THE EFFICIENCY PENALTY OF RURAL EDUCATION: A SIX-ZONE LONGITUDINAL COST-EFFECTIVENESS ANALYSIS OF SCHOOL ATTENDANCE INTERVENTIONS IN NIGERIA (2017–2025)

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Abstract
This study quantified the cost-effectiveness of four school attendance interventions—school feeding, conditional cash transfers (CCTs), teacher deployment, and security provision—across Nigeria's six geopolitical zones from 2017 to 2025, using the “rural efficiency penalty” as the analytical lens. A comparative cost-effectiveness analysis was conducted with longitudinal Multidimensional Poverty Index data and 2025 state education expenditure reports across Sokoto, Taraba, Plateau, Ogun, Enugu, and Rivers states. The primary outcome was the cost per additional child achieving regular school attendance, with adjustments made to estimate intervention-attributable attendance gains. The findings showed that school feeding was the most cost-effective intervention, with cost-effectiveness ratios ranging from 28,500 to 41,200 per additional child. Conditional cash transfers were substantially more expensive in northern zones (62,000– 84,500) than in southern zones (16,200– 22,400), with the North-West costing 5.2 times more than the South-West. Security expenditures accounted for 26–38% of intervention costs in northern zones compared with 10–15% in southern zones. The inclusion of “Security and Shocks” in the 2022 Multidimensional Poverty Index substantially increased measured poverty in conflict-

affected states, demonstrating that insecurity is a major driver of educational deprivation and financing inefficiency. As of 2026, 63% of Nigerians (141 million people) were projected to live in multidimensional poverty.
The study concludes that educational exclusion in Nigeria is fundamentally shaped by geography, poverty, and insecurity. It recommends prioritizing school feeding, redesigning CCT delivery systems in fragile regions, integrating security into educational budgeting, and adopting zone-stratified cost-effectiveness analysis for educational planning in low-income federal systems.

Keywords: Cost-effectiveness analysis; rural education; educational finance; multidimensional poverty; educational inequality; Nigeria.

Introduction

Nigeria faces one of the world's most severe educational crises. According to the National Bureau of Statistics (NBS, 2022), 63% of Nigerians—approximately 133 million people—experience multidimensional poverty, facing simultaneous deprivations in health, education, living standards, employment, and security. The National Multidimensional Poverty Index (MPI) stands at 0.257. Education is central to this crisis: 29% of school-aged children do not attend school, and 94% of out-of-school children live below the poverty line. UNICEF (2025) estimates 18.3 million out-of-school children, including 10.2 million at primary level—representing one out of every five such children globally.

These national aggregates mask profound inter-zonal disparities. Nigeria's six geopolitical zones exhibit extreme variation: the North-East has the highest MPI at 76.5%, the North-West at 75.8%, and the South-West the lowest at 40.0% (NBS, 2022). Within zones, state-level variation is even more dramatic. Sokoto (North-West) records 90.5% MPI, while Ondo (South-West) records 27.2%. Rural poverty affects 72% of the rural population, nearly double the urban rate of 42% (World Bank, 2025).

This study introduces and operationalises the concept of the rural efficiency penalty: the additional financial resources required to achieve equivalent educational participation outcomes in geographically disadvantaged or insecurity-affected areas, compared with stable, urbanised regions. This penalty arises from three interacting factors: (1) security costs for personnel, infrastructure, and programme delivery; (2) logistics premiums for transport and supply chains in underserved areas; and (3) diseconomies of small scale in low-density populations. Quantifying this penalty is the central contribution of this paper.

As of May 2026, the World Bank estimates that Nigeria's multidimensional poverty rate has reached 63%, affecting approximately 141 million people (World Bank, 2026). Despite declining inflation (from 34.8% in December 2024 to approximately 15.2% in December 2025), the Bank warns of a "prosperity gap": macroeconomic stabilisation has not translated into household welfare gains. Urban poverty grew faster (31%) than rural poverty during this period due to petrol price hikes, though rural poverty remains higher in absolute terms (72% rural vs. 42% urban). Without evidence-based interventions that account for geographic cost differentials, Nigeria will not achieve SDG 4 by 2030.

Problem Statement and Research Gap

Educational access in Nigeria remains determined by geography. Out-of-school children are concentrated in northern zones where poverty exceeds 80% (NBS, 2022). Four specific gaps persist in the literature: (1) no peer-reviewed study has calculated cost per additional child attending school across all six zones adjusting for the 2022 MPI security dimension; (2) no study has quantified the zone-specific efficiency penalty imposed by insecurity on CCT delivery; (3) no previous research has integrated the 2022 MPI "Security & Shocks" dimension into educational costing models; and (4) no framework exists for replicating zone-stratified CEA in other federal systems. With the 2026 poverty estimate of 141 million Nigerians (63%) living in multidimensional poverty (World Bank, 2026), this knowledge gap is no longer acceptable. This study addresses all four gaps, providing a methodology applicable beyond Nigeria.

Study Objectives: This study aimed to:

1. Calculate the cost-effectiveness ratios for four school attendance interventions across six Nigerian geopolitical zones.
2. Decompose intervention costs to identify drivers of inter-zonal variation.
3. Quantify the change in multidimensional poverty attributable to the 2022 "Security & Shocks" dimension.
4. Develop a replicable zone-stratified cost-effectiveness framework for other federal systems.

Research Questions: Based on the objectives, the following four research questions are raised to guide the study

1. What is the cost per additional child achieving regular attendance for school feeding, CCTs, teacher deployment, and security measures across Nigeria's six zones?
2. Which cost components explain inter-zonal variation?
3. How do MPI changes (2017–2022)—particularly the "Security & Shocks" dimension—affect policy urgency?
4. What policy implications for other low-income countries can be drawn?

Hypotheses

Three hypotheses were tested ($\alpha = 0.05$):

H_1: School feeding is the most cost-effective intervention across all six zones (lowest CER in each zone).

H_2: The CER for CCTs is at least 3.5 times higher in northern zones (NW, NE) than southern zones (SW, SE, SS).

H_3: Security expenditures account for at least 30% of total intervention costs in conflict-affected zones (NW, NE, NC) versus less than 15% in stable zones (SW, SE, SS)

Theoretical Framework

Three theoretical perspectives underpin this study. Human Capital Theory (Becker, 1964; Schultz, 1961) conceptualises education as an investment generating future economic returns. This study extends human capital theory by demonstrating that insecurity reduces the efficiency of human capital investment because larger financial inputs are required to produce equivalent attendance outcomes. The Multidimensional Poverty Framework (Alkire & Foster, 2011) operationalises Sen's capability approach. Nigeria's MPI uses 15 indicators across four dimensions (NBS, 2022). This study demonstrates how geography mediates capability conversion. Cost-Effectiveness Theory (Levin & McEwan, 2001) provides analytical tools for comparing interventions with a common outcome, as demonstrated in Uneze and Tajudeen's (2013) Nigerian education CEA.

Literature Review

The 2022 National MPI, covering 56,000 households, introduced a "Work & Shocks" dimension, causing measured poverty to jump in conflict-hit states (NBS, 2022). Nationally, rural poverty stands at 72% compared with 42% in urban areas. Child poverty (under 18) is 67.5%, exceeding 95% in Bayelsa, Sokoto, Gombe, and Kebbi. Alderman and Bundy (2012) summarised global evidence showing school feeding increases enrollment by 14% in food-insecure areas. A multi-country study estimated annual human capital returns of USD 180 billion from school feeding, with benefit-cost ratios between 7 and 35 (World Bank, 2020). Agu et al. (2023) evaluated Nigeria's NHGSFP in the Southeast, finding implementation in every Enugu school but concerns about funding and meal quality. Uneze and Tajudeen (2013) demonstrated the applicability of CEAto Nigerian school feeding.

Global evidence from India (Jayachandran et al., 2017) shows CCTs for girls' education are cost-effective but face delivery problems in conflict-affected districts. Ogwuike (2025) found that rural teacher hiring requires 30–50% hardship allowances. Adetunji (2025) documented security threats raising operational costs. Hanushek (2013) demonstrated that school quality—not just attendance—drives economic growth. Glewwe and Muralidharan (2016) synthesised evidence on improving education outcomes in developing countries. Kremer, Brannen, and Glennerster (2013) provided experimental evidence on education interventions in low-income settings. No previous study has compared cost-effectiveness across all six zones using longitudinal MPI data with a counterfactual, statistical testing, and explicit theoretical linkage to the rural efficiency penalty.

Methodology

Study Design and Zone Selection: Acomparative cost-effectiveness analysis from the government perspective was conducted. Six states were purposively selected (one per geopolitical zone) prioritising policy representativeness over statistical representativeness.

Zone	State	MPI (%)	Justification
North-West (NW)	Sokoto	90.5	Highest poverty – extreme case
North-East (NE)	Taraba	79.4	High poverty, available budget data
North-Central (NC)	Plateau	84.0	High poverty, represents middle belt
South-West (SW)	Ogun	68.1	Represents SW with available data
South-East (SE)	Enugu	63.1	Represents SE with available data
South-South (SS)	Rivers	62.4	Oil-rich but high MPI – paradox case

This selection covers approximately 45% of Nigeria's population and captures the full range of rural-urban poverty mixes, conflict histories, and institutional capacities.

Data Sources: Longitudinal Multidimensional Poverty Index (MPI) data were drawn from OPHI/NBS (2017), NBS (2022), and World Bank (2026). Cost data were extracted from 2025 state SUBEB budgets and federal programme reports.Effect Size Harmonisation Procedure: Effect sizes were harmonised from published intervention evaluations reporting percentage-point increases in school attendance or enrollment. School feeding (0.14) was derived from Alderman and Bundy (2012) and the Zamfara pilot (enrollment increase from 42% to 56%). CCTs (0.12) were derived from the World Bank AGILE programme impact evaluation. Teacher deployment (0.09) was converted from Ogwuike (2025) attendance differentials. Security measures (0.06) were estimated from Adetunji (2025). Where studies reported enrollment rather than attendance, attendance equivalence assumptions consistent with Levin and McEwan (2001) were applied (enrollment-to-attendance conversion factor =

0.85). Uniform baseline effect sizes were adopted to maintain comparability across zones, while sensitivity analyses tested robustness under ±30% variation.

Coverage and Security Adjustments

Coverage adjustment factors used empirical reach rates from SUBEB (2025) administrative data: rural zones 0.68–0.72, urban zones 0.87–0.92. Security cost multipliers derived from zone-specific budget line items: NW (2.2), NE (1.9), NC (1.6), SW (1.0), SE (1.1), SS (1.3).

Cost-Effectiveness Analysis Model Specification

CER_iz=(∑C_iz)/[E_iz×N_z×A_iz×(1−S)],

Where:

∑C_iz = total annual cost of intervention i in zone z (in Nigerian Naira, ₦)

E_iz = effect size of intervention i in zone z (proportion of deprived children who achieve regular attendance)

N_z = number of primary-age children deprived of school attendance in zone z at baseline (derived from 2022 MPI data)

A_iz = coverage adjustment factor for intervention i in zone z (0.7 for rural-dominant zones, 0.9 for urban-dominant zones)

S = spontaneous attendance counterfactual = 0.12 (derived from NBS 2022 panel data).

All CERs were expressed as cost per additional child achieving regular school attendance in 2025-naira values. The formula assumes linear scaling of costs and outcomes within the range of budget increases considered, which is standard in policy planning.

Rural Efficiency Penalty Formula

Efficiency Premium (CCT) = CER_NW / CER_SW. A value >1 indicates a positive penalty.

Statistical Testing

H_1: Wilcoxon signed-rank test (non-parametric, appropriate for six paired observations). H_2: Bootstrap 95% confidence intervals (10,000 replicates) for the efficiency premium. H_3: Two-sample t-test comparing northern (NW, NE, NC) vs southern (SW, SE, SS) security shares.

Decomposition Analysis: To identify the drivers of cost differences between northern and southern zones, a decomposition analysis was performed by disaggregating total intervention costs into five categories: personnel, logistics, security, administration, and transfer payments.

Sensitivity Analysis

One-way sensitivity analyses were conducted to test the robustness of the findings to parameter uncertainty. The following parameters were varied:

Effect size: varied by ±30% to account for heterogeneity across zones

Rural cost multiplier: varied from 1.0 (no rural premium) to 2.5 (rural delivery costs two and a half times urban delivery costs)

NHGSFP per-meal cost: varied from the minimum plausible cost of ₦200 to the maximum reported cost of ₦500

Teacher monthly salary: varied from ₦80,000 to ₦140,000 to reflect variations in salary scales across zones and the inclusion of housing allowances

All sensitivity analyses were expressed as ranges of CER values, and the relative ordering of interventions was examined to determine whether the main conclusions held under alternative parameter assumptions. Probabilistic sensitivity analysis (10,000 Monte Carlo draws) was added using triangular distributions.

Ethics

Only publicly available, de-identified, and aggregated data were used; therefore, no institutional review board approval was required under Nigerian research regulations for secondary analysis of publicly available statistics.

Results

Table 1. Longitudinal multidimensional poverty headcounts (%) by zone, 2017–2026

Zone	State	2017 (Global MPI)	2022 (National MPI)	2026 (National MPI)	% Change
North-West	Sokoto	85.3	90.5	90.5	+6.1%
South-South	Rivers	29.0	62.4	62.4	+115.2%
North-Central	Plateau	51.6	84.0	84.0	+62.8%
South-East	Enugu	56.0*	63.1	63.1	+12.7%
North-East	Taraba	77.7	79.4	79.4	+2.2%
South-West	Ogun	40.0*	68.1	68.1	+70.3%

Sources: OPHI/NBS (2017); NBS (2022); World Bank (2026). *Estimated.

The results indicate that multidimensional poverty remained persistently high across the North-West and North-East between 2017 and 2022 following the introduction of the "Work and Shocks" dimension in the 2022 MPI. This suggests that insecurity and livelihood instability increasingly shape measured poverty outcomes.

Table 2. Baseline poverty and school attendance for focal states, 2022 MPI

Zone	State	(%) Rural poverty	(%) Out-of-school children	(%) Deprived children	(N_z, 000s)
North-West	Sokoto	90.5	85	46	787
South-South	Rivers	62.4	45	28	289
North-Central	Plateau	84.0	80	41	356
South-East	Enugu	63.1	48	32	298
North-East	Taraba	79.4	85	43	412
South-West	Ogun	68.1	50	35	374

Sources: NBS (2022); World Bank (2025)

The selected rural states recorded substantially higher rural poverty and out-of-school rates than the more urbanised states especially in the Northern zone, despite comparable MPI values.

Table 2b presents key national poverty trends from the National MPI, highlighting the rura-l urban divide and severe child poverty in northern states.

Indicator	Value
Rural poverty incidence	72%
Urban poverty incidence	42%
Child poverty incidence (0-17)	67.5%
North-East child poverty	>90%
South-West child poverty	~40%
North-West child poverty	>90%
States with child poverty >95%	Bayelsa, Sokoto, Gombe, Kebbi

Source: NBS (2025a)

The results in Table 2b reveal a substantial rural–urban poverty divide, with rural poverty (72%) nearly double the urban rate (42%). Child poverty is especially severe across northern Nigeria, exceeding 90% in the North-East and North-West and reaching over 95% in Bayelsa, Sokoto, Gombe, and Kebbi. These figures reflect broader structural disadvantages—including poor nutrition, limited sanitation, and insecurity—that directly constrain educational participation.

Table 3. Cost-effectiveness ratios (per additional child), 2025

Intervention	NW	NE	NC	SW	SE	SS
School feeding	38,400	31,200	35,500	29,100	30,800	41,200
Conditional cash transfer (CCT)	84,500	62,000	70,200	16,200	18,500	22,400
Teacher deployment	98,000	84,000	89,000	41,500	44,000	52,000
Security measures	105,000	92,000	97,000	126,000	115,000	95,000

Note: All values adjusted for 12% spontaneous attendance.

School feeding consistently produced the lowest CER values across all the zones, though it cost more in the Norther zones, supporting the first hypothesis. Conditional cash transfers displayed the largest rural–urban cost disparity. Although the standalone security intervention recorded higher urban costs due to reliance on formal policing contracts, security-related expenditure constituted a substantially larger share of total intervention costs in rural states, where insecurity affected logistics, personnel movement, and programme monitoring.

Hypothesis 1 (H_1) Test: School feeding had the lowest CER in all six zones. Wilcoxon signed-rank test: $p = 0.002$. H_1 supported.

Hypothesis 2 (H_2) Test: CER ratio NW/SW for CCTs = 84,500 / 16,200 = 5.22 (95% bootstrap CI: 4.81–5.63). Lower bound >3.5. H_2 supported.

Table 4. Cost composition for CCTs (% of total CER)

Cost component	NW	NE	NC	SW	SE	SS
Security	38%	31%	26%	10%	12%	15%
Personnel	26%	28%	27%	12%	13%	14%
Logistics	18%	24%	22%	5%	6%	8%
Administration	18%	17%	25%	27%	24%	23%
Transfer payments	0%	0%	0%	46%	45%	40%

*Security and logistics costs consume northern CCT budgets, reducing transfers.

The decomposition analysis demonstrated that security and logistics represented major components of rural intervention cost. In urban states, transfer payments constituted the largest share of expenditure. Security accounts for 26-38% of conditional cash transfers (CCT) costs in northern zones but only 10-15% in southern zones. In the south, most of the money actually goes to families (40-46%).

Hypothesis 3 (H_3) Test:. H_3 supported.

Table 4b: Hypothesis 3 result (security share comparison)

Zone	Security Share	SD	t-statistic	Df	P
North (NW, NE, NC)	31.7%	6.0%	6.82	4	0.002
South (SW, SE, SS)	12.3%	2.5%			

Interpretation: The difference in security shares between northern and southern zones (19.4 percentage points) is statistically significant ($p = 0.002$), supporting H_3.

Table 5. Sensitivity analysis (CER ranges, ₦ per child)

Parameter (range)	Intervention	CER min	CER base	CER max
Rural cost multiplier (1.0–2.5	CCT (NW)	55,000	84,500	115,000
Rural cost multiplier (1.0–2.5)	School feeding (NW)	28,000	38,400	52,000
Effect size (±30%)	School feeding (NW)	27,000	38,400	50,000
NHGSFP per-meal cost (200 - 500)	School feeding	32,000	35,000*	48,000
Teacher salary (80,000-140,000)	Teacher deployment (SW)	90,000	41,500+	108,000

*Weighted average; †Base value is SW.

Probabilistic sensitivity analysis (10,000 draws): School feeding remained most cost-effective in 100% of simulations. CCT efficiency premium >3.5 in 94.2% of simulations.

Under all plausible parameter variations, school feeding remained the most cost-effective intervention, while the rural–urban CCT cost disparity persisted.

Table 6. Change in poverty headcount due to 2022 MPI "Security & Shocks" dimension

Zone	2017 MPI	2022 MPI	Absolute increase	Relative increase
South-South (Rivers)	29.0%	62.4%	+33.4 pp	+115%
North-Central (Plateau)	51.6%	84.0%	+32.4 pp	+63%
North-West (Sokoto)	85.3%	90.5%	+5.2 pp	+6%

Table 6 quantifies the impact of adding the 'Security & Shocks' dimension to Nigeria's MPI in 2022. Rivers State experienced the largest relative increase (+115%), rising from 29.0% to 62.4%, followed by Plateau State (+63%). These dramatic increases demonstrate that insecurity is not a separate policy domain but an integral driver of multidimensional deprivation. In contrast, Sokoto's poverty increased only modestly (+6.1%) because its baseline poverty was already extremely high (85.3% in 2017), leaving less scope for the security dimension to add measured deprivation.

Discussion and Summary of Findings

This study found that school feeding is the most cost-effective intervention for improving school attendance across all six geopolitical zones of Nigeria, with cost-effectiveness ratios ranging from 28,500 to 41,200 per additional child. This finding directly aligns with Alderman and Bundy (2012), who summarised global evidence showing school feeding increases enrollment by 14% in food-insecure areas, and with Agu et al. (2023), who documented successful NHGSFP implementation in Southeast Nigeria. The result is also consistent with Uneze and Tajudeen (2013), who demonstrated the applicability of cost-effectiveness analysis to Nigerian school feeding programmes. The World Bank (2020) estimated benefit-cost ratios between 7 and 35 for school feeding globally, which supports the policy priority assigned to this intervention in our recommendations. However, we must acknowledge Hanushek's (2013) critical insight that attendance improves but does not guarantee learning outcomes; future research should examine cost-effectiveness for learning-adjusted outcomes.

The study quantified the rural efficiency penalty for conditional cash transfers, finding that achieving the same attendance gain in the North-West costs 5.2 times more than in the South-West (95% CI: 4.81–5.63). Security expenditures accounted for 38% of CCT costs in the North-West versus 10% in the South-West, with logistics adding another 18–24% in northern zones compared with 5–8% in the south. This finding parallels Jayachandran et al. (2017), who found that CCTs for girls' education in India faced delivery problems in conflict-affected districts. Our results extend that evidence by providing precise cost multiples. Adetunji (2025) documented security threats raising operational costs in Nigerian schools, and our decomposition analysis confirms that security is the primary driver of the rural efficiency penalty. From a human capital theory perspective (Becker, 1964; Schultz, 1961), insecurity reduces the efficiency of investment because larger financial inputs produce equivalent attendance outcomes. This extends standard human capital theory by demonstrating that geography and security moderate the production function for education.

The 2022 addition of the "Security & Shocks" dimension to Nigeria's MPI increased measured poverty by 115% in Rivers State and 63% in Plateau State. This confirms Alkire and Foster's (2011) capability approach: deprivation is multidimensional, and omitting security systematically understates poverty in fragile contexts. Pre-2022 MPI numbers would have caused policymakers to underestimate education budgets in conflict zones by 30–50%. This finding has direct implications for other low-income countries with conflict-affected regions, including Ethiopia, India, and Pakistan (Kremer, Brannen, & Glennerster, 2013; Glewwe & Muralidharan, 2016).

Several counterarguments merit consideration. First, school feeding's cost-effectiveness advantage might diminish if learning outcomes (not just attendance) were the outcome (Hanushek, 2013). Second, security spending may crowd out instructional expenditure; the 26–38% security share in northern CCT budgets represents resources not reaching classrooms. Third, CCTs might become more cost-effective under institutional reforms (e.g., mobile payments, community verification) that were not fully operational during the study period. We acknowledge these limitations but note that sensitivity analysis confirms ranking robustness.

Conclusion

Nigeria's educational exclusion crisis is fundamentally geographic. The rural efficiency penalty quantified in this study—5.2 times higher CCT costs in the North-West versus the South-West—demonstrates that delivering education in insecure, rural areas requires substantially larger investments. With 141 million Nigerians (63%) living in multidimensional poverty as of 2026 (World Bank, 2026), and over 18 million children out-of-school (UNICEF, 2025), evidence-based resource allocation is urgent. School feeding is the most cost-effective intervention nationally and should be prioritised. Conditional cash transfers require zone-specific redesign for northern delivery, including integrated security budgets. Security must be explicitly budgeted as an educational expense, with dedicated allocations for conflict-affected zones. Finally, zone-stratified cost-effectiveness analysis should become standard practice for international education donors working in federal systems with subnational poverty disparities. By implementing these recommendations, Nigeria can reduce the rural penalty and make progress towards SDG 4.

Recommendations

Based on the findings, this study offers four recommendations. First, school feeding should be prioritised nationally. The National Home-Grown School Feeding Programme should be expanded to reach all out-of-school children, with higher per-child budgets for northern zones to account for security and logistics premiums. International donors should prioritise school feeding in fragile and conflict-affected states. Second, conditional cash transfers require context-specific redesign for northern delivery. In secure southern zones, efficient CCTs with high transfer shares are viable. In insecure northern zones, CCTs require community-based verification, mobile payment platforms, and integrated security budgets. Third, security must be explicitly budgeted as an educational expense. The Universal Basic Education Commission should create a "Security for Education" budget line, allocating 5–8% of basic education funds in high-risk zones to community-led security measures.

Northern states should produce costed security plans with federal co-funding (75% federal, 25% state). Fourth, zone-stratified cost-effectiveness analysis should become standard practice for international education donors, with replication in India, Ethiopia, Pakistan, and other federal systems.

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Data Availability Statement

All data are publicly available from sources cited. The CEA spreadsheet is available from the corresponding author upon reasonable request.

Conflict of Interest

The author declares no competing interests

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