra	677	9.28
Fathers_Education	No-Education	4,397	60.29
	Basic Education	1,946	26.68
	Secondary Education	215	2.95
	Tertiary Education	735	10.08
Mothers_Education	No-Education	5,531	75.84
	Basic Education	1,375	18.85
	Secondary Education	76	1.04
	Tertiary Education	311	4.26
Who Paid child Education	Father	3,707	50.83
	Mother	1,316	18.04
	Both Parents	1,104	15.14
	Other Relatives	1,166	15.99
Marital Status of parents	Married	4,465	61.22
	Unmarried	2,828	38.78

Source: Author's own computation using GLSS 6, GLSS 7.

Foster-Greer-Thorbecke poverty indices Results

Objective one: To examine the nature of child poverty, learning outcomes and hours among children in Ghana

Foster-Greer-Thorbecke (FGT) poverty indices for upper poverty line using GLSS 6 and 7 highlights disparities in poverty incidence (P0), gap (P1), and severity (P2), focusing on children's abilities, location, ecological zones, and gender under the upper poverty line.

GLSS 6 shows that children with lesser abilities (unable to write, calculate, or read) had significantly higher poverty levels. For example, the headcount ratio (P0) was 0.682 among children unable to write, while it was 0.588 among those able to write. Limited literacy and numeracy skills correlated with greater poverty severity and in keeping with findings by Adebayo et al. (2022) and Mensah (2022).

There was a general increase in poverty experienced across all groups as revealed by GLSS 7. The P0 of children unable to write rose from 0.682 to 0.741, while those able to write absorbed some increase but were relatively less bad at incurring poverty. This corroborates findings by Nkrumah (2023) and Owusu (2023). Educational skills in writing, calculation, and reading are pivotal in combating poverty levels.

Similar trends in the FGT indices under lower poverty line show significant disparities due to children's abilities, geographical area, ecological zones, and gender. Children unable to write had a P0 score of

0.32 (GLSS 6) and 0.335 (GLSS 7) while their severity of poverty (P2) was 0.10 and 0.11 respectively for each. Similarly, children unable to calculate faced P0 of 0.349 (GLSS 6) and 0.534 (GLSS 7), with P2 rising from 0.113 to 0.192, emphasizing the role of basic education in mitigating poverty (Becker, 1964; Sen, 1999).

Geographical disparities are grievous, with rural areas recording higher poverty levels (P0: 0.541; P2: 0.17) compared to urban areas (P0: 0.325; P2: 0.08). The savannah zone records the highest poverty indices in contrast with the coastal zone which is relatively better-off but with still fairly high poverty indices, with P0 of 0.9123 and P2 of 0.49 indicating very severe deprivation conditions in the savannah zone. Gender-wise analysis shows that male children are more affected as compared to females (P0:0.549; P2:0.18; P0:0.439; P2:0.12) necessitating gender-sensitive interventions (Becker, 1964).

Table 3. Foster-Greer-Thorbecke (FGT) Poverty Indices by Various Groups (Upper and Lower Poverty Lines)

Group	Subgroup	GLSS 6 Upper P0, P1, P2	GLSS 7 Upper P0 , P1, P2	GLSS 6 Lower P0, P1, P2	GLSS 7 Lower P0, P1, P2
Child Ability to Write	Cannot Write	0.682, 0.635, 0.621	0.741, 0.708, 0.699	0.320, 0.335, 0.421	0.541, 0.608, 0.439
	Can Write	0.588, 0.557, 0.548	0.627, 0.604, 0.596	0.483, 0.547, 0.447	0.527, 0.304, 0.296
Child Ability to Do Written Calculation	Cannot Do Calculation	0.689, 0.644, 0.631	0.741, 0.709, 0.700	0.349, 0.534, 0.451	0.651, 0.699, 0.600
	Can Do Calculation	0.597, 0.564, 0.554	0.641, 0.615, 0.607	0.497, 0.764, 0.654	0.341, 0.415, 0.407
Child Reading Ability	Cannot Read	0.680, 0.631, 0.616	0.733, 0.697, 0.687	0.580, 0.531, 0.416	0.533, 0.697, 0.587
	Can Read	0.592, 0.561, 0.552	0.634, 0.611, 0.603	0.492, 0.361, 0.352	0.434, 0.411, 0.703
Location	Urban	0.415, 0.376, 0.365	0.482, 0.459, 0.459	0.325, 0.346, 0.425	0.582, 0.329, 0.559
	Rural	0.671, 0.623, 0.608	0.762, 0.734, 0.725	0.541, 0.533, 0.548	0.432, 0.634, 0.625
Ecological Zone	Coastal	0.465, 0.402, 0.386	0.530, 0.494, 0.483	0.535, 0.543, 0.266	0.430, 0.454, 0.453
	Forest	0.573, 0.523, 0.506	0.655, 0.622, 0.613	0.653, 0.453, 0.546	0.755, 0.633, 0.512
	Savannah	0.812, 0.791, 0.784	0.848, 0.835, 0.831	0.912, 0.821, 0.804	0.713, 0.544, 0.543
	Accra	0.217, 0.186, 0.176	0.268, 0.242, 0.235	0.237, 0.586, 0.476	0.368, 0.142, 0.435
Gender	Male	0.519, 0.469, 0.454	0.000, 0.000, 0.000	0.549, 0.369, 0.454	0.321, 0.316, 0.125
	Female	0.639, 0.605, 0.594	0.658, 0.632, 0.624	0.439, 0.505, 0.339	0.126, 0.542, 0.714

Source: Author's computation using GLSS 6 & GLSS 7.

Logistic Regression results

Objective two: To analyze the role of ecological zones in the association between child poverty and child learning outcomes

A number of critical findings on the moderating role played by ecological zones in the relationship between child poverty and child learning outcomes in Ghana include writing, numeracy, and reading.

The following analysis in Table 4 below finds child poverty has an undeniable negative impact on learning outcomes in Ghana particularly in writing and reading, confirming the literature that child poverty generally has such effects. Indeed, writing by children suffering from poverty has a negative dy/dx = 0.05607, $p<0.01$ and reading dy/dx = 0.05314, $p<0.01$. This conforms to other studies such as Glewwe and Kremer (2006), which proved that poverty undermines the educational success of children. However, between child poverty and ecological zones, interactions are shown that bring into perspective the relative amplification or attenuation by these regions of the effects of poverty on learning.

Beginning with numeracy, the direct effect of forest zone alone is positive and significant (0.05106, $p<0.05$) i.e., the forest children tend to perform better in numeracy than those of coastal zone. Under the condition of being affected by child poverty, however, the outcome of the interaction of forest zone and child poverty yield a significantly negative effect on both writing (0.22364) and numeracy (0.1739). This indicates that poverty amplifies the effects of harm; going in to mean while those in the forest zone may at first appear to have an advantage, poverty tends to reverse that-the fact that poverty-induced stress can overtake other positive situational factors was put forth in Evans and Schamberg (2009).

Location alone within the savannah zone does not significantly matter as far as the educational outcomes are concerned. Nevertheless, poverty worsens the reading challenge (0.32655, $p<0.05$), representing the region's limited educational infrastructure and resources (Glewwe & Kremer, 2006). Again, the interaction of poverty with the savannah zone does not provide any significant effect in writing and numeracy meaning that these skills are less affected by the ecological context.

Poverty had, very importantly, a devastating effect on reading (1.693, $p<0.01$) and numeracy (0.58705, $p<0.01$) output in GAMA zone. Although infrastructurally superior, urban inequality is a severe risk with the educational disadvantage of poorer children which, according to Davis et al. (2018), overcrowded schools have limited resources for the poor urban children.

Overall, it can be said that ecological zones moderate the impacts of poverty on learning, often elevating the negative impact on education.

Table 4. Marginal Effect of Child Poverty on Child Learning Outcomes in Ghana (Moderating Role of Ecological Zones)

VARIABLES	**(A.M.E) Writing Dy/Dx**	**(A.M.E) Numeracy Dy/Dx**	**(A.M.E) Reading Dy/Dx**
Child Poverty			
Poor	-0.0560***	-0.0555**	-0.0532***
	(0.0213)	(0.0181)	(0.01875)
Ecological zones(Base:coastal)			
Forest	0.0055	0.0510**	0.0174
	(0.0176)	(0.0152)	(0.0173)
Savannah	0.0448*	0.0086	0.0472*
	(0.0250)	(0.0230)	(0.02458)
GAMA	0.0534*	0.0850**	0.103***
	(0.0315)	(0.0248)	(0.0264)
Moderating effects			
Ecologicalzone interaction(Base:Coastal*childpov)			
Forest*child_poverty	-0.3551**	0.1633	-0.2236*
	(0.1590)	(0.1836)	(0.02331)
Savanah*child_poverty	-0.2531	-0.2225	-0.3265*
	(0.1609)	(0.1780)	(0.1634)
Gama* Child_poverty	-0.8412*	-0.3722**	-1.3766*
	(0.0054)	(0.0323)	(0.7602)

CONTROLS	YES	YES	YES
Constant			
Observations	3,250	3,250	3,250
R-squared	NA	NA	NA

Robust Standard errors in parentheses

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

Source: Author's own computation using GLSS 6, GLSS 7.

Coastal households classified as poor in Table 5 below suffer the greatest negative impacts on mathematics, writing, and reading (coefficients 0.1249, 0.1349, 0.1264; all significant at 1%) (UNICEF, 2019). The impacts here are still salient for forest zones (coefficients: 0.0735 for math and writing; 0.1088 for reading; significant at 5%) (Bronfenbrenner, 1979). Even slight impacts were noticed in the GAMA zone (coefficients: 0.0114, 0.0284, 0.0805; significant at 10%) (Blake, 1981).

In forest zones, challenges reflect Ecological Systems Theory's concept of limited resources (Bronfenbrenner, 1979). The milder effects in GAMA and savannah correspond to Resource Dilution Theory regarding discrepancies in allocation of resources (Blake, 1981).

Table 5. AME/Sub-Group Analysis (Ecological Zone) on the Effect of Child Poverty on child's Learning outcomes in Ghana (1/0).

Variables	Written Calculation	Writing Ability	Reading Ability
Coastal poor child	-0.1249***	-0.1349***	-0.1264***
	(0.0339)	(0.0357)	(0.0350)
Forest poor child	-0.703**	-0.0735**	-0.1088***
	(0.0264)	(0.0319)	(0.0319)
Savannah poor child	-0.0318*	-0.0241*	-0.0150*
	(0.0409)	(0.0441)	(0.0438)
GAMA poor child	-0.0114*	-0.0284*	-0.0805*
	(0.0508)	(0.0716)	(0.0480)
Observations	3,250	3,250	3,250
R-squared	NA	NA	NA

Robust Standard errors in parentheses

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

Source: Author's own computation using GLSS 6, GLSS 7

Quantile regression Results

Objective three: To ascertain the character of ecological zones as moderators in the relationship between child poverty and leaning hours.

The quantile regression analysis has indicated an impact of child poverty on learning hours in Ghana, moderated by the ecological zones (Coastal, Forest, Savannah, and GAMA). Poverty has a significant reducing effect on the number of learning hours in almost all quantiles, with the largest reduction at the 25th quantile (1.33% at p<0.05), with a smaller reduction at the median (0.44% at p<0.05), and more significant at the 75th quantile (2.33% at p<0.01). Such findings show that poverty reduces learning hours more for the children able to study the least, which adheres to Bourdieu's theory on cultural capital (Bourdieu, 1973) and resonates with the work of Glewwe on educational inequality (Glewwe, 2005).

Regionally, poverty worsens disparity in the Forest zone, more so at the 75th quantile (p<0.05), a symptom of acute resource limitation. In the Savannah zone, children at the 25th quantile gain above-average learning hours (0.217***), probably because of the available educational support, but this advantage is eroded by poverty at higher quantiles. Then, in GAMA, urban poverty further accentuates the disadvantage even though resources are better off with the negative 75th quantile interaction (p<0.05).

Household size interferes with learning hours at lower quantiles and is consistent with the resource-dilution paradigm (Downey, 1995), while household income steadfastly boosts learning hours, particularly at higher quantiles, emphasizing financial steadiness for educational success (Coleman, 1988).

Table 6. Quantile regression of the effect of child poverty on child learning hours in Ghana. (Moderating role of ecological zones)

VARIABLES	Lhours(0.25)	Lhour (0.5) Lhour(0.75)
Child Poverty	-0.0133*	-0.0044* -0.0233**
Poor	(0.0045)	(0.0129) (0.0663)
Moderating Effects		
Ecologicalzone		
interaction(Base:Coastal*pov)		
Forest*poverty	-0.0054*	0.00465** -0.004*
	(0.0091)	(0.0169) (0.0087)
Savannah*poverty	-0.0080	

	(0.0130)	-0.0084 0.0130
		(0.02024) (0.0104)
Gama*poverty	0.0030**	0.0043** -0.0051*
	(0.0280)	(0.0038) (0.0019)
Ecological zones (Base:coastal)		
Forest	-0.0051	-0.00134 -0.0011*
	(0.0025)	0.01514) (0.0077)
Savannah	0.2170***	0.2088*** 0.0011*
	(0.0027)	(0.0163) (0.0084)
Gama	-0.0070	-0.0116 -0.2171***
	(0.0059)	(0.0373) (0.0192)
CONTROLS	YES	YES YES
Constant	6.8480***	6.6664*** 6.8900***
	(0.0115)	(0.0364) (0.0187)
Observations	3,250	3,250 3,250
Pseudo R2	0.2923	0.3569 0.1776

Robust Standard errors in parentheses

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

Source: Author's own computation using GLSS 6, GLSS 7

4. Discussion

This study establishes the moderating effects of ecological zones within the relationship child poverty has with education results in Ghana. The Savannah, Forest, Coastal, and GAMA are examples of ecological zones that determine how poverty impacts learning access. To elaborate, children in these Savannah and Forest zones face quite severe education-related obstacles caused by dearth and poor infrastructural provisions; kids from the Coastal zones, on the other hand, benefit from some economic activities like that of a tourist, even though this may be seasonal in pattern and expose children to environmental dangers. Urban areas like GAMA have better resources but are still affected by the fact that those resources are not equitably distributed due to overcrowding (Glewwe & Kremer, 2006; Davis et al., 2018).

This research has important theoretical and practical implications in exploring the linkage among poverty, ecological zones, and educational outcomes in Ghana. It thus adds to Bronfenbrenner's Ecological Systems Theory: environmental components and socio-economic conditions form a nexus that defines opportunities for learning. This model of moderation by ecological zones-such as Savannah, Forest, Coastal, and urban GAMA-can potentially alter the theory because it adds geographical dimensions to development. This perspective resonates with Glewwe and Kremer's (2006) research emphasis on the need to understand the circumstances of the environment in looking into educational seeds. Further, the study consolidates the Education Production Function Theory of education, pointing out that socioeconomic and ecological fronts critically define the educational outputs.

Practically, this indicates the need to develop bespoke educational and poverty alleviation strategies for each ecological zone's idiosyncratic problems. The priority area for Savannah and Forest areas should be infrastructural investment by the Minister for Education, especially schools and transportation networks. These two measures remain critical in solving the problems of unequal access to education articulated by Glewwe and Kremer (2006). Similarly, the GES should ensure a more equitable distribution of learning resources, for example textbooks and digital tools; and qualified teachers, to close regional gaps. UNESCO (2019) underscores equitable input allocation as perquisite toward inclusive education.

Construction of new facilities and addressing teacher-student ratios in overcrowded schools would be initiatives metropolitan educational authorities could start to make in urban areas like those under GAMA. As income levels vary while tourism and fishing sustain reliable economic activity during certain seasons, the Ministries of Fisheries and Aquaculture Development, Tourism, Arts and Culture, and NADMO must collaborate as income diversifiers and environmental risk management mechanisms against disasters, like flooding. According to Beine and Noël (2018), risk management and economic stability are important since they influence the continuity of education.

Although this study has made significant contributions, it is limited by its use of secondary data, a cross-sectional design, and mainly quantitative methods. It would also be beneficial to portend future longitudinal studies, mixed-methods, and environmental factors such as climate change. Locally specific policy impact assessments could translate to actionable insights for enhancement of educational equity (UNESCO, 2019).

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APPENDIX TABLES

Table A1. Marginal effect of child poverty on child learning outcomes in Ghana (Moderating role of Ecological zones)

VARIABLES	Writing Dy/Dx	Numeracy Dy/Dx	Reading Dy/Dx
Age of child	0.0198***	0.0092**	0.0184***
	(0.0051)	(0.0364)	(0.0050)
Hhsize	-0.0058**	-.0084***	-0.0053**
	(.0025)	(0.0020)	(.00241)
logincomehousehold	0.0268***	0.0161***	0.0261***
	(0.0065)	(0.0055)	(0.0063)
Male child	0.0208	0.0227*	0.0155

	(0.0151)	(0.1046)	(0.0146)
Books and school supplies			
	0.0009***	0.0063***	0.0010***
	(.000129)	(0.00011)	(0.00013)
Fathers Education (Base: No edu.)			
Basic Education	-0.0319	-0.0258	-0.0254
	(0.0194)	(0.0165)	(0.0189)
Secondary_Education			
	0.0195	-0.0072	0.0093
	(0.0389)	(0.0355)	(0.0388)
Tertiary_Education	0.0139	-0.0161	0.0396*
	(0.0252)	(0.0223)	(0.0236)
Mothers Education (Base: No edu.)			
Basic Education	0.0369*	0.0355*	0.0388**
	(0.02007)	(0.0167)	(0.0194)
Secondary_Education	0.0039	0.0710*	0.0459
	(0.0610)	(0.0395)	(0.0550)
Tertiary_Education	-0.0302	0.00738	-0.0418
	(0.0376)	(0.03074)	(0.0379)
Constant			
Observations	3,250	3,250	3,250
R-squared	NA	NA	NA

Robust Standard errors in parentheses

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

Source: Author's own computation using GLSS 6, GLSS 7.

Table A2: Quantile regression of the effect of child poverty on child learning hours in Ghana. (Moderating role of ecological zones)

VARIABLES	Lhours(0.25)	Lhour (0.5)	Lhour(0.75)
HHsize	-0.0010*	0.0208	-0.0510
	(0.0012)	(0.00104)	(0.0053)
Household Income(log)	0.0100**	0.0112	0.0220***
	(0.0006)	(0.0026)	(0.0013)
Age of child	-0.0050*	-0.0033	-0.0210
	(0.0008)	(0.0020)	(0.0014)
Male child	0.0016	0.00390	-0.0052
	(0.0050)	(0.0059)	(0.0030)
Books and school supplies	0.0333	0.0049***	-0.0050
	(0.0005)	(0.0027)	(0.0013)
Fathers Education:((Base:No Edu.)			
Basic_Education			
	-0.0005	0.0047	-0.0113
	(0.0006)	(0.0075)	(0.0038)
Fathers_Education: Secondary	0.0006**	-0.0012	0.004
	(0.0023)	(0.01569)	(0.0807)
Fathers_Education: Tertiary	-0.0018	-0.002485	-0.0020*
	(0.008)	(0.01019)	(0.0524)
Mothers_Education(Base:No Edu.)			
Basic_Education			
	0.0011	0.0016	-0.0028**
	(0.0060)	(0.0081)	(0.0041)
Mothers_Education: Secondary	0.0032	0.0032	-0.0020
	(0.0019)	(0.0234)	(0.0120)
Mothers_Education: Tertiary	0.0022**	0.0005	0.0021*
	(0.0211)	(0.0136)	(0.0070)
Constant	6.8480***	6.6664***	6.8900***
	(0.0115)	(0.0364)	(0.0187)
Observations	3,250	3,250	3,250
Pseudo R2	0.2923	0.3569	0.1776

Robust Standard errors in parentheses

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

Source: Author's own computation using GLSS 6, GLSS 7