

The impact of institutional quality, development assistance, ICT, and foreign direct investment on higher education



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ABSTRACT

Achieving Sustainable Development Goal (SDG) 4, which focuses on providing inclusive and equitable quality education, remains a key priority for African governments. However, several factors—such as institutional quality, official development assistance (ODA), information and communication technology (ICT), education spending, and foreign direct investment (FDI)—can either support or hinder progress, particularly in improving higher education outcomes. Existing studies offer limited empirical evidence and rarely examine the combined effects of these factors on higher education. This study investigates how institutional quality, ODA, ICT, education expenditure, and FDI influence higher education enrolment in West Africa, a region with one of the lowest tertiary education enrolment rates globally. Using panel data from 12 West African countries between 2009 and 2020, the study applies fixed effects, random effects, and generalized method of moments (GMM) regression techniques. The findings reveal that ODA to the education sector, GDP per capita, and ICT development positively affect higher education enrolment, while FDI has a negative impact. Overall, the results highlight the importance of improving institutional quality, enhancing ICT infrastructure, and increasing targeted ODA to boost enrolment in higher education. Effective education policies, supported by economic growth and investment in ICT, are essential to achieving SDG 4 in West Africa and similar regions.

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1. Introduction

The consensus towards achieving Sustainable Development Goal (SDG) 4 of ensuring quality education that is equitable and inclusive remains at the forefront of African governments. However, several factors continue to either facilitate or militate against achieving targets under SDG-4. For instance, a country's level of institutional quality influences its educational outcomes in many ways (Hall and O'Hare, 2024; Odhiambo, 2024). Good governance is a prerequisite to achieving sustainable development, and good governance includes the

quality of institutions. Institutional quality includes the rule of law, political stability/absence of violence/terrorism, control of corruption, voice and accountability, government effectiveness, and regulatory quality. This article probes the question of whether institutional quality (IQ), official development assistance, information and communication technologies (ICTs), and foreign direct investment (FDI) impact tertiary school enrolment. We argue that IQ, ODA, ICTs, and FDI significantly impact tertiary school enrolment. Even though the variables in our study remain important in shaping policy and practice, there is a dearth in the extant literature on West Africa, especially with regard to a study that considers all variables together. We take turns to examine the nexus between our explanatory variables and our dependent variable (school enrolment).

Institutional quality is an important indicator that enhances school enrolment; however, the account in the extant literature on West Africa

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remains sparse and inconsistent. Specifically, the literature (Nir and Kafle, 2013) showed that corruption, political instability, and violence lead to school closures, destruction of school infrastructures, and low enrolment in schools. On the contrary, good governance has been shown to improve educational outcomes (enrollment and school life expectancy) (Hall and O'Hare, 2024; 2023). Richards and Vining (2015) showed that good governance influenced primary school enrolment and completion in the global south. This finding has recently been given credence by Fomba et al. (2023), who found that good governance improved primary school completion rate and student achievement. Duerrenberger and Warning (2018) argued that corruption affects school enrolment and the duration spent in schools in developing countries that are corrupt. Whereas Ouedraogo et al. (2022) showed that the absence of violence, control of corruption, political stability, and government effectiveness are important institutional quality factors that improve tertiary school enrolment in 49 African countries. The literature shows that studies that examine institutional quality and educational outcomes in Africa are often neglected in the literature received. Dridi (2014) earlier indicated that the nexus between institutional quality and education outcome involving cross-country has received little attention. This trend has lingered for a long time and runs contrary to the radical literature that focuses on the global North (Sabzalieva et al., 2023; Gerganov et al., 2022; Palmisano et al., 2022; Gerged and Elheddad, 2020). Generally, we find the nexus between institutional quality and the tertiary school enrolment in Africa to be important because, typically, less than 50% of countries in the global south obtain a positive score on the governance effectiveness index annually (Fomba et al., 2023). Yet, the extant literature on Africa and specifically West Africa appears scant and inconsistent, thus presenting a gap in knowledge that needs to be bridged. Rightly so, this article presents evidence that potentially opens further conversations.

Official development assistance (ODA) contributes immensely to achieving positive educational outcomes in African countries, including West Africa. Given the fact that most African governments are unable to adequately fund the budgetary allocation needed for important economic sectors such as education, FDI comes in very handy. However, there are mixed results associated with the effectiveness of educational aid similar to that of aid generally. ODA improved enrolment in schools, and some strands of literature (Turrent, 2016; Wolf, 2007) showed positive results of ODA on school enrolment. Collier (2008) argued that ODA (aid) is not necessary for improving educational outcomes. For instance, primary school completion shot up in Malaysia, Korea, Thailand, and other Asian countries that received no ODA. Other strands (Asongu, 2014) of literature showed a negative effect of ODA on educational outcomes. The extant literature that examines the nexus between ODA and school

enrolment appears scant (Yiheyis and Woldemariam, 2020; Asongu and Tchamyoun, 2019). For instance, very few studies attempt to do justice to this. The account so far has been mixed and inconclusive, with a dearth of literature that examines ODA and school enrolment at the tertiary level focusing on Africa, thus, a need to interrogate the nexus between ODI and educational outcomes in Africa, particularly in the contemporary discourse, where ODI effectiveness continues to linger.

The use of information and communication technologies (ICTs) has been found to foster educational growth in Africa. The account, even though replete in the global North, remains scant (Awad and Albaity, 2022) with mixed and inconsistent findings (Zhang and Danish, 2019; Samarakoon et al., 2017). Few literatures (Ahmed et al., 2021; Asongu and Andrés, 2020; Asongu and Odhiambo, 2020a; 2020b; Donou-Adonsou, 2019; Zhang and Danish, 2019; Ahmed and Wang, 2019) established that ICTs influence positive educational outcomes in African countries. Generally, the literature establishes that ICTs enhance positive educational outcomes in Africa through the provision of access to educational resources and opportunities for learning. Smartphones, television, radio, and computers are commonly used ICTs in most African educational institutions. For instance, in some African countries, educational programs are aired on television for targeted groups of school children. The use of computers in educational institutions remains common in parts of Africa. E-learning platforms have been deployed to facilitate learning among school children, which leads to enhanced educational outcomes. Other strands of literature showed widening inequalities and digital divide gaps in education due to ICTs, thereby influencing lower educational outcomes. ICTs enhance educational outcomes in the presence of stable electricity, robust internet infrastructure, and good governance, which remains uneven in most African countries. The main gaps in the related literature show a few cross-country studies that dwell on panel data in examining the nexus between ICTs and tertiary school enrolment in West Africa. Additionally, the use of a robust estimation technique such as the modified generalized method of moments (MGMM) in examining the relationship between ICTs and school enrolment remains under-explored. The findings on ICTs' impact on educational outcomes remain inconclusive and mixed. Thus, a need to interrogate this nexus further in deepening understanding.

Generally, foreign direct investment (FDI) is an important conduit that allows investment in education to achieve desirable educational outcomes. FDI has been shown to have mixed impacts on educational outcomes in Africa. While some literature (Djokoto and Wongnaa, 2023; Wang and Zhuang, 2021; Gui-Diby, 2014; Reiter and Steensma, 2010) pointed to a positive impact, others (Miningou and Tapsoba, 2020; Kaulihowa and Adjasi, 2019; Gui-Diby, 2014) indicated negative

impacts. For instance, Wang and Zhuang (2021) found that inward FDI did not significantly impact male primary and tertiary enrolment. Adeniyi et al. (2021) observed both negative and positive impacts of FDI across different countries in Africa in a single study using the autoregressive distributed lags modelling technique. Indeed, other studies (Kaulihowa and Adjasi, 2019; Iwasaki and Sukanuma, 2015) confirmed similar findings in a single study. Most of the literature received pays much attention to the relationship between FDI and primary school enrolment, with limited attention to tertiary enrolment. The impact of FDI on educational outcomes in Africa appears mixed, inconsistent, and inconclusive. The direct impact of the nexus between FDI and educational outcomes in West Africa is scant, and our paper attempts to deepen understanding and open further conversations. Overall, our paper, in explicit terms, presents in a single study a snapshot of the impact of institutional quality, development assistance, ICT, and FDI on educational outcomes in West Africa, which so far remains scant and inconclusive. The quest to achieve quality education (SDG-4) in West Africa is of prime importance, but how covariates such as development assistance, institutional quality, ICT, and FDI impact educational outcomes, particularly higher education enrolment, remain largely under-explored.

Surprisingly, studies that analyze the joint impacts of institutional quality, development assistance, ICT, and foreign direct investment in West Africa are missing. This study fills a niche in the literature by investigating the impact of institutional quality, development assistance, ICT, and foreign direct investment in West Africa, the region with the worst educational statistics based on data from the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the World Bank. This study contributes to the literature by arguing that higher education enrolment depends on the quality of institutions, ICT, development assistance, and foreign direct investment.

This article answers the research question: Do institutional quality, development assistance, information and communication technology (ICT), and foreign direct investment (FDI) influence educational outcomes in West Africa? Even though knowledge abounds in the conventional wisdom space on this question, the related extant literature

appears scarce and inconclusive in sub-Saharan Africa (SSA) and West Africa in particular.

This paper makes the following contributions. First, the study considers the synergy nexus of ICT, FDI, institutional quality, development assistance, and tertiary education enrolment. The study fills a gap in the literature on these relationships, particularly in the context of West Africa, where empirical evidence is scarce. Second, on a methodological strand, this study utilizes the modified generalized method of moments (MGMM) method, a more robust analytical technique of estimation proposed by Kripfganz (2019) relative to the conventional generalized method of moments (GMM) estimation technique.

The rest of the paper is structured as follows: the next section presents the methodology that underpins the study, while Section 3 presents the results and discusses them. The last section draws a conclusion and proffers some related policy recommendations that potentially address the challenges that confront education in West African countries.

2. Methodology

This paper focused on the West African region. We used data from twelve (12) countries in West Africa (Table 1) spanning a period of twelve years (2009–2020). The data on the variables used in this study came from the World Development Indicators of the World Bank and the Organization for Economic Cooperation and Development (Table 2), which are freely available on the organization's websites.

Table 1: Countries included in the West Africa sample (2009–2020)

No.	Country
1	Benin
2	Burkina Faso
3	Cape Verde
4	Cote d'Ivoire
5	Ghana
6	Guinea
7	Mali
8	Mauritania
9	Niger
10	Nigeria
11	Senegal
12	Togo

Table 2: Variables, definitions, and data sources

Variable	Data source
School enrolment, tertiary (% gross)	World Bank Group
Adjusted savings: Education expenditure (current US\$)	World Bank Group
GDP per capita (current US\$)	World Bank Group
ODA to the education sector (US dollar, Millions, 2022 constant prices)	Organization for Economic Co-operation and Development
Institutional quality (Principal component score)	Computed by the authors with data from the World Development Indicators (World Bank Group)
Foreign direct investment, net inflows (% of GDP)	World development indicators (World Bank Group)
ICT index (Principal component score)	Computed by the authors with data from the World Development Indicators (World Bank Group)

2.1. Econometric framework

Our dependent variable, educational outcome, was proxied by primary and tertiary school enrolments. Our independent variables include institutional quality, official development assistance to the education sector, foreign direct investments, and the control variable—gross domestic product per capita. Institutional quality was computed using principal component analysis. There are six indicators of institutional quality identified. They include control of corruption (number of sources), political stability and absence of violence/terrorism (number of sources), government effectiveness (number of sources), rule of law (number of sources), regulatory quality (number of sources), and voice and accountability (number of sources). These indicators/proxies were subjected to factor analysis, and the data were reduced to one principal component, which we used as the index of institutional quality in this paper. The index was not transformed into a natural logarithm for further analysis since it has already been subjected to factor analysis. Information and communication technology (ICT) was computed using principal component analysis. Four ICT-related variables were subjected to principal component analysis, and the score produced by the main component was used in this study as the ICT index. The ICT-related variables include mobile cellular subscriptions, individuals

using the internet (% of population), fixed telephone subscriptions, and fixed broadband subscriptions.

We used the PCA to develop an ICT index from mobile, fixed broadband use, internet, and fixed telephone use, following Huang et al. (2022). We also used PCA to develop an institutional quality index from the institutional quality indicators identified. The indicators include control of corruption (number of sources), political stability and absence of violence/terrorism (number of sources), government effectiveness (number of sources), rule of law (number of sources), regulatory quality (number of sources), and voice and accountability (number of sources). The two principal component analyses (one for institutional quality and the other for the ICT index) produce new variables by transforming the whole dataset.

Tables 3 and 4 show the results. We found that PC1 showed about 85.72% of the differences in the institutional quality indicators original dataset; therefore, we chose PC1 to estimate the institutional quality (Table 3). Also, we found that PC1 showed about 45.62% of the differences in the original dataset; therefore, we chose PC1 to estimate the ICT index (Table 4). We used the new datasets of PC1 generated by the statistical software (SPSS 15) in each case (institutional quality and ICT index) as our variables for the institutional quality index and ICT index, which we used for further analysis in this paper.

Table 3: Total variance explained for the institutional quality principal component analysis

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
PC1	5.143	85.719	85.719	5.143	85.719	85.719
PC2	0.506	8.429	94.148			
PC3	0.187	3.112	97.260			
PC4	0.092	1.535	98.795			
PC5	0.044	0.740	99.535			
PC6	0.028	0.465	100.000			

Extraction method: Principal component analysis

Table 4: Total variance explained for the ICT principal component analysis

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
PC1	1.825	45.615	45.615	1.825	45.615	45.615
PC2	0.985	24.635	70.250			
PC3	0.775	19.385	89.635			
PC4	0.415	10.365	100.000			

Extraction method: Principal component analysis

The implicit model of our fixed and random effects and generalized method of moment regression models is stated as follows:

$$EDUC = f(IQ, ODA, FDI, EXP, ICT, GDP) \quad (1)$$

where, EDUC represents tertiary school enrolment measured as gross percentage. IQ denotes institutional quality, expressed through a principal component score. ODA refers to official development assistance allocated to education in constant US dollars. FDI indicates foreign direct investment, measured as net inflows in relation to GDP. EXP represents adjusted savings in terms of education expenditure, recorded in current US dollars. ICT

captures the role of information and communication technologies, also measured by a principal component score. Finally, GDP stands for gross domestic product per capita in current US dollars.

To control potential heteroskedasticity in our dataset, we converted the real values of other variables to their natural logarithmic values. The fixed and random effects and generalized method of moment regression models with the logarithms is presented thus:

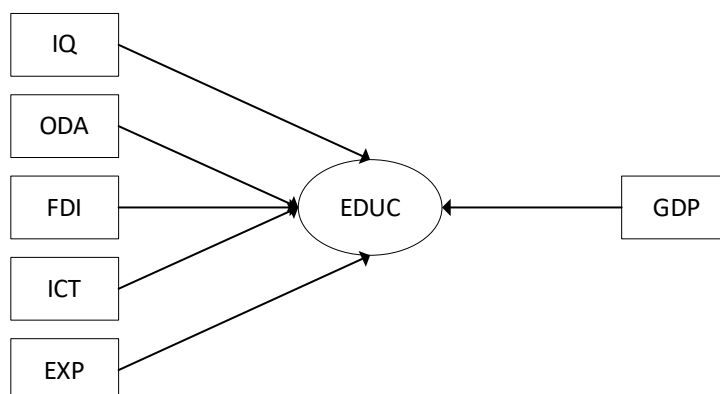
$$\ln EDUC_{it} = \beta_0 + \beta_1 IQ_{it} + \beta_2 \ln ODA_{it} + \beta_3 \ln FDI_{it} + \beta_4 \ln EXP_{it} + \beta_5 ICT_{it} + \beta_6 \ln GDP_{it} + \varepsilon_{it} \quad (2)$$

where, $i: 1, 2, 3, \dots, 12$ countries; $t: 2009, 2010, 2011, \dots, 2020$ year; $\ln$ denotes natural logarithm; ε is the

error term. Furthermore, β_1 , β_2 , β_3 , β_4 , β_5 , and β_6 define the estimated percentage change in school enrolment caused by a one percent change in institutional quality, official development assistance to education, foreign direct investments, education expenditure, gross domestic product per capita, and information and communication technologies, respectively, while all other factors are constant. ε_{it} is the unobserved country-specific fixed effects.

This study initially leverages the fixed and random effects regressions to provide baseline estimates that are resilient to cross-sectional and temporal dependency. Following the relevant empirical literature and experiential learning on the

topic, we built our models based on the schematic diagram shown in Fig. 1 to explain the dynamic relationships among the five main variables of interest. School enrolment is the dependent variable and it is influenced by independent variables which include, institutional quality (IQ), official development assistance to education (ODA), foreign direct investment (FDI), education expenditure (EXP), and information and communication technologies (ICT) (indicated by the green arrows on the left hand side of Fig. 1), while the control variable—gross domestic product per capita—is indicated by the blue arrow on the right hand side of Fig. 1.



Official development assistance (ODA), institutional quality (IQ), Foreign direct investment (FDI), Information and communication technology (ICT), education expenditure (EXP), and higher education enrolment (EDUC)

Fig. 1: Conceptual framework

The static econometric model specification is as follows:

The dynamic model can be specified as:

$$\ln EDUC_{it} = \beta_1 \ln EDUC_{it-1} + \beta_2 IQ_{it-1} + \beta_3 \ln ODA_{it-1} + \beta_4 \ln FDI_{it-1} + \beta_5 \ln EXP_{it-1} + \beta_6 \ln ICT_{it-1} + \beta_7 \ln GDP_{it-1} + \varepsilon_{it} + u_i + \delta_t \quad (3)$$

where, $t-1$ is the previous years' time periods. There are two extra error terms in Eq. 3: μ_i and δ_t , which are the idiosyncratic error terms and the unobserved time effects, respectively. Based on our *a priori* expectations (Fig. 1), we expect all the parameters in the above models to be positive. At this point, it is necessary to state that in estimating Eq. 3, an endogeneity problem may arise because of the inclusion of the lag of the dependent variable ($\ln EDUC$) as an independent variable. However, this concern was addressed by applying the system of generalized method of moments (GMM) econometric procedure proposed by Arellano and Bover (1995). The GMM results were further subjected to two standard robustness tests, namely, the Breusch-Pagan and Hausman tests. This was done to validate the GMM results. Other post-estimation tests were carried out to check if the instruments are valid. The pre and post-estimation tests ensured the reliability of our GMM results.

Nickell (1981) observed that GMM controls unobserved heterogeneity and prevents biased estimates when the dependent variable has a time

lag. To perform our model specification exploration as a precondition for developing an efficient and consistent GMM estimator, we followed the recommendations of Kripfganz (2019) and performed model specification exploration as a precondition for developing an efficient and consistent GMM estimator. The process of defining the model aims to categorize all-important regressors as strictly exogenous, endogenous, or present in accordance with economic theory. The absence of correlation between regressors and error terms (time-variant) classifies a variable as strictly exogenous, whereas the inverse is true for endogenous variables. Predetermined variables are those that could be associated with previous values of time-variant error terms but not with the present or future values of those terms. The exclusion criterion implies that the exogenous variables influence the dependent variable – higher education enrolment – through exogenous elements of the independent variables, and this is consistent with the literature on GMM (Boateng et al., 2018).

Roodman (2009) gave credence to this approach and suggested that time-invariant variables have the potential to be strictly exogenous variables. The low likelihood of time-invariant variables becoming endogenous when considering the first difference series makes them suitable instruments. In this test, the alternative hypothesis suggests that the exogenous variables used may not be valid instruments. This means that they could potentially impact the outcome variable in a manner that is

distinct from the proposed exogenous explanatory variables or mechanisms. Based on this null hypothesis, it is suggested that the exogenous variables will only have an impact on higher education enrolment through the independent variables involved. In the context of GMM, this clarification does not deviate from the more conventional approaches of GMM. These approaches involve rejecting the alternative hypothesis of the Sargan–Hansen test, which confirms that the adopted instruments strictly exogenously influence higher education enrolment solely through the proposed mechanisms (Amavilah et al., 2017). The Hansen test was undertaken to determine the suitability of our instrument. The Hansen test p-value of 0.2620 for higher education enrolment implies that the null hypothesis of no overidentification of the instrument is accepted because a rejection would have cast doubt on the validity of our instruments. We utilized lags of endogenous regressors to identify the endogenous regressor in this study. Donou-Adonsou (2019) has addressed the endogeneity issue using internally generated instruments.

3. Results and discussion

To begin this section, we present the descriptive statistics on the eight selected variables used in this study. Table 5 provides details on the minimum, maximum, mean, and standard deviation for the respective variables. The summary statistics also cover the skewness and kurtosis for each of the selected variables. From Table 5, we see that school enrolment (tertiary) had a mean value of 9.61 with a minimum value of 1.24 and a maximum value of 22.2. The variable education expenditure was about US\$926,490,578.54 on average; its minimum and maximum values were US\$78,103,269.30 and US\$4,717,697,865.00, respectively. We also established the mean for GDP per capita (current US\$) to be 1,468.4; the minimum value in the dataset was 458.42, while the maximum value was 1468.44. The variable institutional quality had a mean value of 0.64, a minimum value of -0.96, and a maximum score of 1.61. In Table 5, the mean, minimum, and maximum values for FDI and ICT (PC) scores are also presented.

Table 5: Summary statistics result

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
School enrolment, tertiary (% gross)	1.24	22.22	9.6140	4.88273	0.647	0.046
Adjusted savings: Education expenditure (current US\$)	78103269.30	4717697865.00	926490578.54	1074572544.09	1.706	1.929
GDP per capita (current US\$)	458.42189	3928.30910	1468.4427725	882.13861383	1.158	0.667
ODA to the education sector (US dollar, Millions, 2022 constant prices)	9.73	143.78	55.5009	36.75410	0.751	-0.423
Institutional quality (Principal component score)	-0.96	1.61	.6444	.59529	-0.687	0.137
Foreign direct investment, net inflows (% of GDP)	-10.95	20.60	3.6738	3.96902	1.200	4.256
ICT (Principal component score)	-1.45	5.53	.0000	1.00000	2.052	7.492

Number of observations = 144; Number of groups = 12

The study conducted a multicollinearity test on the selected variables using the variance inflation factor (VIF) test. The tolerance levels and the values for the VIFs are presented in Table 6. We note from the results that the variance inflation factor (VIF) for all the variables was < 6, signifying the absence of

multicollinearity. Nonetheless, we support the current finding with previous studies (Onyeneke et al., 2024; Elom et al., 2024) who used a similar figure as the cut-off point for the determination of multicollinearity.

Table 6: Multicollinearity test result

Variable	Tolerance	Variance inflation factor (VIF)
lnEXP	0.184	5.447
lnGDP	0.667	1.498
lnODA	0.497	2.011
IQ	0.298	3.360
lnFDI	0.933	1.072
ICT	0.326	3.064

3.1. Cross-section dependence test

As part of the econometric analysis of the data, a preliminary test to determine cross-sectional dependence was conducted. This formed our first step in the estimation strategy for this paper. The CD test is critical to the validity of the study results since the presence of cross-sectional dependence can bias

the results from the estimated model. To reject the null hypothesis of no cross-sectional dependency, the p-values should be lower than 1%. From Table 7, we observed probability values for the computed CD were lower than 1%; hence, the null hypothesis (absence of cross-sectional dependencies) is rejected, and the subsistence of cross-sectional dependencies between the panels is found. The

result indicates that the variables, lnEDUC, lnEXP, lnGDP, lnODA, IQ, lnFDI, and ICT had their computed CDs lower than 1%. This suggests that the dependent variable in one of the countries is likely to influence

those of other African countries. The cross-section dependence tests suggest that the countries chosen for this research have similar traits and shocks (Pesaran, 2015).

Table 7: Cross-section dependence test

Variable	CD-test	p-value
lnEDUC	7.14	0.000
lnEXP	14.36	0.000
lnGDP	16.50	0.000
lnODA	2.72	0.006
IQ	18.74	0.000
lnFDI	3.44	0.000
ICT	3.93	0.000

3.2. Stationarity test

The second level of the estimation process focused on the stationarity test. The unit root test results for the data with their respective p-values are presented in Table 8. Pesaran's Panel unit root test (CIPS) approach was used on the panel and time series data. The predictors were tested at levels and first differences. We found that the predictor (lnODA) was stationary at the level, while all the variables were stationary at the first difference.

Based on the results, the study rejected the null hypotheses that all panels contain unit roots, and the time series data are not stationary (i.e. series have a unit root). The test findings indicate that the predictors are I(1), and the maximum integration level is specified as 1. The variables used for this paper showed a mixed nature of stationarity properties, being stationary at the level and first difference. The paper also carried out a cointegration test, the results are presented in Table 8.

Table 8: Unit root test

Pesaran panel unit root test (CIPS)				
Variable	At level I(0)	At first difference I(1)	Decision: H_0	Result
	t-statistic	t-statistic		
lnEDUC	-1.807	-2.910***	Reject	I(1) at 1%
lnEXP	-1.525	-3.424***	Reject	I(1) at 1%
lnGDP	-2.097	-3.272***	Reject	I(1) at 1%
lnODA	-2.684***	-4.081***	Reject	I(0) at 1%
IQ	-2.244	-3.714***	Reject	I(1) at 1%
lnFDI	-2.053	-3.982***	Reject	I(1) at 1%
ICT	-1.588	-3.813***	Reject	I(1) at 1%

***: indicate significance at 1% levels; H_0 = All panels contain unit roots; H_0 = Series have a unit roots

3.3. Cointegration test

The test for co-integration between the dependent variable and the independent variables is presented in Table 9. The null hypothesis of no cointegration was tested against the alternative using the Pedroni test (Philips-Perron t statistic). From Table 9, we confirm that a long-run relationship exists among the variables studied in the paper. Given the score for the p-values (critical

values at a 1% level of significance), the null hypothesis of no cointegration is rejected. We concluded, therefore, that there is a cointegration relationship between the dependent variable (higher education enrolment) and the predictors (gross domestic product per capita, education expenditure, information and communication technology, foreign direct investment, institutional quality, and official development assistance).

Table 9: Cointegration test

Pedroni test for cointegration	
Statistic	Higher education enrolment
Modified Phillips-Perron t	6.427***
Phillips-Perron t	-3.813***
Augmented Dickey-Fuller t	-3.768***
Westerlund test for cointegration	
Variance ratio	3.651***

***: indicate significance at 1% level; H_0 : No cointegration; H_a : All panels are cointegrated

3.4. Main findings

Table 10 shows the findings of static models, fixed effects, and random effects estimators. To determine which of the two estimators is most unbiased, efficient, and consistent, we conducted Breusch-Pagan Lagrange multiplier and Hausman tests. The p-value of the Breusch-Pagan Lagrange

multiplier test in the model was significant (p-value = 0.000). This implies that the random effects are legitimate and have non-zero variances (Baltagi, 2021). Using the Hausman test, the fixed effects and random effects estimators were compared to further identify the best unbiased, efficient, and consistent estimator. Significant p-values (0.000 in each case) were produced by this test. We therefore reject the

null hypothesis of random effects and propose a fixed-effect estimator for the two models. The fixed effect result in Table 10 shows that expenditure in education and ODA have a positive significant effect on higher education enrolment.

On the other hand, a consistent fixed effects estimator requires stringent exogeneity of the independent variables. We used the Wooldridge test to check the exogeneity of the independent variables

in the models. The Wooldridge test results show significant p-values (0.000 in each case). We reject the null hypothesis of no first-order serial correlation. The fixed effects models' assumption that the regressors are wholly exogenous is false and supports a relationship between the potential regressor and the error term. This implies that the parameter estimates of the fixed effects model are skewed and inconsistent.

Table 10: Static estimates of our model

Variables	Higher education enrolment	
	Fixed effects	Random effects
lnEXP	0.52*** (0.13)	0.25*** (0.09)
lnGDP	-0.01 (0.22)	0.40** (0.16)
lnODA	0.11* (0.06)	0.08 (0.07)
IQ	-0.005 (0.07)	-0.07 (0.07)
lnFDI	-0.02 (0.02)	-0.02 (0.02)
ICT	-0.02 (0.04)	-0.04 (0.04)
Constant	-8.56*** (1.77)	-5.99*** (1.52)
Observations	144	144
Groups	12	12
Post-estimation diagnostics		
Wooldridge test (p-value)	p-value = 0.000	
Breusch-Pagan LM test	chi2 (12) = 365.79	
	Prob > chi2 = 0.0000	
Hausman (p-value)	Wald chi2(6) = 38.93	
	Prob > chi2 = 0.0000	
	chi2(6) = 10.43	
Test of H ₀ : Difference in coefficients not systematic	Prob > chi2 = 0.1077	

The parentheses contain the standard errors; LM: Lagrange multiplier; ***: $p < 0.01$; **: $p < 0.05$; *: $p < 0.1$

Following an intense model search, we use a one-step difference GMM estimator. The model passes all the post-estimation tests and fits our data very well. For example, the Kleibergen-Paap rk LM statistic p-value of 0.000 in each model indicates that our models are identified. Also, the Sanderson-Windmeijer multivariate F test of excluded instruments' p-value of 0.000 in each model shows that our instruments are valid and identified. Our Cragg-Donald Wald F statistic value (20.48) is higher than the Stock-Yogo weak ID test critical value of 5% maximal IV relative bias (19.28), indicating that our instrument is strong. Table 11 presents the result of the GMM model.

Foreign direct investment was found to be significant but negative in the model. The findings show that higher education enrolment tends to decline with FDI in the selected data. This supports the findings of Wang and Zhuang (2021), who stated the possibility of a negative outcome of FDI on educational outcomes. They indicate growth in the use of outsourcing and assembly often does not provide an incentive to stay in school. Since such jobs often require a less skilled workforce to execute. This could make it less attractive to stay in school (Feldmann, 2025). Competition from foreign-owned firms may crowd out domestic entities, leading to a reduction in labor demand. We, however, expected an increase in FDI to influence higher education enrolment positively. Specifically, we hypothesize that larger stocks of FDI generally increase school enrollment in developing countries. This effect can be direct and indirect. For example, FDI may lead to improved educational outcomes through infrastructure development, the creation of new

skilled jobs that require skilled human capital, and improved income levels. These improvements may provide incentives for parents in developing countries to enroll and keep their children in education (Feldmann, 2025). These incentives arise since new jobs require skills from at least a basic education.

We also tested the relationship between GDP per capita and school enrolment rate at the tertiary level. The results show a significant positive relationship between GDP per capita and enrollment in tertiary-level education. This suggests that GDP per capita influences enrollment level in the tertiary level of education.

Official development assistance (ODA) was statistically significant in the estimated model. The results show that ODA has an influence on tertiary-level enrollment in the selected countries. This finding supports the work by Cooray (2016), who established a direct effect of ODA on educational outcomes. This notwithstanding, volatility and fungibility of ODA may limit the expected effect of ODA on educational outcomes. Education and human capital development are critical to reducing poverty and inequality on the continent of Africa (Ouedraogo et al., 2022).

Information and communication technologies had a positive impact on higher education enrolment in West Africa. This implies that ICTs significantly increased students' enrolment in higher education institutions. This is expected because ICTs relatively increase accessibility to education by enabling online learning, reaching geographically diverse students, and offering flexible learning options, thereby potentially boosting overall enrolment numbers in

higher education institutions. Rivers et al. (2015) confirmed this when they opine that ICT is important to higher education projects in Africa. Likewise, researchers have found a positive relationship between ICT use and educational quality (Cabras and Tena Horriilo, 2016; Gubbels et al., 2020; Lei et al., 2021).

The quality of institutions has a role to play in human capital development. From the results presented in Table 9, institutional quality showed a positive but not significant relationship with educational outcome in the estimated model. This thus suggests that institutional quality (IQ) has no significant effect on higher education enrollment in West Africa. This result deviates from the findings by Dias and Tebaldi (2012), who established that when studying the effect of institutional quality on education on a panel of 61 developed and developing countries observed on five-year data over the period 1965-2005 that institutional quality significantly affects school enrolment rates. Nifo et al. (2017) findings indicated that higher institutional quality is associated with higher proportions of graduates with productive technical and general skills, suggesting that institutions play an important role in determining educational choices. Thus, a decline in institutional quality may undermine the effect of public spending on education and deteriorate the quality of teaching. Improving educational outcomes and quality may be significantly constrained by low-quality institutions. Governments may invest in education, but if the institutions are poor, such investments may not yield the desired results. Therefore, the government can allocate significant educational resources without seeing positive results if corruption is pervasive. In sub-Saharan Africa, the quality of institutions in the region is the worst across all measures of institutional quality (Musah et al., 2024). The poor state of institutions could therefore be the reason for the insignificant impact of institutional quality on higher educational outcomes in West Africa.

The results indicate that spending on education does not significantly affect higher education

enrollment in West Africa. Normally, an increase in education spending is expected to enhance skills development by improving school enrollment. Based on this expectation, education expenditure should have a positive and significant impact on enrollment. This variable has been used in the past as a proxy for human capital. Our findings do support the study by Ihugba and Ukwunna (2019), who observed that an insignificant relationship exists between government education expenditure on school enrolment. However, the study by Carsamer and Ekyem (2015) found that in sub-Saharan Africa shows that increase in education expenditure positively increases school enrolment at the tertiary school level. The effectiveness of public spending in improving educational outcomes may be significantly affected by corruption. Corruption can derail the benefits of government social intervention expenditures. Governments may spend money on education, but if there is corruption in the system, that expenditure may not produce the expected results. Acemoglu and Verdier (2000) observed that corruption is a natural by-product of public intervention in providing social services. Funds may be misappropriated, bureaucracy may slow the application of funds to educational programs, corruption may reduce the return on public financing of education, and a lack of action to punish corrupt people may encourage people to steal more (Musah et al., 2024). Public servants buy equipment and materials employed as tools in generating public goods (Haque and Kneller, 2015). Also, public servants may falsely advertise high-quality projects with higher costs at the contracting stage while delivering low-quality projects with lower costs owing to informational disparity (Van Bon, 2019; Haque and Kneller, 2015). Hence, even if corruption increases the amount of money utilized for investment in public projects, it decreases the returns on that money, in this case, because the projects either fail or are of poor quality (Van Bon, 2019). This may be the reason why education expenditure insignificantly impacts higher education enrolment in West Africa.

Table 11: Generalized method of moments, estimation results (one-step difference)

Variables	Tertiary school enrolment
	Estimates
lnEXP	-0.05 (0.08)
lnGDP	0.76*** (0.09)
lnODA	0.23*** (0.07)
IQ	0.07 (0.11)
lnFDI	-0.07** (0.03)
ICT	0.10** (0.05)
Constant	-2.97** (1.37)
Observations	144
Groups	12
Post-estimation diagnostics	
Sanderson-Windmeijer multivariate F test of excluded instruments (p-value)	F(6, 137) = 25.08 Prob > F = 0.0000
Hansen-Sargan (p-value)	Chi-sq(5) P-val = 0.2620
Kleibergen-Paap rk LM statistic (p-value)	Chi-sq(6) P-val = 0.0000
Cragg-Donald Wald F statistic	21.67
Stock-Yogo weak ID test critical values: 5% maximal IV relative bias	19.28

The parenthesis contains robust standard errors; ***: p < 0.01; **: p < 0.05

4. Conclusions

Human capital development is critical to economic growth and poverty reduction. The aim of this study is to contribute to a better understanding of the relationship between institutional quality, development assistance, information and communication technology, and foreign direct investment on educational outcomes proxied by enrollment level in tertiary school. Using a panel data set obtained from 12 West African countries, we assessed the above relationship. The study employs a dynamic model based on a two-step system generalized method of moments. The signs and the coefficients obtained from the models met the *a priori* expectations of the study. Generally, the study established the need to improve institutional quality to foster school enrollment in the selected West African countries. This should be done with concrete educational policies combined with key dimensions such as FDI and ODA inflows, growth in GDP per capita, and ICT infrastructure needs in the educational sector. We also conclude that success in achieving development outcomes using aid will depend on the extent of effectiveness of public expenditure on education.

Specifically, GDP per capita was a strong determinant of higher education enrollment. GDP per capita as a measure for economic power and wealth of countries and their people, increases in GDP per capita for the selected countries may lead to improvement in educational infrastructure. Also, with growth in per capita income, we expect purchasing power to improve, hence the middle class will be incentivized to keep their children in school beyond the basic level. In other words, with higher income and purchasing power of people, the more capable and interested they will be in attending school. In general, we conclude that GDP per capita has a strong effect on educational outcomes. We also capture the likely effect of disparity in the distribution of national income on the quality of education in the selected countries.

Expenditure on education was not statistically significant in the two models; we attribute this to the possible existence of a lag period between the level of capital expenditure in the sector translating into the expected outcomes (i.e., enrollment levels). In the long term, there is the likelihood that increased government expenditure in the education sector will incentivize people to enroll themselves and their children at different educational levels, especially at the tertiary level.

ODA and FDI are significant determinants of higher education enrolment in the selected countries. We therefore conclude that ODA and FDI inflows complement government policy in education through infrastructure development, ICT support, and capacity development (i.e., introduction of new pedagogy and curriculum, etc.). We also conclude that spillovers resulting from increases in FDI thus create demand for a better educated labor force, hence people will enroll in higher levels of education

in the long term. Even though the institutional quality variable was not significant in the model, ODA and FDI inflows will only translate into the expected educational outcome if accompanied by government policies and strong institutions.

In developing countries, strengthening institutional quality is essential for improving human capital development. Better institutional quality can contribute to improvements in education. The absence of a significant relationship between institutional quality and educational outcomes suggests that institutions in these countries are weak. To strengthen the link between institutional quality and education, governments should increase public spending on education with a focus on improving teaching quality. A decline in institutional quality is likely to harm both the quality of teaching and the effectiveness of public spending on education.

List of abbreviations

CD	Cross-section dependence
EDUC	Tertiary school enrolment/higher education enrolment
EXP	Education expenditure
FDI	Foreign direct investment
GDP	Gross domestic product
GMM	Generalized method of moments
I(0)	Integrated of order zero (stationary at level)
I(1)	Integrated of order one (stationary at first difference)
ICT	Information and communication technology
IQ	Institutional quality
IV	Instrumental variable
LM	Lagrange multiplier
MGMM	Modified generalized method of moments
ODA	Official development assistance
PC	Principal component
PCA	Principal component analysis
SDG	Sustainable development goal
SPSS	Statistical package for the social sciences
SSA	Sub-Saharan Africa
VIF	Variance inflation factor

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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