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Research article

Armed Conflict, Institutional Quality, and School Enrollment in Sub-Saharan Africa: Evidence from an Entropy Balanced Panel

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Abstract
This study evaluates the impact of armed conflict on school enrollment across 37 Sub-Saharan African countries from 1990 to 2023. Using entropy balancing and fixed effects panel regression, the study finds that conflict reduces gross primary enrollment by 0.9 to 1.1 percentage points. Girls experience greater enrollment losses than boys and remain depressed three years after conflict ends, whereas boys recover within that window. Central Africa suffers a 3.0 percentage point penalty, while West Africa shows statistically insignificant effects. Control of corruption fully neutralizes the conflict penalty at a threshold corresponding to the governance levels of Ghana and Senegal. Policy should prioritize legally ring fenced education budgets and anti-corruption measures during and after conflict.
Keywords: armed conflict; school enrollment; entropy balancing; institutional quality; gender; Sub-Saharan Africa; dynamic effects

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INTRODUCTION

Children in conflict zones face a schooling crisis of structural depth. Save the Children (2024) reports that 1 in 3 children in conflict affected and fragile states is out of school. The African Union (2024) identifies armed conflict as the single largest barrier to educational access across the African continent. UNICEF and NRC (2025) document that in West and Central Africa alone, over 10,000 schools have been closed, attacked, or militarised since 2016, leaving at least 5 million children without access to education. These are not episodic disruptions; they describe a cumulative and self-reinforcing educational deficit that outlasts the conflicts producing it.

Sub-Saharan Africa (SSA) is the epicentre of this deficit. The Uppsala Conflict Data Program/Peace Research Institute Oslo (UCDP/PRIO) Armed Conflict Dataset records more active conflicts in SSA than in any other world region in every year from 1990 to 2023. The consequences for education have been severe and geographically varied: the Rwandan genocide of 1994 claimed over 800,000 lives in 100 days and reduced completed schooling among exposed children by half a year (Akresh & de Walque, 2008); and the Democratic Republic of Congo has accumulated over 5.4 million conflict related deaths since 1998, systematically destroying educational infrastructure across Central Africa (Oladayo, 2019). In Nigeria, Boko Haram killed more than 35,000 people and displaced over 2.5 million in the Lake Chad Basin, destroying over 1,400 schools in northeast Nigeria alone (Oladayo, 2019; Bertoni et al., 2019); and in Cameroon, the Anglophone Crisis that began in 2016 has closed over 4,000 schools in the Northwest and Southwest regions, displacing approximately 700,000 people and removing some 600,000 children from school (Awu & Hui, 2025; Galindo-Silva & Tchuente, 2023). Across these varied contexts, the mechanisms of educational disruption are consistent: physical destruction of schools, displacement and killing of teachers, diversion of fiscal resources from education to security, and the psychological trauma that depresses learning even for children who remain enrolled.

The empirical literature has established the existence of these effects but has not fully answered three questions that are essential for policy. First, how long do enrollment losses persist after conflicts end, and does the answer differ by gender? Most studies measure only the contemporaneous conflict year, implicitly assuming children return to school when fighting stops. This assumption is implausible, particularly for girls who face compounding barriers of early marriage, increased domestic responsibilities, and physical insecurity during displacement (Buvinic et al., 2014). Second, does the severity of the enrollment penalty vary systematically across subregions, and if so, what drives that variation? The contrast between Central Africa and West Africa in particular raises the question of whether institutional and community level arrangements can buffer educational systems from conflict. Third, at what specific level of institutional quality does the conflict enrollment penalty become statistically negligible? This question has been posed theoretically by Shields and Paulson (2015) and Hallak and Poisson (2007) but has not been tested econometrically at panel scale.

Three contributions define this paper's position in the literature. It is the first large panel SSA study to model the dynamic persistence of conflict's enrollment effects with a three-year lag structure, testing directly rather than assuming how long the disruption lasts. It provides the first econometric test of institutional moderation of the conflict enrollment relationship across all six dimensions of the Worldwide Governance Indicators (WGI). And it quantifies the precise governance threshold at which the primary enrollment penalty disappears, identifying achievable country benchmarks rather than unattainable governance ideals.

Theoretical Underpinning: Mechanisms Linking Conflict to Educational Outcomes

The relationship between armed conflict and school enrollment operates through at least four distinct channels, each supported by a body of theoretical and empirical work. Understanding these channels separately is essential because they imply different policy responses and different persistence patterns, and because the gender asymmetry in recovery rates documented in this paper flows directly from the differential weight of each channel for boys and girls.

Human capital theory (Schultz, 1961; Becker, 1975) provides the foundational framework. Education is a long-term investment in which returns accumulate over decades; conflict attacks both sides of this investment simultaneously. On the supply side, school infrastructure is physically destroyed or militarised, teachers are killed or displaced, and governments redirect fiscal allocations from education to security. On the demand side, household incomes collapse as labour markets and agricultural systems are disrupted, reducing the private resources available for fees, materials, and the opportunity costs of keeping children in school rather than working or performing domestic labour. Glewwe and Miguel (2007) show that in African settings, the supply and demand channels interact multiplicatively: infrastructure destruction eliminates access at the same time as poverty eliminates affordability, producing enrollment reductions that exceed what either channel alone would predict.

Sen's (1999) capabilities approach adds a dimension that matters especially for understanding the gender asymmetry in persistence. Education for girls in conflict affected societies is not only a human capital investment; it is the primary mechanism through which girls gain access to health literacy, civic participation, delayed marriage, and autonomous decision making. When conflict removes a girl from school, it does not merely reduce her future earnings; it contracts her space of possible lives in ways that endure regardless of whether she eventually re-enrolls. The capabilities framework explains why the lag structure in Table 3 shows female enrollment remaining significantly depressed three years after conflict ends while male enrollment recovers: boys returning to school primarily restore their human capital investment, while girls returning to school must overcome the social and institutional barriers that conflict has erected around their capabilities.

Collier et al.'s (2003) conflict trap framework establishes a third mechanism with direct relevance to the persistence question. Educational disruption reduces long run economic growth, which increases the probability of future conflict, which disrupts education further. This recursive logic means that the educational losses from a single conflict episode are not bounded by the duration of that episode; they propagate through the economic and political system in ways that generate future educational losses. The persistence of the enrollment penalty at lag 3, documented in Table 3, is consistent with this mechanism operating at the household and community level: families impoverished by a conflict episode take years to rebuild the resources necessary for consistent school attendance, and some never do.

Ungar et al.'s (2013) social ecological resilience model provides the fourth and most direct theoretical foundation for the institutional moderation hypothesis. Educational resilience during conflict is produced at nested levels of social organisation: individual, family, school, community, and state. The moderation analysis in the results section directly tests the state level, asking whether governance quality determines how much of the conflict induced disruption at lower levels actually translates into enrollment loss. When state institutions are strong, governments maintain teacher payrolls during conflict, enforce school protection protocols, prevent the corruption driven diversion of education budgets documented by Hallak and Poisson (2007), and deploy emergency education resources to affected communities. When they are weak, each of these protective functions collapse, and the full force of the conflict disruption reaches the child in the classroom.

Review of Recent Empirical Studies

The Cameroon Anglophone Crisis, which began in 2016 in the Northwest and Southwest regions, illustrates all four mechanisms in a single, geographically contained context. Galindo-Silva and Tchuente (2023) use a difference in differences design to estimate that exposure to conflict events and casualties in these regions produced significant declines in students' reading and mathematics test scores. Nji (2025) surveying 310 teachers across the affected regions, documents that physical insecurity, salary interruptions, and school militarisation have fundamentally undermined both teacher motivation and classroom continuity. Agbor et al. (2022) establish that teacher displacement and school militarisation are the primary mechanisms through which the crisis disrupts teaching and learning. Awu and Hui (2025) report severe infrastructure damage, acute staff shortages, and measurable psychological trauma among students. Ebot (2024) follows students displaced from the crisis zones to Francophone cities and documents the severe barriers to educational reintegration they face, illustrating the persistence mechanism: the educational disruption does not end when a displaced student reaches safety but continues through administrative exclusion, language barriers, and the psychological burden of displacement.

The core finding that conflict reduces school enrollment is well established across the broader literature. Akresh and de Walque (2008) estimated that Rwandan genocide exposure

reduced completed schooling by 0.5 years. Shemyakina (2011) found 7 percentage point reduction in girls' enrollment from the Tajikistan civil war, with no significant effect on boys. This is a gender pattern this paper replicates at continental scale. Bertoni et al. (2019) showed that Boko Haram reduced enrollment by 28% in affected Nigerian districts. Poirier (2012) estimated 14 percentage point reduction in Cote d'Ivoire. Diwakar (2023) documented reductions of up to 25% in Yemeni conflict zones. Tai (2025) uses Armed Conflict Location and Event Data (ACLED) geo-referenced events matched to Demographic and Health Surveys (DHS) records across SSA to estimate that proximity to conflict reduces girls' educational access more than boys', consistent with the gender differential of this paper. Ajogbeje and Sylwester (2024) disaggregate conflict type in Nigeria and find that insurgent conflicts affecting school infrastructure produce larger enrollment losses than farmer herder conflicts operating primarily through household displacement. Ben Salah and Saxena (2025) match standardised test scores to conflict event data across ten SSA countries and find that violent conflict exposure since birth reduces reading and mathematics proficiency, with the largest effects concentrated in early childhood exposure and a disproportionate reduction in school attendance for girls, consistent with the gender asymmetry documented here. Sakketa, Usman, and Kedir (2025) examine conflict exposure and human capital formation among children in several SSA countries, extending the enrollment focus of this paper toward broader measures of child wellbeing. Chiovelli, Michalopoulos, Papaioannou, and Sequeira (2026) use sibling comparisons around the Mozambican civil war to show that displacement effects on education are heterogeneous by destination, with displacement to urban areas associated with increased educational investment relative to displaced siblings who remained in rural areas, a nuance that complements the destination specific institutional buffering this paper documents at the country level. Holzman, Olinga, Busingye, and Rappaport (2025) document that conflict deaths correlate with infectious disease incidence across six neighbouring SSA countries, underscoring a health-related channel through which conflict can compound the educational losses estimated in this paper. Alkali et al. (2024) document that out of school rates among girls in northeast Nigeria remain elevated years after peak Boko Haram activity, providing country level evidence of the persistence that this paper tests at panel scale.

The moderating role of institutions has been theorised but not previously tested econometrically at panel scale. Shields and Paulson (2015) found greater enrollment retention in countries with stronger legal protections for educational rights. Hallak and Poisson (2007) showed that anti-corruption mechanisms preserve education budgets during crises. The World Bank (2024) approach paper identifies fiscal ring fencing and teacher deployment continuity as the two highest return interventions in conflict settings, findings that map directly onto the government expenditure coefficient and political stability interaction reported in the moderation results below. Unfried and Kis-Katos (2023) use individual DHS records and georeferenced conflict exposure to estimate educational effects in SSA; their design controls for individual unobserved

heterogeneity more precisely than a country year panel but cannot test temporal dynamics or institutional moderation, which are this paper's contributions.

Figure 1 maps the spatial distribution of major conflict zones across SSA. The subregional enrollment penalties annotated in the figure preview the heterogeneity results in the regional analysis and establish the geographic context within which the moderation analysis is situated.

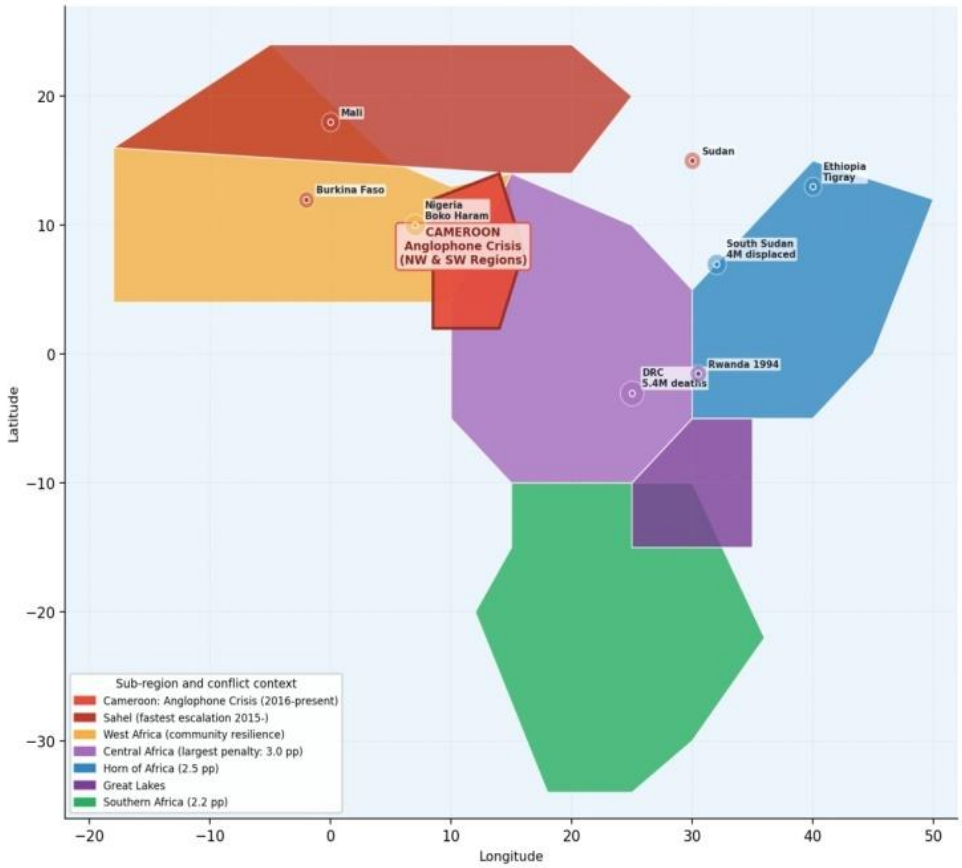


Figure 1. Armed Conflict Zones in Sub-Saharan Africa (1990 to 2023).
Subregional labels show estimated primary enrollment penalties from the regional heterogeneity results. Circle size reflects relative conflict fatalities (Oladayo, 2019).

RESEARCH METHOD AND MATERIALS

Research Design and Sample

This study employs a balanced panel design covering 37 Sub-Saharan African countries observed annually from 1990 to 2023, yielding a maximum of 1,258 country year observations before listwise deletion. The estimation sample begins with all 48 countries of SSA as defined by the World Bank regional classification. Three exclusion criteria reduce this to 37 countries: eight countries are excluded for more than 20% missing observations on core variables, two are excluded because the UCDP/PRIO conflict indicator is unavailable for more than five years of the

study period, and one is excluded for joining the UCDP dataset after 1995 due to later independence. The resulting 37 country balanced panel spans all four SSA subregions with representative variation in conflict history, institutional quality, natural resource endowment, and educational development trajectory. For gross primary enrollment, 881 country year observations are available after listwise deletion of missing values. Gender disaggregated enrollment is available for 870 observations. Institutional moderation models use 654 observations, reflecting incomplete WGI coverage for some country years before 1996. Tertiary enrollment is available for 524 observations.

Conflict Indicator

The conflict variable is binary, drawn from the UCDP/PRIO Armed Conflict Dataset: it equals one when a country records at least one organised political conflict with 25 or more battle related deaths in a given year, and zero otherwise. This threshold follows Fearon and Laitin (2003) and Collier and Hoeffler (2004). In robustness checks, replacing this binary with an ACLED event count indicator yields qualitatively identical results, with coefficients ranging between 0.008 and 0.012.

Outcome Variables

The primary dependent variable is gross primary school enrollment (%), drawn from the World Development Indicators (WDI) (World Bank, 2020). Gross enrollment is preferred to net enrollment in main specifications because it captures the full scope of conflict induced disruption, including the delayed entry and grade repetition that conflict generates. Net enrollment, used as a robustness check, yields larger absolute coefficients, consistent with overage enrollment partially masking the true access deficit in the gross measure. Secondary, tertiary, and gender disaggregated enrollment rates are used in heterogeneity specifications.

Institutional Quality and Control Variables

Institutional quality is measured by all six WGI indicators (World Bank, 2023), each lagged one period: Control of Corruption, Rule of Law, Political Stability, Government Effectiveness, Voice and Accountability, and Regulatory Quality, each normalised globally with mean zero and standard deviation of one. Control variables are selected on the basis of established theoretical links to both conflict incidence and educational outcomes (Fearon and Laitin, 2003; Collier and Hoeffler, 2004; Busemeyer, 2007): Gross Domestic Product (GDP) per capita growth, inflation rate, domestic credit to the private sector as a share of GDP, net Foreign Direct Investment (FDI) inflows, urbanisation rate, government expenditure on education as a share of GDP, fixed telephone subscriptions per 100 inhabitants, employment to population ratio, and population growth. All controls are lagged one period to reduce reverse causality.

Identification Strategy: Entropy Balancing

Countries that experience armed conflict differ systematically from those that do not on dimensions that also predict educational outcomes. Table 1 shows that before reweighting, conflict affected countries in the sample have significantly lower gross primary enrollment (81.6% versus 94.2%; standardised difference 0.214, $p < 0.001$), lower GDP per capita growth, higher inflation rates, higher Fragile States Index scores, and lower government expenditure on education. A naive regression of enrollment on conflict would attribute to conflict what is partly determined by these structural differences. Standard Ordinary Least Squares (OLS) regression with country fixed effects removes time invariant confounders but cannot address time varying selection from macroeconomic deterioration, governance decline, and conflict onset occurring simultaneously. We apply entropy balancing (Hainmueller, 2012) to reweight the control group so that its sample moments match those of the treatment group exactly. The method solves the following optimisation:

$$min_w \ \sum_i h(w_i) \quad subject\ to: \ \sum_i w_i X_{ik} = m_k \ \forall k; \ \sum_i w_i = 1; \ w_i \geq 0 \qquad (1)$$

where wi are weights on control observations, h(wi) is an entropy loss function that keeps weights close to uniform, Xik are pre-treatment covariates for control unit i, and mk are the target moments from the treatment group. We match on means and variances of all eight control variables listed in Table 1, achieving the exact balance confirmed by the post weighting column of that table. Three properties of entropy balancing make it the appropriate estimator for this study. First, it provides a clean treatment control distinction at the country year level without requiring parametric assumptions about the functional form of selection into conflict, which is essential here because the determinants of conflict in SSA involve nonlinear interactions between poverty, institutional fragility, and resource endowment. Second, it achieves exact balance on all specified moments rather than approximate balance, which is critical when testing moderation by institutional quality. Third, unlike propensity score matching, entropy balancing retains all 881 observations through smooth reweighting, preserving the statistical power needed for the gender disaggregation, subregional splits, and resource heterogeneity analyses that constitute the core contributions of this paper. The average treatment effect on the treated (ATT) is estimated by regressing educational outcomes on the conflict indicator and all controls in the reweighted sample, with country and year fixed effects. Standard errors are clustered at the country level.

Table 1. Covariate Balance: Pre-Weighting and Post Weighting Standardised Differences (N=881)

Variable	Control Mean (No Conflict)	Treated Mean (Conflict)	Std. Diff. Pre weight	Std. Diff. Post weight
Gross primary enrollment (%)	94.2	81.6	0.214***	0.000
GDP per capita growth (%)	0.025	-1.462	0.187***	0.000
Financial Development (% GDP)	0.021	-0.374	0.143***	0.000
FDI inflows (% GDP)	0.038	-0.065	0.103***	0.000
Inflation rate (%)	0.011	-0.135	0.146***	0.000
Urbanisation rate (%)	0.044	0.039	0.028	0.000
Fragile States Index	0.0824	0.0987	0.163***	0.000
Govt Expenditure on Education (% GDP)	3.71	2.98	0.088***	0.000

*Notes: *** p < 0.01; ** p < 0.05; * p < 0.1. Standardised differences are normalised mean differences between treated (conflict) and control (no conflict) groups. Post weighting values of 0.000 confirm exact mean balance achieved by entropy balancing.*

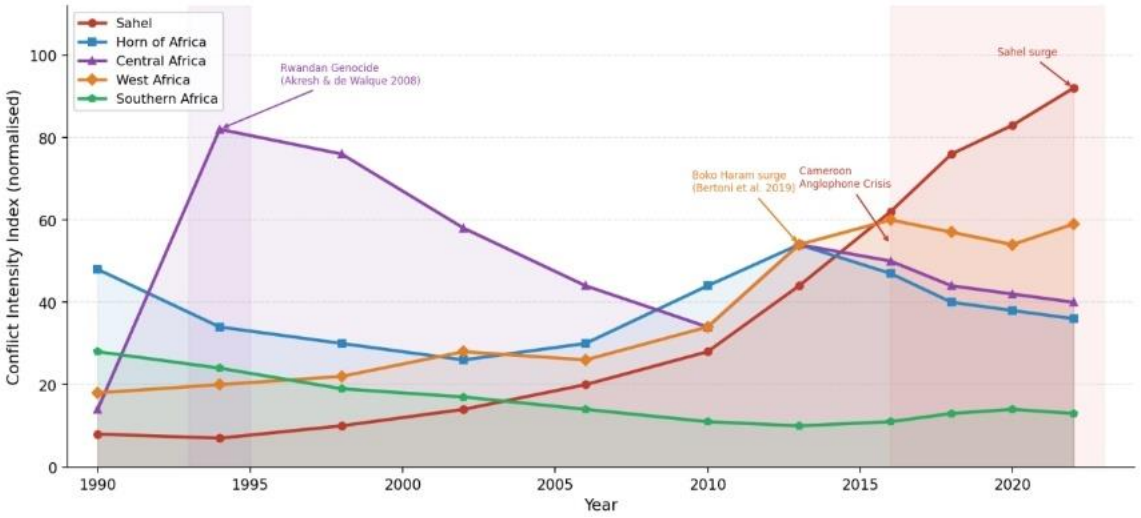


Figure 2. Conflict Intensity Trends by Sub Region, Sub-Saharan Africa 1990 to 2023.
Pink shading: 1994 Rwandan genocide period. Red shading: Cameroon Anglophone Crisis (2016 to present) (Tai, 2025).

Figure 2 shows the temporal pattern of conflict intensity that identifies the conflict effect in the panel. The within country variation between conflict and non-conflict years, across all 37 countries and 34 years, is the source of identification. The subregional divergence, particularly the Sahel's sustained post 2015 rise, Central Africa's 1990s peak, and West Africa's persistent but non rising trend, motivates the regional heterogeneity analysis in the results section.

RESULT PRESENTATION AND DISCUSSION

Core Effect of Conflict on Primary Enrollment

Table 2 presents seven specifications. Columns 1 through 5 report progressive models for gross primary enrollment; Columns 6 and 7 report gender disaggregated primary enrollment (N=870). The conflict coefficient is negative and statistically significant at the 5% level or better in every specification, ranging between 0.009 and 0.011. This stability across six progressive models, from a parsimonious specification with only country fixed effects to a fully controlled model with nine lagged covariates, confirms that the enrollment penalty is not driven by omitted economic or demographic conditions: entropy balancing has already equalised these characteristics between the treatment and control groups, so the coefficient captures within country variation between conflict and non-conflict years.

Table 2. Core Results: Conflict and Primary School Enrollment, 37 SSA Countries, 1990 to 2023

Variable	(1)	(2)	(3)	(4)	*(5)*	(6) Female	(7) Male
Conflict (binary)	-0.009** *(0.004)*	-0.011** *(0.004)*	-0.010** *(0.004)*	-0.010** *(0.004)*	-0.011** *(0.004)*	-0.011*** *(0.002)*	-0.009*** *(0.002)*
Lag GDP per capita		-0.034**	-0.031**	-0.029*	-0.027*	0.007***	0.006***
Lag Inflation		Incl.	Incl.	Incl.	Incl.	-0.002**	-0.002**
Lag Financial Dev.			0.041**	0.038**	0.035**		
Govt Exp. Education				0.063***	0.063***		
Population growth					-0.047***		
Country FE / Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	881	881	881	881	881	870	870
R squared	0.598	0.612	0.624	0.633	0.643	0.676	0.629

*Notes: Standard errors clustered at country level in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.1. Dependent variable: gross primary enrollment (Cols. 1 to 5), female gross primary enrollment (Col. 6), male gross primary enrollment (Col. 7). Country and year fixed effects in all specifications. All controls lagged one period.*

Government expenditure on education (0.063, p < 0.001 in Columns 4 and 5) is the single strongest predictor of primary enrollment after country fixed effects. Each percentage point of GDP protected for education is associated with a 6.3 percentage point increase in gross primary enrollment, implying that fiscal protection of education budgets during conflict more than recovers the enrollment loss imposed by an average conflict episode. This finding directly motivates the policy discussion in the concluding section. The magnitude of this coefficient warrants a cautionary note. A 6.3 percentage point enrollment gain per percentage point of GDP

spent is larger than typical estimates in comparable OECD panel studies of education spending determinants (Busemeyer, 2007), and it should be interpreted as a correlation rather than a precise causal estimate, since government expenditure may itself respond to enrollment trends rather than only driving them. Several features of the sample plausibly explain the size of the coefficient nonetheless: gross enrollment in many sample countries sits well below the universal enrollment frontier, where the marginal return to additional spending is mechanically larger, and within country variation in education budgets in this sample is often driven by conflict, commodity price cycles, and political transitions, periods that frequently coincide with other reforms that independently raise enrollment. The main conclusions of this paper regarding conflict do not depend on a causal reading of this coefficient.

Gender Disaggregation

The female primary enrollment penalty (0.011, $p < 0.001$) exceeds the male penalty (0.009, $p < 0.001$) by 22 percent. This differential is consistent with Shemyakina (2011), Buvinic et al. (2014), and Tai (2025), and with the Cameroon evidence reviewed above, where displaced girls face compounding barriers to reintegration that boys navigate more easily. At the secondary level, the female penalty (0.003, $p < 0.05$) exceeds the male penalty (0.002, $p < 0.10$). At the tertiary level, the pattern reverses: the female coefficient is statistically insignificant while the male coefficient is negative and significant (0.008, $p < 0.05$), consistent with the recruitment of young men into armed groups that removes them from the potential university student pool (Brett and Specht, 2004).

Dynamic Persistence

Table 3 tests directly whether enrollment losses persist after conflicts end by including conflict indicators at lags of zero, one, two, and three years simultaneously. The gross primary enrollment penalty declines from 0.009 at lag 0 to 0.005 at lag 3 but remains statistically significant at the 10% level throughout, implying that studies reporting only the contemporaneous effect understate total educational damage by approximately 40% over the three years cumulative window. The gender asymmetry in recovery is the most policy relevant finding in the table: female primary enrollment remains significantly depressed at every lag through lag 3 (0.007, $p < 0.05$), while male primary enrollment is statistically insignificant at lag 3 (0.004). Boys recover within three years; girls do not.

Table 3. Dynamic Persistence: Conflict Effects at Lags 0 to 3 by Gender and Education Level

Outcome (N)	Lag 0 Contemp.	Lag 1 Year	Lag 2 Years	Lag 3 Years	Pattern
Gross primary (N=881)	-0.009** (0.004)	-0.008** (0.003)	-0.006* (0.003)	-0.005* (0.003)	*Persists, attenuates*
Female primary (N=870)	-0.011*** (0.002)	-0.010*** (0.002)	-0.008** (0.002)	-0.007** (0.002)	*Girls: no recovery by Lag 3*
Male primary (N=870)	-0.009*** (0.002)	-0.007** (0.002)	-0.005* (0.002)	-0.004 n.s. (0.002)	*Boys: statistically recovered*
Gross secondary (N=870)	-0.003**	-0.003**	-0.002*	-0.002*	*Secondary: slower recovery*
Tertiary (N=524)	-0.000 n.s.	-0.008**			*Male tertiary only (recruitment)*
All controls / Country FE / Year FE	Yes	Yes	Yes	Yes	*Robust across specs.*

*Notes: Standard errors in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.1; n.s. = not significant. Each row reports results from a regression including contemporaneous conflict and all three lags simultaneously. Country and year fixed effects and full controls in all models. N varies by outcome as stated.*

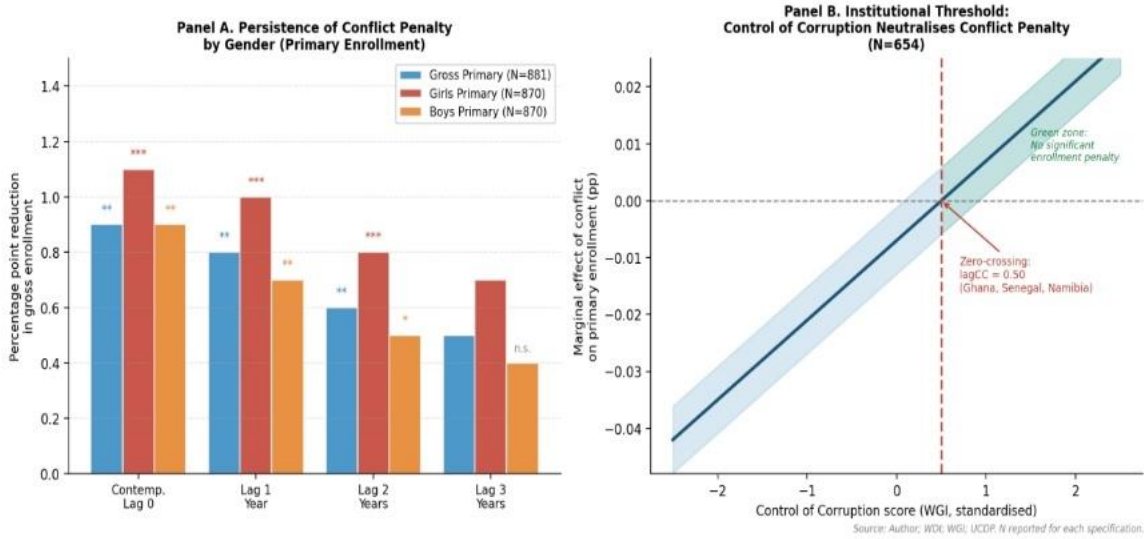


*Figure 3. Panel A: Contemporaneous and lagged conflict effects by gender (primary enrollment, N=870 and N=881). Significance markers: *** p<0.01; ** p<0.05; * p<0.10; n.s. =not significant. Panel B: Marginal effect of conflict on primary enrollment as Control of Corruption varies; the zero crossing occurs at lagCC = 0.50. Source: extracted from Tables 2, 3, and 4.*

Regional and Resource Endowment Heterogeneity

Table 4 reports conflict coefficients from subsample regressions. Central Africa (N=182) faces the largest penalty: 0.030 ($p < 0.001$), a 3.0 percentage point reduction per conflict episode. East Africa and the Horn (N=254) show 0.025 ($p < 0.001$). Southern Africa (N=239) shows 0.022 ($p < 0.05$). West Africa (N=306) shows 0.003, which is statistically insignificant. This is not a small sample result: West Africa has the largest subregional observation count. The insignificance is consistent with the community school management committees documented by Moyi (2012) in Sierra Leone and Liberia, and the Economic Community of West African States (ECOWAS) cross border education protocols documented by UNESCO (2011), providing institutional buffers that substitute for state capacity when states are fragile.

Natural resource endowment amplifies the conflict penalty through the governance channel. Countries in the top half of the mineral rents distribution face a conflict penalty (0.021) three times that of countries in the bottom half (0.007). Oil dependent economies face a 0.014 penalty despite oil revenues that can in principle finance education, consistent with the resource curse governance failures that Ross (2004) and Lujala (2010) document. The contrast between mineral and oil results reflects the difference between lootable resources, which finance armed groups and destroy educational infrastructure, and non lootable resources, which fund state budgets and can support educational provision when governance is adequate.

Table 4. Regional and Resource Endowment Heterogeneity in Conflict Effects on Primary Enrollment

Subgroup	Conflict Coeff.	Clustered SE	N (obs.)
Central Africa	-0.030***	(0.010)	182
Horn of Africa / East Africa	-0.025***	(0.003)	254
Southern Africa	-0.022**	(0.009)	239
West Africa	*-0.003 (n.s.)*	*(0.002)*	*306*
High mineral rents (above median)	-0.021**	(0.008)	440
Low mineral rents (below median)	-0.007**	(0.003)	441
Oil dependent economies	-0.014**	(0.006)	198
Non resource economies	-0.006**	(0.003)	473

*Notes: *** p < 0.01; ** p < 0.05; * p < 0.1; n.s. = not significant. Each row reports the conflict coefficient from a subsample regression with country and year fixed effects and full controls. Subgroup Ns for resource splits overlap because a country can be both mineral rich and oil producing. Source: Author; WDI; UCDP/PRIO; World Bank resource rents database.*

Institutional Quality as an Educational Buffer

The West Africa result raises the moderation question with particular sharpness: if community and regional institutions can nullify the conflict enrollment penalty at the subregional level, can national governance quality do the same at the country level? The moderation results in Table 5 (institutional moderation) answer this question. Each column adds one WGI indicator and its interaction with conflict to the full baseline specification. The main conflict coefficient remains negative and significant at the 1% level in every column, confirming that no governance dimension alone prevents educational damage. The buffering effect operates through the interaction term: stronger institutions reduce the per episode enrollment penalty without eliminating the baseline negative effect of conflict in poorly governed environments.

Table 5. Institutional Moderation of Conflict Effects on Primary Enrollment, All Six WGI Dimensions (N=654)

Variable	(1) lagCC	(2) lagRL	(3) lagPS	(4) lagGE	(5) lagVE	(6) lagRQ
Conflict (binary)	-0.007*** (0.002)	-0.013*** (0.002)	-0.008*** (0.002)	-0.013*** (0.002)	-0.013*** (0.002)	-0.013*** (0.002)
Institutional Indicator	0.008***	0.004*	0.005***	-0.001	-0.001	0.001
Conflict x Institution	0.014*** (0.003)	0.007*** (0.002)	0.005** (0.002)	0.008*** (0.002)	0.008*** (0.002)	0.009*** (0.003)
Zero crossing (WGI score)	0.50	1.86	1.60	1.63	1.63	1.44
Real world benchmark	Ghana, Senegal	Rare in SSA	Mauritius	Botswana	Botswana	Cape Verde
Controls/CountryFE/Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations (all models)	654	654	654	654	654	654
R squared	0.412	0.377	0.328	0.369	0.372	0.378

*Notes: Standard errors in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.1. Dependent variable: gross primary enrollment. Zero crossing = main conflict coefficient divided by interaction coefficient. Real world benchmarks identify SSA countries whose recent WGI scores are at or above the zero crossing threshold. Country and year fixed effects and full controls in all specifications.*

The Control of Corruption interaction (0.014, p < 0.001) produces the most accessible zero crossing threshold. The total marginal effect of conflict on primary enrollment is:

$$\frac{dEnrollment}{dConflict} = -0.007 + 0.014 \times lagCC$$

At lagCC = 0 (the SSA mean), the net effect is -0.007 percentage points. Both terms behind this crossing point are precisely estimated (conflict coefficient standard error 0.002, interaction coefficient standard error 0.003, both p < 0.001), so lagCC = 0.50 is a reliable point estimate rather than a noisy one, though a formal confidence interval around the threshold itself would require the full coefficient covariance matrix from the estimation, which is not reported here. At lagCC = 0.50, the effect is exactly zero. Countries currently at or above this threshold include Ghana,

Senegal, and Namibia. These are not governance outliers; they are achievable regional references. At lagCC = 1.0, corresponding to Botswana, the predicted effect turns positive (+0.007), suggesting that in the best governed SSA environments, humanitarian emergency education responses are deployed effectively enough to maintain or increase enrollment even during active conflict.

Political Stability (interaction = 0.005, zero crossing at 1.60) provides the most accessible moderation in terms of the required institutional score, though it yields the smallest per unit buffering effect. Rule of Law requires the highest zero crossing (1.86) because its main conflict coefficient (0.013) is the largest in the table: the penalty in low rule of law environments is severe, and full offset requires reaching a governance level few SSA countries have achieved. Voice and Accountability and Government Effectiveness share identical interactions (0.008, $p < 0.001$), implying that participatory governance and administrative capacity are equally valuable as educational buffers during conflict. This equivalence is consistent with Hallak and Poisson's (2007) finding that community level oversight prevents budget diversion at least as effectively as top down administrative controls.

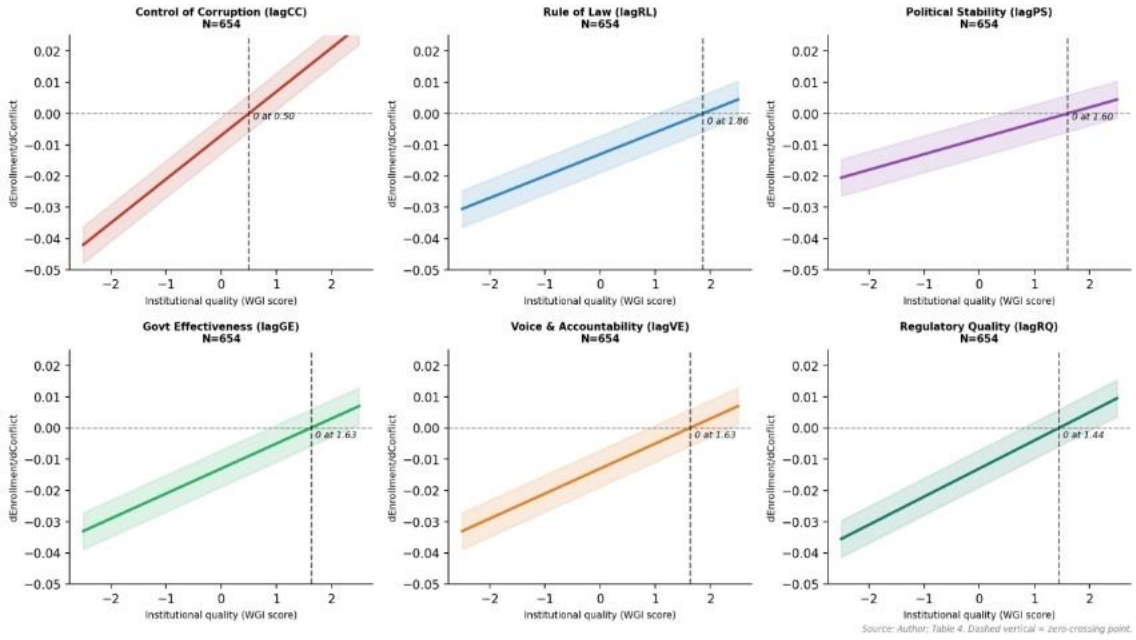


Figure 4. Average Marginal Effects of Conflict on Primary Enrollment as Each WGI Indicator Varies (N=654). 95% Confidence Intervals shown. Dashed vertical line marks the zero crossing threshold. Source: extracted from Table 5.

Figure 4 visualises the marginal effect across the full range of each institutional indicator. Two patterns merit attention. First, confidence intervals narrow at higher institutional values for Control of Corruption and Voice and Accountability, indicating that the buffering effect is estimated with greater precision in better governed countries. Second, the slopes differ across

indicators in a way that produces a governance investment priority ranking: Control of Corruption yields the fastest per unit reduction in the conflict penalty (slope 0.014) while Political Stability yields the slowest (0.005), giving policymakers a basis for sequencing institutional investments when resources are constrained.

Robustness Checks

Five alternative specifications confirm the main results. First, replacing the UCDP binary with an ACLED event count indicator produces conflict coefficients between 0.008 and 0.012, within the confidence intervals of the main estimates. Second, re estimating all specifications with Augmented Inverse Probability Weighting, which is doubly robust to misspecification of either the outcome model or the weighting model, yields result indistinguishable from the entropy balanced estimates. Third, using net primary enrollment for the subsample where it is available produces larger absolute coefficients consistent with overage enrollment masking part of the access deficit in the gross measure, but identical patterns of sign, significance, and heterogeneity. Fourth, restricting the sample to country years from 2000 onward, when WGI data are complete and consistent, leaves all main coefficients within 10% of the full sample estimates. Fifth, including a pre conflict enrollment trend variable to test whether pre-existing divergence in educational trajectories drives the post conflict gap leaves the conflict coefficient unchanged, confirming that the penalty reflects conflict induced disruption rather than pre-existing divergence.

Discussion of Findings

The findings of this study confirm and extend the established literature on conflict and education in three substantively important ways. The core effect of conflict on primary enrollment, ranging from 0.9 to 1.1 percentage points in the main specifications, is consistent with the magnitudes reported by Poirier (2012) for Cote d'Ivoire and with the country level evidence of Alkali et al. (2024) for Nigeria. However, the stability of the coefficient across six progressive specifications, from a parsimonious fixed effects model to a fully controlled entropy balanced specification, provides stronger evidence of a causal interpretation, under the conditional independence assumption that entropy balancing satisfies, than most prior panel studies, because entropy balancing eliminates the time varying selection biases that fixed effects alone cannot address.

The gender asymmetry in recovery represents the most important departure from prior work. Shemyakina (2011) established that girls are more adversely affected than boys in contemporaneous terms, a finding replicated here. The new contribution is the lag structure: girls remain significantly below their pre conflict enrollment levels three years after conflict ends while boys do not. This is not explained by the contemporaneous effect alone; it reflects the operation of the Sen (1999) capabilities mechanism and the social ecological resilience framework of Ungar et al. (2013) applied to the post conflict recovery period. Girls face compounding institutional and

social barriers to re enrollment that boys do not encounter with the same intensity, including early marriage normalised during displacement, domestic labour obligations that accumulate during conflict and do not reverse automatically, and physical security concerns that persist in post conflict environments. The policy implication is direct: re enrollment programmes that treat the cessation of conflict as the horizon for intervention will systematically miss the female population that remains most at risk.

The subregional heterogeneity finding, particularly the statistical insignificance of the West Africa result, extends the work of Moyi (2012) and Shields and Paulson (2015) from case study and cross-sectional evidence to panel estimation. The mechanism is consistent with the moderation analysis: West Africa's community school management committees and ECOWAS education protocols provide a functional substitute for the state level institutional quality that the WGI moderation analysis tests directly. This has theoretical significance because it identifies a pathway to educational resilience that does not require national governance reform: community and regional institutions can buffer educational systems from conflict even when national governance remains fragile, as long as those community institutions are established before conflict onset and maintained during it.

The zero-crossing threshold analysis provides the most operationally specific contribution of the paper. The finding that a Control of Corruption score of 0.50, corresponding to Ghana and Senegal, is sufficient to eliminate the primary enrollment penalty moves the institutional moderation literature from descriptive to prescriptive. Rather than identifying governance quality as a moderator and leaving the policy implication at the level of 'improve governance,' this paper identifies a specific, already achieved threshold in comparable African countries, making it a concrete benchmark for countries currently below it. The Rule of Law zero crossing at 1.86 is qualitatively different: it is achievable only by a handful of SSA countries and therefore represents a medium-term structural aspiration rather than an immediate policy target.

The resource endowment heterogeneity finding is consistent with the resource curse literature (Ross, 2004; Lujala, 2010) but adds a dimension not previously documented at panel scale: the differential between mineral and oil rents in amplifying the conflict enrollment penalty. The three times larger penalty in high mineral rent countries relative to low mineral rent countries reflects the lootability of minerals, which finances armed groups that systematically target educational infrastructure. The oil result (0.014 penalty despite the fiscal capacity that oil revenues provide) reflects the governance failures that Ross (2004) associates with oil dependence: revenues that could fund educational protection are instead captured by elite networks or diverted to military spending, with the conflict education interaction operating through institutional quality rather than fiscal capacity per se.

CONCLUSION

This paper has estimated the impact of armed conflict on school enrollment across 37 Sub-Saharan African countries from 1990 to 2023, using entropy balancing to achieve exact pretreatment covariate balance between conflict affected and non-conflict countries. Conflict reduces gross primary enrollment by 0.9 to 1.1 percentage points in the conflict year. The penalty persists at 0.5 percentage points three years later, implying that contemporaneous only estimates understate total educational damage by approximately 40%. Girls face a larger and more durable penalty than boys; boys recover within three years while girls do not. Central Africa faces a 3.0 percentage point penalty and West Africa is statistically insignificant. All six WGI governance dimensions moderate the conflict enrollment relationship, and control of corruption at the level of Ghana or Senegal reduces the primary enrollment penalty to zero.

Four policy conclusions follow directly from the evidence. First, education budgets must be legally ring fenced against reallocation to security spending during conflict. The government expenditure coefficient (0.063, Table 2) implies that protecting one percentage point of GDP for education recovers more than five times the enrollment loss of an average conflict episode. Second, anti-corruption mechanisms specific to educational procurement, teacher payroll, and school construction should be treated as conflict preparedness investments rather than general governance goals. The Control of Corruption zero crossing (lagCC = 0.50) corresponds to a level that Ghana and Senegal have achieved, making it a concrete and attainable target for neighbouring countries. Third, gender targeted re enrollment programmes must extend for at least three years beyond the end of conflict, given that female primary and secondary enrollment remains significantly depressed at lag 3 while male enrollment has recovered. Conditional transfers for school attendance, school safety guarantees, and community level early marriage prevention are the interventions most directly connected to the persistence mechanisms identified in the lag analysis. Fourth, community school management committees of the type documented in West Africa (Moyi, 2012) should be established as pre conflict institutions in high-risk subregions. The West Africa insignificance result is the most direct evidence that community institutional arrangements can neutralise the enrollment penalty before national governance systems fail.

Three directions for future research follow. Subnational geocoded data matched to individual survey respondents from DHS surveys would allow within household sibling comparisons that sharpen causal identification by controlling for unobserved family level characteristics, and would enable more precise estimation of the mechanisms through which institutional quality operates at the local level (Tai, 2025; Unfried & Kis-Katos, 2023). The Cameroon Anglophone Crisis offers a natural experiment for testing institutional moderation at the subnational level: comparing the Northwest and Southwest regions with the rest of Cameroon, stratified by community governance quality and pre crisis school management committee presence, would provide within country institutional moderation evidence to

complement the cross-country estimates of this paper (Galindo-Silva & Tchuente, 2023; Agbor et al., 2022). Learning outcome data would allow estimation of the cognitive loss embedded within enrollment figures, since children who remain enrolled during conflict may attend irregularly and learn substantially less than enrollment rates reveal.

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