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Income inequality: The effects of public education expenditure and information and communications technology in sub-Saharan Africa

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Background: As nations globally strive to meet the United Nations Sustainable Development Goal (SDG) 10, which underscores the reduction of inequality, there is an increasing need to harness the power of education and information and communications technology (ICT) to achieve this aim. Therefore, this study is motivated by this rationale.

Aim: The synergistic effect of government spending on education and ICT on income inequality in sub-Saharan Africa (SSA) in the long run.

Setting: Panel data for 30 SSA countries from 1990 to 2022 are used.

Method: This research used the Fully Modified Ordinary Least Square (FMOLS) technique, which provides long-run estimates, to achieve the aim of the article.

Results: The FMOLS results reveal that public education expenditure increases income inequality while its squared expenditure reduces it in the long run. However, over time, ICT diminishes inequality. Notably, the combined effect of public education spending and ICT strengthens the effect of public education expenditure on income inequality in SSA in the long term.

Conclusion: In summary, with the incorporation of additional control variables in the analyses, it suggests that SSA's governments, along with policymakers, have the opportunity to achieve income inequality reduction by strategically making use of public education spending and ICT.

Contribution: This article adds significant value to the literature by demonstrating the effect of public education spending and ICT on income inequality in SSA (characterised by higher level of income inequality). To mitigate concerns regarding endogeneity, this article uses FMOLS.

Keywords: ICT; income inequality; public education expenditure; FMOLS; SSA countries.

Introduction

The 2022 World Inequality Report reveals that the wealthiest 10% of people worldwide currently earn more than half of the global income, whereas the bottom 50% receive a mere 8.5% (Chancel et al. 2021). Literature has shown that income inequality is a significant socioeconomic determinant impacting both industrial and emerging countries (Dossou, Emmanuelle & Bekun 2023; Ndjobo & Otabela 2023). The COVID-19 epidemic has made this trend worse. For instance, according to the International Monetary Fund (IMF) (2021), extreme poverty and billionaires' wealth have increased during COVID-19. Similarly, wealth inequality, as noted by Ajide and Alimi (2021), has the potential to impede human advancement and fuel terrorism, both of which have the knock-on effects of slowing economic growth in emerging nations, particularly in Africa. In general, if inequality is above socially tolerable levels, as suggested by the report above, policy intervention must use a dual strategy. On the one hand, it should implement programmes to promote asset ownership and opportunity equality, such as by improving access to education to address the root causes of inequality. However, this will probably be a long-term process, with most benefits appearing years from now. On the other hand, policymakers should ensure that the fiscal system (tax or government expenditure) successfully carries out its redistributive function by implementing the required fiscal reforms to reduce income inequality. Skill-biased technical change (SBTC) has significantly contributed to the escalation of income inequality in numerous developed countries in recent decades (see Van Reenen 2011). Skill-biased technical change, which favours skilled workers, amplifies the demand for their expertise relative to unskilled labour. If this demand outpaces the supply of skilled workers, it leads to a rise in the skill premium and consequently, income inequality. The concept of income inequality being shaped by the competition between education and technology traces back to Tinbergen (1975). He proposed that governments should bolster investment in education to augment the pool of skilled workers and effectively compete with technological advancements in order to mitigate inequality.

In this context, education provided by universities, schools, among others, is seen as a focal element of the knowledge-based economy because they provide human capital with the necessary skills for development (Zaika & Gridin 2020). This shows that education has the potential to reduce societal inequities. The Human Capital Theory of Earnings views education, in the form of human capital, as a fundamental factor influencing variations in income levels (Becker 1962; Becker & Chiswick 1966; Mincer 1970). The Human Capital Earnings Model typically examines the connection between income disparities and the extent and variability of education, as well as the returns on education (Chiswick 1974). This model suggests a partially positive relationship between the level of education and inequality, as well as a positive relationship between the inequality in education and income disparities. Hence, the model anticipates that diminishing educational disparities would lead to a decrease in income inequality. However, it also suggests that income inequality is likely to rise when the average years of schooling increase, all else being equal. The core argument put forth by the Becker-Mincer-Chiswick (B-M-C) Model is that an expansion in the supply of labour results in a composition of the workforce, as unskilled individuals evolve into skilled workers. Although this composition may initially lead to an increase in income inequality, it is anticipated that over the long run, income inequality will decrease as the skilled workforce continues to grow. It is important to note that the B-M-C group's prediction relies on the assumption that the rates of return to education and the level of education are not interdependent.

Most scholars have demonstrated that government spending on education can reduce inequality between individuals. This reduction is done through human capital accumulation, which increases productivity and economic growth, decreasing income disparity (see Samanta & Kayet 2020). Economic theory has acknowledged public spending as a source of economic expansion. According to Lucas (1988), government investment in education raises human capital levels, supporting the knowledge-based economy and economic growth. A country's growth and prosperity are increasingly being attributed to investments in its human capital through investments in education and health. These cost-effective investments can increase a country's adaptability and resilience to fast change, like what is occurring in information and communications technology (ICT) right now. Through mobile technology, Africa has already demonstrated that advancing development and widening inclusion is feasible. As mentioned earlier, COVID-19 has played a vital role in a recent increase in income inequality worldwide. The pandemic has resulted in limitations on physically interactive activities, including work, which serves as a primary income source (Ndjobo & Otabela 2023). Consequently, despite these restrictions, countries have turned to ICTs to sustain economic operations. The International Telecommunication Union (ITU) (2021) asserts that ICTs have played a vital role in ensuring the continuity of corporate activities, employment, education and essential service provision. Therefore, ICTs have been instrumental in maintaining economic activity during the COVID-19 pandemic. However, economic progress often correlates with an increase in inequality, particularly in developing regions like SSA.

Several scholars have demonstrated that ICTs can help close the wealth gap in a community by enhancing access to knowledge and creating new avenues for economic growth (Das & Drine 2020). If ICTs enable access to new knowledge, then access to and spread of ICTs require a particular level of knowledge and human capital. Therefore, a certain level of government spending on education is needed to promote human capital accumulation. Furthermore, the difficulty of comprehending the different causes and effects of economic disparity in emerging countries forces us to take into account more than just the direct effects of ICTs. In fact, a rise in ICT may not affect the income gap if it is not linked to a certain amount of government expenditure. Education, when well-managed, leads to human capital accumulation in society. As SSA countries are characterised by low levels of government spending on education and high levels of income disparity, there is a need to test the synergistic impact of education expenditure and ICTs on income disparity to comprehend better the association between public education expenditure (PEDEXP) and income gap in SSA.

The combined impact of public education spending and ICT on income inequality in sub-Saharan Africa (SSA) can be comprehended through various economic and social theories. Technological advancements driving economic growth, as posited by the Technology-Driven Growth Theory (Romer 1990), are exemplified in SSA through ICT integration in education, which prepares students for a technology-driven economy, fostering a skilled workforce that utilises technology for productivity and innovation, thereby reducing income disparities (Helpman & Trajtenberg 1998). Furthermore, according to the Modernization Theory (Rostow 1960), economic development progresses linearly from traditional to modern stages, with education and technology serving as key drivers. In SSA, public education spending and ICT initiatives modernise the workforce, aligning it with contemporary economic demands, improving economic outcomes, and reducing inequality (Inglehart & Welzel 2005). Finally, the Capability Approach (Sen 1999) underscores the importance of expanding individuals' capabilities through education and technology. In SSA, public investment in education and ICT enhances capabilities, providing knowledge and tools for diverse opportunities, leading to more equitable income distribution (Nussbaum 2000).

The association between ICTs and inequality has been investigated, but the results remain inconclusive. As ICTs need investment, we assume that ICT requires a certain amount of PEDEXP. Although COVID-19 has increased income disparity worldwide, internet penetration has increased by more than 20% in Africa (ITU 2021).

However, Richmond and Triplett (2017) argue that the increasing prevalence of ICTs, coupled with unequal access and a premium on skill, could exacerbate inequality, as the availability of education has significant disparities. Dervis and Qureshi (2016) suggest that the disparity in well-being is likely to be markedly lower in countries where education is predominantly free for all, compared to those where it is predominantly fee-based, even if their Gini coefficients for disposable income are similar. Considering the close connection between ICTs and government spending on education, it is crucial to account for the moderating influence of ICTs on the relationship between government education expenditure and income disparity in SSA. Therefore, this study aims to examine how PEDEXP and ICT interactions affect income disparity in 30 SSA countries from 1990 to 2022.

A review of the existing literature shows that the interaction term of ICTs with government spending on education has not been thoroughly studied regarding how they affect income disparity. The results of this study filled this gap by helping us better understand how ICTs and income inequality are related. Accordingly, the results indicate that ICT significantly reduces inequality in SSA countries in the long run. Interestingly, the results also reveal that public education expenditure is significant and positive while its squared negatively and significantly affects inequality in most columns in the long run. It is observed that the interaction between public spending on education and ICT strengthens the impact of public spending on education on inequality in SSA countries in the long run.

Motivation and literature review

The significant literature concerning the correlation between education and income dates back to 1955, when Kuznets (1955) initially proposed the notion that enhancing residents' education levels could mitigate income inequality. Subsequent literature underscores the significant role of education in reducing inequality. Policymakers frequently advocate for increased investment in education as an effective strategy for mitigating income inequality. Schultz (1963) argued that enhancing human capital, as measured by educational attainment, could help alleviate inequality, with increased public spending on education serving as a means to achieve this goal. Schultz's analysis compared the returns on investment in human capital to those on physical capital, noting that income derived from physical resources tends to be distributed more unequally. Despite notable variations in education and earnings related to human capital, they are generally expected to be smaller than disparities in income stemming from physical capital. Consequently, as education and human capital grow at a faster pace than physical capital, it is anticipated that overall income inequality will decrease.

A more prevalent viewpoint indicates that there is a nonlinear link between public expenditure on education and inequality. According to Knight and Sabot's theory (1983), the expansion of education has a dual effect within the framework of the Human Capital Mechanism, involving both Composition and Wage Compression Impact. Initially, the composition impact of education spending produces more income inequality by expanding the number of highly educated individuals. However, as education expenditure continues to rise, and the supply of highly educated labour surpasses market demand, these groups' earnings (highly skilled premium) decrease because of the wage compression effect of education spending outweighing the composition effect. In this scenario, an increase in education spending can actually help reduce economic inequality to a certain extent. Moreover, the Theory of Structural Transformation (TST), described by Fisher (1935) and Clark (1940), provides understanding regarding the evolving significance of educational expansion as an economy grows. According to this theory, as an economy grows, it undergoes a transition from agriculture to manufacturing, and eventually, to the service sector. This transformation also alters the workforce composition. During the initial stages of development, when the economy is predominantly agricultural and a substantial portion of the workforce is employed in agriculture, income distribution is chiefly influenced by land ownership. However, as the economy transitions from being primarily agrarian to focusing on manufacturing and eventually services, there is an increasing demand for highly skilled labour rather than low-skilled labour. With a larger services sector, the need for highly skilled workers grows. In such circumstances, a household income becomes significantly influenced by their level of skill and educational attainment. It can be posited that as the economy expands, the distribution of income becomes increasingly tied to the distribution of skills and education. This leads to inequality reduction over time.

Regarding the correlation between ICT and inequality, the Neoclassical Theory of Economic Development has been identified as a pertinent theoretical framework for elucidating this connection (Awad 2022). According to this theory, ICT has the potential to enable the redistribution of economic wealth. Additionally, it has been suggested that ICT could help increase agricultural productivity. Ofori et al. (2021), who have demonstrated how ICT has been employed in Hong Kong, Japan and China to promote the distribution of income, wages and social welfare, have lately supported the Neoclassical Theory. Literature shows that there are various channels through which ICT can lead to income inequality reduction. For instance, increased ICT infrastructure in Africa, according to Ofori et al. (2021), could help boost economic efficiency and lessen poverty and income disparity. By making ICT more productive, which has the potential to spur economic growth, income distribution can be made more equitable (Appiah-Otoo & Song 2021). According to Awad and Albaity (2022), ICT has the potential to boost overall economic output, and it can foster economic growth while also enhancing income distribution and social welfare. The Organisation for Economic Co-operation and Development (OECD) (2011) argues that access to computer technologies and information has the potential to increase income levels, reduce poverty rates and elevate living standards globally. Consequently, access to ICT and education plays a distinct role in addressing inequality. Moreover, the same source suggests that individuals with a fundamental understanding of modern ICTs and requisite job-specific skills have experienced substantial growth in earnings and personal income. Workers with lower skill levels, or those without any abilities at all, experience no change in pay. As a result, there is a growing income gap between low- and high-skilled employees. Although few scholars assessed the connection between government expenditure and inequality, others have examined the effect that government expenditure on education plays in fighting inequality. Goodspeed (2000) found that public education spending has a positive effect on economic growth and a negative effect on inequality. However, Goodspeed (2000), Holzner (2011), and Samanta and Kayet's (2020) results demonstrated that government education spending negatively influences income disparity.

An investigation of the literature does not reveal a clear result regarding the effect of government expenditure on education on inequality. Scholars use different channels (level of development, good governance) to assess the link between government expenditure and inequality. Lai Desheng's (1997) study using cross-border panel data demonstrated that the influence of education spending on income distribution is correlated with the level of economic development. In the context of lower economic development, the disparity in income distribution tends to widen, and as the economy develops to a higher level, the income distribution gap tends to narrow. As Zhang Xiaofang et al. (2021) suggests, the connection between education expenditure and inequality depends on the quality of governmental governance. The development of the Human Capital Theory has instilled optimism regarding the influence of educational investment on income inequality. With education being recognised as a powerful long-term mechanism for balancing earnings and income distribution, researchers have placed significant emphasis on empirically validating the role of education in alleviating disparities in income distribution in the long run. Therefore, this study applies Fully Modified Ordinary Least Square (FMOLS) technique, which provides long-run estimates, to investigate the impacts of public education spending on inequality in 30 SSA countries from 1990 to 2022 using ICT channel. However, this study contributes to the existing literature by testing the synergistic effect of PEDEXP and ICT on inequality in SSA countries for 30 countries using FMOLS.

Methodology and data

Empirical specification

To empirically examine the synergistic impact of ICT and public education spending on inequality in 30 SSA countries[1] from 1990 to 2022, this study followed Asamoah (2021) and Canh et al. (2020). However, our model differs from these studies. While Canh et al. focus on the impact of government education expenditure on inequality and Asamoah assesses the effect of ICT on inequality, this study addresses a gap in the economic development literature by examining the moderating role of ICT in the relationship between public education spending and inequality. It is important to note that the selection of the specific time period and countries included was driven by data availability. Our equation is written as in Equation 1:

$$Gini_{it} = \beta_1 PEDEXP_{it} + \beta_2 ICT_{it} + \beta_3 PEDEXPSQ_{it} + \beta_4 \mathrm{PEDEXP}_{it} * ICT_{it} + \beta_5 GDPpc_{it} + \beta_6 HC_{it} + \beta_7 Gov_{it} + \epsilon_{it} \quad \text{[Eqn 1]}$$

The Gini coefficient series, recently made accessible by version 8.2 of the SWIID published by Solt (2019), is the source of our annual statistics on aggregate net income inequality. Information and communications technology is the individual using the internet (% population) as an information communication technologies' proxy variable and was obtained from World Development Indicator (WDI); public education expenditure (PEDEXP) as a percentage of Gross Domestic Product (GDP), which includes primary, secondary and tertiary education, Research & Development (R&D) education, expenditure funded by transfers from international sources to government, etc., and was taken from WDI. PEDEXPSQ is the squared of PEDEXP, showing the further increase of PEDEXP. Gross Domestic Product per capita (GDPpc) was taken from WDI, while Gov is governance quality and was taken from World Governance Indicators (WGIs). Hence, HC is human capital and was taken from Penn World Tables (PWT) version 9.0. The approach used to calculate the human capital index accounts for the return to education described by Psacharopoulos (1994) and the average years of schooling as stated in Barro and Lee (2013) version 1.3. PEDEXP*ICT is the interaction between PEDEXP and ICT. In this study, we assume a significant effect of the interaction term between PEDEXP (leading to human capital accumulation) and ICTs on inequality in SSA. Hence, if we assume that this effect leads to inequality reduction, there could be a rise in the income shares for the poorest segment of the population. All variables were chosen according to the literature. We also noted that some data were missing; however, this issue was addressed using interpolation and extrapolation techniques (Equation 2):

$(PEDEXP*ICT)_{it}$ = The interaction term between PEDEXP and ICT.

$$\frac{dGINI_{it}}{dPEDEXP_{it}} = \beta_1 + \beta_3 \overline{ICT}_{it} \quad \text{[Eqn 2]}$$

where $\overline{ICT}$ is the mean value of ICT.

Estimation technique

This study examined how public education spending and ICT affect inequality in SSA. To address the substantial variations among countries, which are crucial factors to consider when analysing heterogeneity between countries, this study employs panel data instead of cross-sectional data to achieve this objective (Ali & Muhammad 2018). Hence, the Ordinary Least Squares (OLS), Fixed Effects (FE), and Random Effects (RE) are

1.The list of countries are: Botswana, Ghana, Lesotho, Burkina Faso, Burundi, Ethiopia, Gambia, Madagascar, Malawi, Mali, Mauritius, Senegal, Swaziland, Cameroon, Central African Republic, Chad, Congo Rep, Côte d'Ivoire, Guinea-Bissau, Guinea, Kenya, Mozambique, Namibia, Niger, Tanzania, Sierra Leone, Uganda, Zambia, Zimbabwe, South Africa.

the most often utilised estimation techniques for this analysis. This study did not employ the aforementioned techniques because of their inability to address endogeneity issues. Instead, FMOLS was utilised, which not only controls for endogeneity but also assesses the long-run equilibrium relationship between the variables.

Long-run equilibrium association

This study utilises FMOLS developed by Pedroni (2000) to analyse the long-run equilibrium association between variables. This method addresses serial correlation of the fitted errors and endogeneity issues, and accommodates significant heterogeneity within each sample unit. It is also consistent with omitted variables not incorporated in the cointegrating association. Before specifying the FMOLS technique, we start by presenting the standard form of the pooled OLS panel equation as follows, in Equation 3:

$$Y_{i,t} = \alpha_i + \theta X_{i,t} + \mu_{i,t} \qquad \text{[Eqn 3]}$$

where $Y_{i,t}$ describes a matrix (1,1) and is our regressand (income inequality). α_i describes a vector of cross-unit factor heterogeneity, θ represents a vector coefficient (K,1), and $\mu_{i,t}$ is a vector of the stationary idiosyncratic error term. Hence, $X_{i,t}$ is a vector of regressors of the first order for all unit (i), where $X_{i,t} = X_{i,t-1} + \varepsilon_{i,t}$.

According to Phillips (1995), the FMOLS estimator is built to correct two OLS econometric issues: serial correlation and endogeneity.

Thus, the FMOLS estimator can be presented in Equation 4:

$$\hat{\beta}_{iFMOLS} = N^{-1}\sum_{i=1}^{N}\left(\sum_{i=1}^{T}\left(x_{it}-\bar{x}_i\right)^2\right)^{-1}\left(\sum_{i=1}^{T}\left(x_{it}-\bar{x}_i\right)y_{it}^{*} - T\hat{\gamma}_i\right) \qquad \text{[Eqn 4]}$$

where y_{it}^{*} is a changed version of y_{it}. This changed version is done to perform the endogeneity correction. $\hat{\gamma}_i$ is a term that corrects the effect of serial correlation produced by heterogeneity dynamics in the short-run process, which determines y and x.

We used both regressions (FMOLS and dynamic OLS) to test for robustness. However, our focus is on data provided by FMOLS rather than Dynamic Ordinary Least Squares (DOLS). According to Maeso-Fernandez, Osbat and Schnatz (2004), one of the reasons is that DOLS reduces the degrees of freedom by including leads and lags. In contrast to DOLS, FMOLS produces consistent results (see Equation 5):

$$\hat{\beta}_{DOLS}^{*} = N^{-1}\sum_{i=1}^{N}\left(\sum_{t=1}^{T} z_{it}\, z_{it}^{i}\right)^{-1}\left(\sum_{t=1}^{T} z_{it}\, y_{it}^{*}\right) \qquad \text{[Eqn 5]}$$

To estimate FMOLS techniques, some requirements need to be met. As we can notice: (1) the panel data should have a sufficient time dimension (from 1990 to 2022) to allow for long-run dynamics to be captured. (2) The majority of the series employed in this article hardly have stochastic trends by their nature. The Gini coefficient index, for instance, varies between 0 and 100, and the government expenditure variables as a share of GDP may contain a deterministic trend, hardly nonstationary. (3) There is evidence of a cointegrating relationship among the variables as it is observed in Table 4.

Ethical considerations

This article followed all ethical standards for research without direct contact with human or animal subjects.

Results

Basic results

Before estimating the association between government education spending, ICT and inequality using FMOLS, we first examine the descriptive statistics, the correlation matrix, the variance inflation factor (VIF), the Ramsey RESET test and scatter plots with quadratic fits for our variables of interest. Table 1 presents the summary statistics. The mean of income inequality is 56.4, with a standard deviation of 6.97, indicating that income inequality remains high in Africa. This finding aligns with Asongu and Odhiambo (2019), who emphasise the importance of reducing income disparity in developing regions to achieve Sustainable Development Goal (SDG) 10. The mean of PEDEXP is 4.16, with a standard deviation of 2.61. The maximum value of income inequality is 66.5, and the minimum is 34, highlighting heterogeneity in the sample, which is also reflected in the standard deviation. Table 2 shows the correlation matrix, revealing that both PEDEXP and ICT individually have a negative correlation with income disparity.

TABLE 1: Summary statistics.

Variable	Observation	Mean	Standard deviation	Minimum	Maximum
GINI	960	56.4	6.97	34.00	66.50
PEDEXP	958	4.16	2.61	0.62	44.33
ICT	960	7.21	10.24	0.00	63.27
HC	960	1.61	0.42	1.02	2.86
GDPpc	960	1.37	4.99	-47.81	36.98
Gov	1079	0.91	1.38	0.00	4.00

Note: The Jarque–Bera test evaluates the null hypothesis of normality against the alternative of non-normality. The significance of the Jarque–Bera statistic indicates the rejection of the null of normality.

ICT, information and communications technology; PEDEXP, public education expenditure; GINI, gini coefficient; HC, human capital; Gov, governance; GDPpc, gross domestic product per capita.

TABLE 2: Correlation matrix.

Variable	GINI	PEDEXP	ICT	HC	GDPpc	Gov
GINI	1.000	-	-	-	-	-
PEDEXP	-0.325	1.000	-	-	-	-
	0.000	-	-	-	-	-
ICT	0.023	-0.047	1.000	-	-	-
	0.480	0.194	-	-	-	-
HC	0.493	0.357	-0.031	1.000	-	-
	0.000	0.000	0.331	-	-	-
GDPpc	-0.002	0.094	-0.070	0.106	1.000	-
	0.940	0.003	0.031	0.001	-	-
Gov	-0.179	-0.027	-0.154	0.064	0.141	1.000
	0.000	0.412	0.000	0.048	0.000	-

ICT, information and communications technology; PEDEXP, public education expenditure; GINI, gini coefficient; HC, human capital; Gov, governance; GDPpc, gross domestic product per capita.

TABLE 3: Variance inflation factor.

Variable	VIF	1/VIF
PEDEXP	1.16	0.863
ICT	1.16	0.864
HC	1.05	0.952
GDPpc	1.04	0.964
Gov	1.03	0.971
Mean VIF	1.09	-

ICT, information and communications technology; VIF, variance inflation factor; PEDEXP, public education expenditure; HC, human capital; GDPpc, gross domestic product per capita; Gov, governance.

To detect multicollinearity in the regression analysis, this study uses the VIF. Table 3 indicates no multicollinearity, as all VIF values are less than 10, demonstrating the reliability of the regression models. To ensure the robustness and appropriate specification of the model, this study performs the Ramsey RESET test and plot scatter diagrams with quadratic fits. The scatter plot indicates that the quadratic fit line closely follows the data points, suggesting that the quadratic term is appropriate and there is a nonlinear relationship between government education expenditure and income inequality (see Figure 1). The Ramsey RESET test results show a p-value of 0.854, which is greater than the chosen significance level of 0.05. Thus, we fail to reject the null hypothesis,[2] indicating no strong evidence of omitted variables or model misspecification. As the model is well specified, this study employs Westerlund (2007) panel cointegration test, which takes into account cross-sectional dependence and heterogeneous slopes, to ensure the variables are cointegrated. The results of Table 4 suggest the rejection of the null hypothesis of panel no cointegration. Two test statistics out of four (G_t, P_t) are statistically significant at 1%. This suggests that income disparity and the regressors cointegrate in the long run. Therefore, FMOLS is required to estimate the long-term relationship between cointegrated variables.

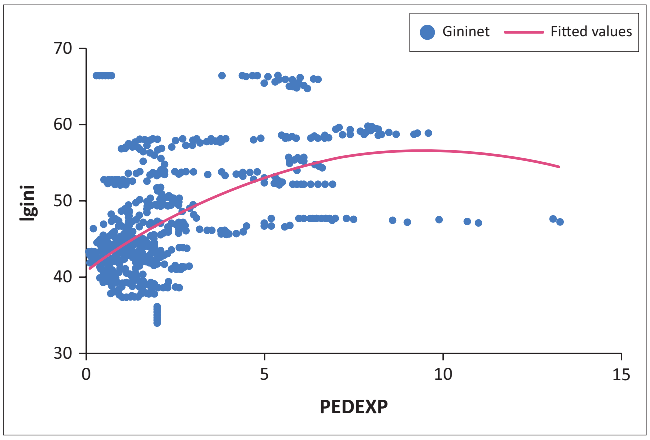
TABLE 4: The Westerlund (2007) panel cointegration test (with CD and structural breaks).

SSA	Value	p
G_t	-2.076	0.002***
G_a	-3.143	1.000
P_t	-13.32	0.026***
P_a	-2.731	0.090*

Note: Null hypothesis: No cointegration.

***, ** and * denote the rejection of the null hypothesis of no cointegration at the 10%, 5% and 1% level of significance, respectively.

CD, cross-sectional dependence; SSA, sub-Saharan Africa.



PEDEXP, public education expenditure.

FIGURE 1: Scatter plot between public education expenditure and inequality.

Fully Modified Ordinary Least Square results

Table 5 presents the results of Equation 1 using the OLS, FE and RE estimation methods, respectively. Additionally, we first estimate the model using each of the aforementioned estimation methods without including the interaction term between PEDEXP and ICTs to confirm that the respective effects of these two factors are consistent with the existing studies (Das & Drine 2020). Table 5 is, therefore, made up of columns 1–6, while columns 1, 3 and 5 show the results of the estimations without the interaction term. Specifically, the results of Equation 1 using OLS, RE and FE techniques show that ICT and PEDEXP and its squared are individually insignificant in reducing income gap in SSA. The reason is that the basic FE, RE and OLS are not appropriate methods for computing Equation 1 given the probable endogenous character of numerous regressors in Equation 1, notably ICTs, PEDEXP and its squared, the interaction of PEDEXP with ICTs, and GDP per capita. Column 5, using the RE estimator, shows that ICTs and PEDEXP individually have an overall insignificant and negative effect on income disparity. Hence, when the interaction term is included in the model (see column 6), it is observed that the insignificant effect on income disparity remains. As the results from OLS, FE and RE are inappropriate, this study focuses on the results of FMOLS to investigate the long-run link between our series. Indeed, the interaction term of government expenditure on education with ICT significantly strengthens the effect of public education spending on income disparity. Therefore, ICT would catalyse the effect of public education spending on income disparity, as the effect of the interaction term is also negative and significant but larger than the impact of public education spending and ICT individually.

TABLE 5: Ordinary Least Squares, Fixed Effects and Random Effects Results.

Variables	OLS-1	OLS-2	FE-3	FE-4	RE-5	RE-6
PEDEXP	0.021	-0.035	0.042	-0.063	0.081	0.095
	0.925	0.532	0.621	0.862	0.584	0.561
PEDEXPSQ	-0.043	-0.031	-0.020	-0.073	-0.062	-0.037
	0.514	0.861	0.742	0.657	0.956	0.762
ICT	-0.052	-0.064	-0.243	-0.046	-0.043	-0.083
	0.753	0.634	0.458	0.537	0.058	0.624
PEDEXP*ICT	-	-0.354	-	-0.684	-	-0.101
	-	0.845	-	0.947	-	0.942
HC	-0.014	-0.042	-0.357	-0.034	-0.357	-0.091
	0.563	0.864	0.638	0.936	0.062	0.103
GDPpc	-0.423	-0.762	-0.852	-0.275	-0.534	0.140
	0.473	0.397	0.496	0.736	0.621	0.962
Gov	-0.383	-0.413	-0.719	-0.462	-0.981	0.231
	0.753	0.864	0.843	0.975	0.734	0.857

ICT, information and communications technology; PEDEXP, public education expenditure; PEDEXPSQ, squared of PEDEXP; HC, human capital; GDPpc, gross domestic product per capita; Gov, governance; OLS, ordinary least squares; FE, fixed effects; RE, random effects.

Table 6 presents the long-run FMOLS estimates for the coefficients on education public spending and other regressors.

2.Ho: Model has no omitted variables.

TABLE 6: Fully Modified Ordinary Least Square and Dynamic Ordinary Least Squares results.

Variables	FMOLS-1	FMOLS-2	DOLS-3	DOLS-4
PEDEXP	0.064	0.123	−0.021	0.127
	0.621	0.061	0.621	0.064
PEDEXPSQ	-0.033	-0.072	-0.084	-0.061
	0.420	0.049	0.191	0.053
ICT	-0.043	-0.083	-0.035	-0.073
	0.458	0.094	0.158	0.089
PEDEXP*ICT	-	-0.009	-	-0.011
	-	0.042	-	0.046
HC	-0.357	-0.091	-0.756	-0.095
	0.638	0.113	0.638	0.125
GDPpc	0.852	0.140	-0.951	0.042
	0.496	0.962	0.170	0.712
Gov	0.719	0.092	0.532	0.183
	0.843	0.057	0.931	0.081

ICT, information and communications technology; FMOLS, fully modified ordinary least square; DOLS, dynamic ordinary least squares; PEDEXP, public education expenditure; PEDEXPSQ, squared of PEDEXP; HC, human capital; GDPpc, gross domestic product per capita; Gov, governance.

When examining the estimations for the SSA countries, the results in column 2 of Table 6 show that the coefficient on lnPEDEXP is, as predicted, positive and statistically significant – a 1% rise in lnPEDEXP results in a 0.123% reduction in income disparity over time. It is also observed that PEDEXPSQ is negative and significant. A 1% increase leads to the income disparity reduction by 0.072%. The GDP per capita result indicates that the association between GDPpc and income disparity is positive and insignificant. Accordingly, a 1% rise in GDP will increase income disparity by 0.140% in the long run. We also found that human capital is negative and statistically insignificant in reducing income disparity. A 1% increase in human capital reduces income disparity by 0.091% in the long run. However, it is also observed that the estimated coefficient for ICT is −0.083, suggesting that a rise of 1% in ICT will lower income disparity by 0.083% over time. Furthermore, the estimated coefficient of governance is positive (0.092) and significant. The governance elasticity indicates that a 1% increase in governance increases inequality by 0.092% in SSA over time. According to Table 5, both FMOLS and DOLS approaches showed largely consistent results for long-term associations among series. The results for FMOLS and DOLS are nearly identical. We focused on FMOLS when evaluating the results because it makes fewer assumptions and produces consistent results.

Following column 2 of Table 6, the net impact of PEDEXP on income disparity is (see Equation 6):

$$\frac{dGINI_{it}}{dPEDEXP_{it}} = \beta_1 + \beta_3 \overline{ICT}_{it}$$

$$= (-0.123) + [(-0.009) * (5.124)]$$

$$=0.221 \text{ score} \qquad \text{[Eqn 6]}$$

where –0.123 is the unconditional impact of PEDEXP on inequality; –0.009 represents the conditional impact of PEDEXP on income disparity. However, 5.124 is the mean value of ICT.[3] Because the net impact is positive, we calculate the ICT threshold at which the positive incidence of PEDEXP on income disparity is attenuated. The threshold for ICT can be computed as follows, in Equation 7:

$$\frac{0.123}{0.009} = 13.66 \qquad \text{[Eqn 7]}$$

Given those mentioned earlier, it is necessary to have internet penetration levels of 13.66 per 100 people to ultimately strengthen the negative impacts of government spending on education on income disparity. The above-computed threshold shows that ICT can effectively moderate PEDEXP for favourable income redistribution results in SSA countries.

Robustness checks

From columns 3 and 4 of Table 6, we examine the robustness of our main results by using a different estimation technique, DOLS. Hence, the results are similar to that of FMOLS. The new results are consistent with FMOLS results concerning the interaction term of PEDEXP with ICT. Indeed, this interaction seems to reinforce the effects of PEDEXP on inequality in SSA countries in the long run.

Discussion

Can PEDEXP and ICT lower income disparity in SSA? To respond to this question, political and socioeconomic factors need to be considered. As for the first objective, the results show that PEDEXP is significant and positive while its squared negatively and significantly affects inequality in most columns in the long run. Though SSA countries remain the region with high level of inequality, this study confirms that PEDEXP reduces income disparity in SSA in the long run. Sub-Saharan Africa's results confirm Knight and Sabot's theory (1983), who demonstrate that the expansion of education has a dual effect within the framework of the Human Capital Mechanism, involving both Composition and Wage Compression Effect as explained earlier. At the initial stage, the composition effect of education expenditure tends to augment income disparity by raising the number of highly educated people. The significant and positive impact of PEDEXP on income disparity means that when the government invests a bigger proportion of government spending in secondary and tertiary education, this gives incentives for the advancement of technologies. These technologies, in turn, may cause a replacement of uneducated worker by educated worker, increasing income disparity to a greater level (Wälde 2000). This could be one of the factors that explain the persistent and higher level of income inequality in some Southern African Development Community (SADC) countries (South Africa, Botswana, Namibia), which invest more in education. For instance, government expenditure on tertiary education as percent (%) of GDP in South Africa increased from less than 0.5% to 1.134%, according to the World Bank collection of development indicators. Nevertheless, there are motivations to create and employ technologies that facilitate the replacement of secondary education graduates by tertiary

3.Summary statistics are available upon request.

education graduates in an economy characterised by a high ratio of skills between tertiary and secondary education graduates.

However, as government education spending continues to grow over time, and the supply of highly educated workers surpasses market demand, the premium for highly skilled workers diminishes. This occurs because the wage compression effect of increased education spending outweighs the positive impact of the composition effect. This is in agreement with the TST developed by Fisher (1935) and Clark (1940). According to this theory, as SSA's economy transitions from agriculture to manufacturing, specifically services sector (as in the case of SSA), there is a rising demand for higher educated worker compared to less educated worker. Therefore, the need for higher educated labours augments as service sector grows. In this case, a household income becomes significantly affected by their educational level. This indicates that as the economy grows, income distribution becomes increasingly related to the distribution of education, which leads to the reduction of income inequality in the long run. This is also in line with Alamanda (2020) and Lokshin and Yemtsov (2005), who found that there is a broad assumption that government spending on public education will help address inequality issues. As education becomes more accessible when the government invests funds, low-income persons are more likely to enroll in school. A better education eventually results in more human capital, and boosting the human capital of those with low incomes is one way to combat economic disparity. Most scholars would also agree that families with children value government benefits for education the most regarding education subsidies. Education subsidies will assist low-income families in providing their children with a better education so they will have better work opportunities, and the cycle of poverty in their family will be broken. For instance, conditional cash transfer (CCT) will probably result in better outcomes in child education; hence, it raises children's human capital and reduces income inequality (Fernald, Gertler & Neufeld 2008).

Concerning ICT, we found that ICT has a negative and significant impact on inequality in the long run. This result is confirmed by Dossou et al. (2023), who discovered that ICT (internet penetration) significantly promotes income gap reduction. In agreement with Dossou et al. (2023), Solow's (1957) original research showed that advancing technology might promote economic development and productivity and, consequently, help to reduce income disparity. We concur with Awad and Albaity (2022) regarding the potential of increased ICT to stimulate economic growth by improving market efficiency, spurring investment, and enhancing wages and income distribution. Furthermore, our results align with the proposition of Tchamyou et al. (2019), who advocated for the integration of ICT in the education sector to boost salaries, enhance social welfare, and promote income equality. This supports the Neoclassical Theory of Economic Development, which posits that ICT could facilitate the redistribution of economic wealth. The expanded accessibility of computer technologies and information has the capacity to elevate income levels and enhance living standards globally, thus alleviating income disparity in SSA. Regarding governance quality, we found that the coefficient of good governance is significantly positive in the long run, suggesting that as Africa's level of governance rises, so does economic inequality. This result is unsurprising, given that Africa's institutions continue to be of poor quality (Kunawotor, Bokpin & Barnor 2020). Promoting ICT in emerging countries may help reduce corruption, improve economic growth and reduce the income gap, according to Sami, Ali and Gasmi (2017). As tax evasion is linked to good governance, the expansion of ICT infrastructure and its involvement in governance may effectively promote tax mobilisation and public spending on education, which, by extension, could ameliorate human capital and lower income disparity. These results are consistent with Ben Ali's (2020) idea that combining ICT and governance could improve income distribution by raising political accountability.

In addition, the interaction term of PEDEXP with ICT, when included, tends to strengthen the association between PEDEXP and inequality in SSA countries in the long run. In line with the second objective, this study concludes that the interaction term between PEDEXP and ICT negatively and significantly influences inequality in SSA countries. Information and communications technology could significantly affect government expenditure on education to lower the income gap. However, low-income earners' access to and use of ICT may enable them to increase their income. In addition, if these low-income individuals have an average level of education, the impact of their use of ICT will be improved. Therefore, ICT must be associated with a certain level of education so that the synergistic impact of government spending on education and ICT may lead to inequality reduction in favour of low-income earners. Information and communications technology and PEDEXP are assumed to be the results of investments funded by countries, firms and individuals to achieve positive results. These positive results can be increased income, productivity or economic growth. One can expect impacts in terms of enhancing the living standards of populations when the products arising from such investments are sufficiently adopted and broadly distributed. However, owning an ICT tool does not guarantee that one will use it to its full potential. It is probable that even with ICTs, one may not be able to utilise all of its functions and, consequently, all of its advantages without a sufficient level and quality of education. This shows that PEDEXP and ICT are significant tools for policymakers to reduce income inequality in SSA.

In contrast to prior studies on inequality, which typically examined the effect of either ICTs or public education spending on income disparity, this study investigates the impact of the interaction of these two variables on income disparity in the long run, focusing on SSA countries.

Conclusion

This study assesses the synergistic impact of public education spending and ICT on inequality in SSA countries. Using 30

SSA countries from 1990 to 2022 and based on the FMOLS estimation technique, we conclude that individually ICT significantly lowers inequality in SSA countries in the long run. Interestingly, the results reveal that PEDEXP is significant and positive while its squared negatively and significantly affects inequality in most columns in the long run. We can observe that the interaction between government expenditure on education and ICT reinforces the effect of government expenditure on education on income disparity in SSA countries in the long run. In fact, the income inequality reduction is accelerated if access to and use of ICT are linked with a significant amount of PEDEXP. Specifically, the interaction of public education spending with ICT lowers inequality in SSA in the long run. These results imply that increasing low-income earners' access to and usage of ICTs and improving public education spending should enable them to use income-generating options. Furthermore, the most vulnerable need to possess the necessary educational and technological skills to be better equipped to adapt and survive whenever the health, political and economic situations prevent them from actively participating in the process. This is particularly true when there are frequent crises, particularly the COVID-19 pandemic-related health crisis, which has forced social distance policies on the various countries of the world.

The main policy recommendation of our results is that SSA countries' public policies should prioritise an increase in PEDEXP to allow low-income earners to acquire human capital. Indeed, the successful adoption and diffusion of any technology, whether technological, social or economic, need a certain amount of PEDEXP to finance human accumulation in society. Governments and policymakers in SSA need to increase ICT infrastructure across the continent, as ICT growth is essential for overall economic development and income distribution. Basic ICT services for the bulk of the people will improve information access, increase demand for better government services and open up job opportunities. In this situation, encouraging private sector participation in the ICT service sector is essential to growing and raising the calibre of ICT. As it is revealed that public education spending affects inequality, tending to lower it, we can also suggest that ICT can reinforce this effect. In contrast to industrialised countries, however, education is not as affordable in SSA nations. The issue of the high costs associated with accessing education is one that low-income individuals face very frequently. Therefore, it would be necessary for authorities in these nations to permit free access to human capital, especially for those with low incomes. In conclusion, given the focus of this study is on SSA countries, it is recommended that future study explores subregion analyses within SSA.

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Data availability

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References

Ajide, K.B. & Alimi, O.Y., 2021, 'Income inequality, human capital and terrorism in Africa: Beyond exploratory analytics', *International Economics* 165, 218–240. https://doi.org/10.1016/j.inteco.2021.01.003

Alamanda, 2020, 'The effect of government expenditure on income inequality and poverty in Indonesia', *INFO ARTHA* 4(01), 1–11. https://doi.org/10.31092/jia.v4i1.614

Ali, G. & Muhammad, S., 2018, 'The relationship between fundamental analysis and stock returns based on the panel data analysis; evidence from karachi stock exchange (kse)', *Research Journal of Finance and Accounting* 9(3), 84–96.

Appiah-Otoo, I. & Song, N., 2021, 'The impact of ICT on economic growth-comparing rich and poor countries', *Telecommunications Policy* 45(2), 102082. https://doi.org/10.1016/j.telpol.2020.102082

Asamoah, L., 2021, 'Institutional quality and income inequality in developing countries: A dynamic panel threshold analysis', *Progress in Development Studies* 21(2), 123–143. https://doi.org/10.1177/14649934211016715

Asongu, S.A. & Odhiambo, N.M., 2019, 'How enhancing information and communication technology has affected inequality in Africa for sustainable development: An empirical investigation', *Sustainable Development* 27(4), 647–656. https://doi.org/10.1002/sd.1929

Awad, A., 2022, 'Information and communication technologies role in alleviating poverty in sub-Saharan Africa: Impacts and transmission channels', *Sustainable Development* 31(2), 1149–1165. https://doi.org/10.1002/sd.2447

Awad, A. & Albaity, M., 2022, 'ICT and economic growth in Sub-Saharan Africa: Transmission channels and effects', *Telecommunications Policy* 46(8), 102381. https://doi.org/10.1016/j.telpol.2022.102381

Barro, R. & Lee, J., 2013, 'A new data set of educational attainment in the world, 1950–2010', *Journal of Development Economics* 104(C), 184–198. https://doi.org/10.1016/j.jdeveco.2012.10.001

Becker, G.S., 1962, 'Investment in human capital: A theoretical analysis', *The Journal of Political Economy* 75(5), 9–49. https://doi.org/10.1086/258724

Becker, G.S. & Chiswick, B.R., 1966, 'Education and the distribution of earnings', *The American Economic Review* 56(2), 358–369.

Ben Ali, M.S., 2020, 'Does ICT promote democracy similarly in developed and developing countries? A linear and nonlinear panel threshold framework', *Telematics and Informatics* 50, 101382. https://doi.org/10.1016/j.tele.2020.101382

Canh, N.P., Schinckus, C., Thanh, S.D. & Ling, F.C.H., 2020, 'Effects of the Internet, mobile, and land phones on income inequality and the Kuznets curve: Cross country analysis', *Telecommunications Policy* 44(10), 102041. https://doi.org/10.1016/j.telpol.2020.102041

Chancel, L., Piketty, T., Saez, E. & Zucman, G., 2021, *World Inequality Report 2022*, World Inequality Lab, Paris.

Chiswick, B.R., 1974, *Income inequality: Regional analyses within a human capital framework*, National Bureau of Economic Research, Books, New York, NY.

Clark, C., 1940, *The conditions of economic progress*, MacMillan & Co., Ltd., London.

Das, G.G. & Drine, I., 2020, 'Distance from the technology frontier: How could Africa catch up via socio-institutional factors and human capital?', *Technological Forecasting & Social Change* 150, 119755. https://doi.org/10.15185/izawol.462

Dervis, K. & Qureshi, Z., 2016, *Income distribution within countries: Rising inequality, global economy and development at Brookings brief*, Brookings Institution, Washington, DC.

Dossou, T.M.A., Emmanuelle, N.K., Bekun, F.V. & Eoulam, A.O., 2021, 'Exploring the linkage between tourism, governance', *Tourism Economics* 29(555), 210–234. https://doi.org/10.1177/13548166211043974

Fernald, L.C., Gertler, P.J. & Neufeld, L.M., 2008, 'Role of cash in conditional cash transfer programmes for child health, growth, and development: An analysis of Mexico's oportunidades', *The Lancet* 371(9615), 828–837. https://doi.org/10.1016/S0140-6736(08)60382-7

Fisher, A.G.B., 1935, *The clash of progress and security*, MacMillan & Co., Ltd., London.

Goodspeed, T.J., 2000, *Education spending, inequality and economic growth: Evidence from US States*, viewed 07 March 2024, from http://econ.hunter.cuny.edu/wp-content/uploads/2013/10/education.pdf.

Helpman, E. & Trajtenberg, M., 1998, 'A time to sow and a time to reap: Growth based on general purpose technologies', in E. Helpman (ed.), *General purpose technologies and economic growth*, pp. 55–83, MIT Press, Cambridge, MA.

Holzner, M., 2011, *Inequality, growth and public spending in Central, East and Southeast Europe*, ECINEQ Society for the Study of Economic Inequality, Working Paper Series, WP 2011–221, OECD, Paris.

Inglehart, R. & Welzel, C., 2005, *Modernization, cultural change, and democracy: The human development sequence*, Cambridge University Press, Cambridge.

International Monetary Fund, 2021, *World Economic Outlook: Recovery during a pandemic*, International Monetary Fund, viewed n.d., from https://www.imf.org/en/Publications/WEO.

International Telecommunication Union (ITU), 2021, *Measuring digital development. Facts and figures*, International Telecommunication Union, Geneva.

Knight, J.B. Sabot, R.H., 1983, 'Educational expansion and the Kuznets effect', *The American Economic Review* 73(5), 1132–1136.

Kunawotor, M.E., Bokpin, G.A. & Barnor, C., 2020, 'Drivers of income inequality in Africa: Does institutional quality matter?', *African Development Review* 32(4), 718–729. https://doi.org/10.1111/1467-8268.12473

Kuznets, S., 1955, 'Economic growth and income inequality', *The American Economic Review* 45(1), 1–28.

Lai, D., 1997, 'Educational expansion and income inequality', *Economic Research* 32(10), 46–53.

Lokshin, M. & Yemtsov, R., 2005, 'Has rural infrastructure rehabilitation in Georgia helped the poor?', *The World Bank Economic Review* 19(2), 311–333. https://doi.org/10.1093/wber/lhi007

Lucas, R.E., 1988, 'On the mechanics of economic development', *Journal of Monetary Economics* 22(1), 3–42. https://doi.org/10.1016/0304-3932(88)90168-7

Maeso-Fernandez, F., Osbat, C. & Schnatz, B, 2004, *Towards the estimation of equilibrium exchange rates for CEE acceding countries: Methodological issues and a panel cointegration perspective*, European Central Bank Working Paper Series, 353, European Central Bank, Frankfurt am Main.

Mincer, J., 1970, 'The distribution of labour incomes: A survey with special reference to the human capital approach', *Journal of Economic Literature* 8(1), 1–26.

Ndjobo, P.M.N. & Otabela, N.N., 2023, 'Can income inequality be affected by the interaction between ICTs and human capital?: The evidence from developing countries', *Journal of Quantitative Economics* 21, 235–264. https://doi.org/10.1007/s40953-022-00336-5

Nussbaum, M.C., 2000, *Women and human development: The capabilities approach*, Cambridge University Press, Cambridge.

Ofori, I.K., Gbolonyo, E.Y., Dossou, M.A.T. & Nkrumah, R.K.., 2021, 'Remittances and income inequality in Africa: Financial development thresholds for economic policy', *Research in Globalization* 4, 100084. https://doi.org/10.1016/j.resglo.2022.100084

Organisation for Economic Co-operation and Development (OECD), 2011, *Divided we stand: Why inequality keeps rising*, OECD Publishing, Paris.

Pedroni, P., 2000, *Fully modified OLS for heterogeneous cointegrated panels*, Department of Economics, Indiana University, Bloomington, Indiana.

Phillips, P.C.B., 1995, 'Fully modified least squares and vector autoregression', *Econometrica* 63(5), 1023–1078. https://doi.org/10.2307/2171721

Psacharopoulos, G., 1994, 'Returns to investment in education: A global update', *World Development* 22(9), 1325–1343. https://doi.org/10.1016/0305-750X(94)90007-8

Richmond, K. & Triplett, R.E., 2017, 'ICT and income inequality: A cross-national perspective', *International Review of Applied Economics* 32(2), 195–214. https://doi.org/10.1080/02692171.2017.1338677

Romer, P.M., 1990, 'Endogenous technological change', *Journal of Political Economy* 98(5), S71–S102. https://doi.org/10.1086/261725

Rostow, W.W., 1960, *The stages of economic growth: A non-communist Manifesto*, Cambridge University Press, Cambridge.

Samanta, T. & Kayet, A., 2020, Public education expenditure and inequality nexus: A critical view in India. *American Journal of Economics* 10(6), 449–458.

Sami, M., Ali, B. & Gasmi, A., 2017, 'Does ICT diffusion matter for corruption? An economic development perspective', *Telematics and Informatics* 34(8), 1445–1453. https://doi.org/10.1016/j.tele.2017.06.008

Schultz, T.W., 1963, *The economic value of education*, Columbia University Press, New York, NY.

Sen, A., 1999, *Development as freedom*, Knopf, New York, NY.

Solow, R., 1957, 'Technical change and the aggregate production function', *The Review of Economics and Statistics* 39(3), 312–320. https://doi.org/10.2307/1926047

Solt, F., 2019, *Economic inequality and political representation: The role of income inequality in shaping democracy*, Cambridge University Press, Cambridge.

Song, Y., Paramati, S.R., Ummalla, M., Zakari, A. & Kummitha, H.R., 2021, 'The effect of remittances and FDI inflows on income distribution in developing economies', *Economic Analysis and Policy* 72, 255–267. https://doi.org/10.1016/j.eap.2021.08.011

Tinbergen, J., 1975, *Income distribution: Analysis and policies*, International Labour Office, Geneva.

Van Reenen, J., 2011, 'Wage inequality and skill-biased technological change: Evidence from the UK', in J.D. Acemoglu, D. Autor & M.P. Autor (eds.), *Handbook of labor economics*, vol. 4, pp. 2383–2440, Elsevier, Amsterdam.

Wälde, K., 2000, 'Egalitarian and Elitist education systems as the basis for international differences in wage inequality', *European Journal of Political Economy* 16(3), 445–468. https://doi.org/10.1016/S0176-2680(99)00055-5

Westerlund, J., 2007, 'Testing for error correction in panel data', *Oxford Bulletin of Economics and Statistics* 69(6), 709–748. https://doi.org/10.1111/j.1468-0084.2007.00477.x

Zaika, O. & Gridin, D., 2020, 'Human capital development in the agricultural economy sector', *Technology Audit and Production Reserves* 1(4[51]), 30–36. http://doi.org/10.15587/2312-8372.2020.194444

Zhang Xiaofang, F., Pan, X.X., Chen, X.D. & Shi, P.H., 2021, 'Public expenditure on education and income inequality: An Empirical study based on structural threshold regression model', *Macroeconomic Research* (1), 164–175.