ADDIS ABABA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

EDUCATION AND ECONOMIC GROWTH IN SUB-SAHARAN AFRICAN COUNTRIES: THE MODERATING ROLE OF EDUCATION EXPENDITURE

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I, Tsion Mekonen Hailu declare that this thesis entitled" **EDUCATION AND ECONOMIC GROWTH IN SUB-SAHARAN AFRICAN COUNTRIES: THE MODERATING ROLE OF EDUCATION EXPENDITURE** "is an outcome of my effort except those which are duly cited and quoted. This study has not been submitted for any degree in this University or any other University. It is offered for the partial fulfillment of the degree of Masters of Science in Economics: Specialization in Economic policy analysis.

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Date 17/09/2024 Place and date of submission: Addis Ababa University, September 2024

DECLARATION

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Acronyms

ARDL	Autoregressive distributive lag model
GMM	Generalized Method of Moments
IMF	International Monetary Fund
LDC	Least developed countries
MDGs	Millennium Development Goals
OECD	Organization for Economic Co-operation and Development
SSA	Sub-Sahara Africa
WB	World Bank
WDR	World Development Report
COMESA	Common Market for Eastern and Southern Africa

Abstract

Even though education has been highlighted in several empirical literature, as a factor that could spur up economic growth, the level of education in sub-Saharan Africa is not effectively channeled into desired levels of economic growth. However, there is an indication in the literature that education will be more relevant to the economic growth of sub-Saharan African economies that maintain strong and effective education spending.

This study investigates the relationship between education and economic growth, with a particular focus on the moderating role of education expenditure. Utilizing a dynamic panel data model, the analysis covers annual data from 41 sub-Saharan African countries between 2001 and 2022. Employing the system Generalized Method of Moments (GMM) estimation technique, the results indicate that education expenditure moderates the effect of education on economic growth in these economies.

The study's findings also shows that GDP per capita growth rate is positively correlated with primary education, secondary education, tertiary education, export, consumption and gross domestic saving while it is negatively correlated with labor force, gross fixed capital formation, education expenditure, import and inflation. The study concluded that education with the support of effective education spending will boost productivity and this resulted in increasing the level of economic growth.

It is therefore recommended that sub-Saharan African economies should apply appropriate measures to boost their education spending so that gains from the education sector can effectively be channeled into economic growth.

Keywords: Education, education expenditure, Economic Growth, Sub-Saharan Africa, Dynamic Panel Data, system General Method of Moment

CHAPTER ONE

1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Growth determinants are an important area of economic studies because they play a key role in the trajectory of a country's economic well-being and improvement. With data indicating that a population's cognitive abilities have a major impact on long-term growth rates, education's role in determining growth dynamics becomes apparent in this regard. A significant amount of the variance in growth rates among nations can be explained by knowledge capital, which is the totality of cognitive abilities (Easterly, 2019:Hanushek & Wößmann, 2020).

In a nation, human capital is greatly influenced by its educational system, which includes the acquisition of skills, competencies, experiences, and productivity-boosting qualities. Beyond promoting the advancement of economies above manual labor and basic production procedures, its influence goes far longer to individual productivity. Hence, Human capital, with education as its core is a fundamental component of economic systems, playing a pivotal role in enhancing fostering innovation, and driving long –term economic growth (Dahal, 2017). Moreover, recognizing the importance of education in building human capital is essential for sustaining economic development and prosperity in modern knowledge-based economy(Leoni, 2023).

According to the World Economic Forum(2016), education boosts a nation's productivity through developing workforce skills, promoting innovation, and facilitating knowledge transfer. In particular, it accelerates the completion of current tasks, facilitates the transfer of novel knowledge and technologies, and strengthens a country's ability to innovate. The Millennium Development Goals (MDGs) place a strong emphasis on education because of the ongoing difficulties that many African nations face in meeting key development indicators, such as GDP per capita and school enrollment. The relationship between human capital and economic growth, which is strengthened by education, makes education a direct means of reducing poverty through the creation of job opportunities for workers with higher levels of skill (Babatunde, 2005; Grant, 2017).

Spending on education becomes a strategic investment that can promote economic growth, increase productivity, support social and personal development, and lessen social inequality. For

governments, businesses, families, and students, deciding how much money to devote to education is an important choice. It is a difficult task for policymakers to strike a balance between the need for high-quality education, the costs involved, and competing demands on public spending (Education et al., 2016).

Studies with a strong empirical base shed light on the connection between economic growth and education spending. Spending on education has a positive and statistically significant impact on economic development (Mallick et al., 2016);analysis of balanced panel data covering 14 important Asian countries from 1973 to 2012. In a similar vein, the research by Ayeni(2018)suggests that there is no clear correlation between the amount spent on education and economic growth in a such number one populous country in Africa, Nigeria .

The study on Educational Expenditure and Economic Welfare in Sub Saharan African Countries by (Atabukum et al., 2020) ,revealed that a significant relationship between public educational expenditure and economic welfare in the region. The correlation analysis revealed that as the economy becomes more liberalized, public educational spending decreases. Moreover, A meta-analysis of 29 empirical studies showed mixed results on the impact of public educational spending on welfare, with some studies indicating positive effects while others showed negative or no significant effects((Atabukum et al., 2020)

The impact of education and education expenditure on the economic growth of Sub-Saharan African (SSA) countries has been a subject of extensive studies by various scholars (Beck et al., 2019; Asongu & Odhiambo, 2020). Some studies, such as Owusu-Nantwi and Erickson (2020), have investigated the general impact of human capital on economic growth in the region. Others, like Afzal et al. (2021), have underlined the positive effects of human capital, specifically improved healthcare, on labor productivity and economic output. Economic growth in SSA has been a focal point of numerous studies, particularly concerning the roles of education, education expenditure and economic growth. Traditionally, these factors have been examined independently (Owusu-Nantwi & Erickson, 2020; Afzal et al., 2021; Anyanwu, 2014). However, it is important to investigate the moderating role and the interactive effect of education expenditure and education on economic growth in the SSA countries using a recent panel data set. For this end, the study followed the evidence provided by Odhiambo(2021) that shows the synergy between human capital and financial sector development ;and the other findings such as Adu, Marbuah, & Mensa(2022) ; Barro & Lee(2013) which shows interactive effect of

human capital and financial sector development is crucial for understanding economic growth in Sub-Saharan Africa.

Recently, Asongu and Odhiambo (2019) have presented findings suggesting that education expenditures have a moderating effect. Research indicates that comprehension of the intricate connections among education spending, economic growth, and education is necessary to make well-informed policy decisions. Spending on education has the ability to moderate the amount that education contributes to economic growth. To fully achieve the potential of education as an engine of economic growth, significant expenditures in infrastructure, teacher training, and curriculum development are required (Pellegrini & Vivanet, 2021). With a focus on the moderating role of education spending, this study intends to investigate the complex relationship between economic growth and education.

1.2 STATEMENT OF THE PROBLEM

Modern technology-based capital is undeniably a catalyst for growth, yet human capital remains the crucial factor in both the generation of capital and its conversion into productivity and continuous enhancement. However, in Sub-Saharan African countries, economic growth has traditionally been perceived as achievable solely through labor and capital, overlooking the importance of human capital development (Mohamed, Liu & Nie, 2022). While capital and labor play a vital role in economic advancement, they are ineffectual without the support of human capital (Smith, 1976). This suggests that a certain level of human resources is necessary to effectively combine, organize, and utilize available resources. In reality, it’s essential to recognize that the region's economic progress is also a result of advancements in human resources and education (Vidal, 2022).

Nevertheless, the educational system in Sub-Saharan Africa has several critical deficiencies. Limited access to education and challenges in school completion adversely affect the region's overall educational outcomes. Many educational institutions face resource limitations, such as inadequate funding, a lack of instructional materials, and restricted access to technology. These constraints hinder students' academic progress and the delivery of quality education (Krzykawska & Żur, 2020). Additionally, the disproportionate annual budget allocation between economic growth and education poses a significant threat to macroeconomic stability, further compounding the issue (Goczek et al., 2021).

Most studies tend to measure education by outcomes such as enrollment rates, literacy levels, and years of schooling instead of costs. A recent meta-analysis by Churchill et al. (2017) examined 29 studies that specifically assess the effects of government educational spending on economic growth. Among these studies, 14 indicated a positive and statistically significant effect of educational expenditure on growth, 12 reported a negative impact, and 3 found no significant effects.

Another study by Hassan (2023) concluded that educational spending has favorable macroeconomic effects and aids economic growth. Similarly, research by Farayibi and Folarin (2020) revealed that government spending on education significantly influences primary and secondary enrollment rates in African nations. Oseni et al. (2020), analyzing data from 24 countries between 2000 and 2016, also found that government expenditures positively and significantly affect primary school enrollment in Sub-Saharan Africa.

Although numerous studies on education, education expenditure, and economic growth have provided valuable insights for both literature and policy, a gap remains in understanding how these elements interrelate. This gap may stem from different perspectives, omitted variables, methodological issues, variable measurement, estimation techniques, or variations in data periods. For example, Hassan (2023) found a positive link between government investment in education and economic growth. However, this study did not explore how public education spending created a positive feedback loop driving economic expansion through educational measures. Identifying education's moderating effect allows for targeted interventions within the education system (Psacharopoulos, 2014).

Chikoko and Mthembu (2020) recently demonstrated that increased public spending on education in sub-Saharan Africa correlates positively with primary and secondary education outcomes. However, this study lacks analysis of how public expenditure affects tertiary education enrollment. Understanding the relationship between education expenditure, tertiary education, and subsequent economic growth is crucial for informed policy-making (Uyar et al., 2022).

Martha (2022) examined the link between human capital development through education and economic growth in Sub-Saharan Africa using Autoregressive Distributed Lag and Error Correction Model analysis. The study revealed that secondary education in SSA countries has a minor but notable positive effect on short-term economic growth and a negligible negative impact on long-term growth. However, while ARDL and ECM are commonly used for time series data analysis, applying them to panel data presents challenges (Enders, 2010).

One challenge is cross-sectional dependence, where observations from different entities (e.g., countries) are correlated. ARDL and ECM assume independence across these cross-sections, potentially leading to biased estimates and unreliable inferences. Additionally, these models assume strict exogeneity of regressors, which may not hold in dynamic panel data settings (Wooldridge, 2010; Enders, 2010; Baltagi, 2021).

Furthermore, despite extensive research on the relationship between education and economic growth in Sub-Saharan Africa, to the best of the researcher's knowledge, there exists a gap in examining the moderating role of educational expenditure in connecting education and economic growth using panel data models. One primary advantage of employing panel data is the extensive number of observations it provides due to its multidimensional nature, allowing for numerous observations across various entities over extended periods (Wooldridge, 2010).

This study aims to enhance existing literature by incorporating education expenditure as a moderating variable, in contrast to previous studies that focused solely on primary or secondary education (Kazanji & Asongu, 2022; Kanyama & Mulenga, 2021; AfDB, 2022). The analysis provides a detailed view of how variations in education spending levels influence the relationship between economic growth and education. A moderator variable can affect the strength or direction of the relationship between two other variables (Subhash Sharma, 1981). This method reveals aspects of the relationship that might be overlooked if education and economic growth were analyzed separately.

Thus, this study contributes to the broader academic literature on the relationship between education, economic growth, and education expenditure by examining both moderating roles and individual effects, and incorporating control variables. It uses a representative sample of Sub-Saharan African countries, addressing gaps from missing data by analyzing 41 out of 47 countries through mean imputation of the latest World Bank data, despite the absence of data for six countries. Mean imputation maintains sample size and dataset structure, preserving valuable information and ensuring consistent handling of missing values across time periods. This approach also allows the use of statistical models that require complete datasets for effective analysis (Jamshidian & Mata, 2007; Grace-Martin, 2023).

Furthermore, the study's distinctive feature is the application of dynamic panel system GMM, which evaluates how education influences economic growth while considering the moderating role of education expenditure. This methodological choice effectively addresses issues such as endogeneity, autocorrelation, and heterogeneity, reducing potential biases in estimation and accommodating time-invariant individual heterogeneity (Wooldridge, 2010).

1.3 OBJECTIVE OF THE STUDY

The general objective of the study is to examine the moderating role of education expenditure on the relationship between education and economic growth in sub-Saharan African countries

1.3.2 SPECIFIC OBJECTIVES

1. To analyze the effect of education on economic growth in Sub-Saharan African countries for the period 2001-2022.
2. To assess the effect of education expenditure on economic growth of Sub-Saharan Africa for the period 2001-2022.
3. To investigate the effect of education expenditure as a moderator on the relationship between education and economic growth for the period 2001-2022.
4. To determine the dynamic causal relationships between education, education expenditure, and economic growth in sub-Saharan African countries for the period 2001-2022.

1.4 RESEARCH QUESTIONS

1. What is the effect of education on economic growth in sub-Saharan Africa for the period 2001-2022?

2. What is the effect of education expenditure on economic growth in sub-Saharan Africa for the period 2001-2022?
3. What is the effect of education expenditure as a moderator on the relationship between education and economic growth for the period 2001-2022?
4. Is there a dynamic causal relationship between education, education expenditure, and economic growth in sub-Saharan African countries for the period 2001-2022?

1.5 SCOPE OF THE STUDY

This study investigates the moderating effect of education expenditure on the relationship between education and economic growth in Sub-Saharan African countries. A dynamic panel data approach is used in the analysis, which uses data from 41 countries in the region between 2001 and 2022.Selection criteria for these countries included data availability, relevance to the research question, and ensuring a diverse representation of Sub-Saharan African economies.

To examine the relationships between education and economic growth, with a specific focus on the moderating role of education spending, the study employed both descriptive and inferential statistical methods. A system GMM model is utilized to control for unobserved heterogeneity, potential time trends, and individual country-specific effects within the data.

Data for the analysis was sourced from reputable institutions such as the World Bank databases, national statistical offices of the respective countries, and the African Development Bank (AfDB). Specific data points of interest include government budget reports pertaining to education expenditure, statistics on school enrollment across different education levels (primary, secondary, tertiary), economic indicators like GDP per capita, and factors that influence economic growth like gross fixed capital formation, gross domestic saving, import-export dynamics, and consumption trends in Sub-Saharan Africa.

1.6 SIGNIFICANCE OF THE STUDY

This study on the moderating role of education expenditure in the relationship between education and economic growth in sub-Saharan African countries holds significant value for various stakeholders. From the perspective of the researchers, the study will contribute to enhancing their knowledge and expertise by familiarizing them with the factual evidence and general information pertaining to the complex linkages between education, economic growth, and educational

expenditure in the region. For governments and policymakers, the findings of this study can inform evidence-based decision-making and the formulation of effective policies aimed at leveraging education as a driver of economic development. By elucidating the moderating influence of education spending, the study can provide crucial insights to guide the strategic allocation of public resources and the design of education financing strategies that optimize the impact of human capital investment on economic growth.

Additionally, the study would improve the practical knowledge and skill of the researcher by making them familiar with the factual evidence and general information on the relationship between education, economic growth, and educational expenditure. This enhanced understanding can equip the researcher with valuable insights to contribute to the broader academic discourse and inform future research endeavors in this field.

1.7 Organization of the study

With this chapter complete, the second chapter will address theoretical concepts and empirical literature. The third chapter will focus on model specification and the methodological framework. The fourth chapter will present and analyze the results from the empirical investigation. Finally, the fifth chapter will provide the paper's conclusions.

CHAPTER TWO
2. LITERATURE REVIEW
2.1 INTRODUCTION

Economists' attention has been focused on the relationship between economic growth and education spending through a combination of theoretical and empirical research. Development theories have attempted to explain how education contributes to economic expansion, with endogenous growth models incorporating human capital as a key driver (Romer, 1990; Lucas, 1988). However, the empirical findings on the precise mechanisms and magnitude of this relationship have been somewhat inconsistent (Aghion et al., 2019).It is widely acknowledged that education plays a critical role in promoting economic growth and development. In the discipline of economics, a substantial body of research has been conducted on the complex linkages between economic growth and education (Hanushek & Woessmann, 2020; Barro, 2013). This growing body of literature has explored various channels through which education can contribute to productivity gains, technological innovation, and overall economic progress (Acemoglu & Autor, 2012 Daren, 2017 and Psacharopoulos & Patrinos, 2018).

The purpose of this review of the literature is to investigate the theoretical underpinnings of the relationship between economic growth, education and education expenditure. We will discuss several theories related to this area in the next section. We will also review empirical evidences from both the global and sub-Saharan African contexts. Finally, we will identify the research gaps and build conceptual framework from our review of literatures

2.2 THEORETICAL LITERATURE REVIEW

2.2.1 HUMAN CAPITAL THEORY

The concept of human capital, which includes an employee's education, knowledge, experience, and skills, is fundamental to modern economic theory. It acknowledges that labor is not a uniform entity but a diverse pool of talent with varying productivity levels (Becker, 1964). This understanding compels businesses to invest in their workforce through training and educational opportunities (Schultz, 1961). Such investments are crucial for driving economic growth; a skilled workforce leads to increased productivity.

As global economies evolve, the opportunity cost of neglecting education rises, making it essential for competitiveness. In corporate finance, human capital and intellectual capital are recognized as renewable sources of productivity. Organizations must actively cultivate these resources to foster innovation and creativity, as some business challenges cannot be solved solely with machines or capital.However, the portability of human capital poses a significant risk. Unlike physical assets, employees can leave an organization, taking their skills with them. This reality highlights the need for businesses to implement strategies to support and retain key employees, ensuring that their investments in human capital yield long-term benefits (Wright et al., 2001; Ross, 2023). Ultimately, investing in human capital is not just advantageous—it is essential for sustainable success.

2.2.2 ENDOGENOUS GROWTH MODELS

Endogenous growth theory emerged as a counterpoint to neoclassical growth models, which posited that long-term economic growth was driven primarily by exogenous factors beyond the control of policymakers, such as population growth and technological progress. In contrast, endogenous growth models, pioneered by economists like Paul Romer and Robert Lucas, emphasize that the internal dynamics and policies within an economy can be leveraged to drive sustained long-term growth.

A key tenet of endogenous growth theory is the role of investments in human capital, particularly education, in fueling economic expansion. As Romer (1990) outlined, human capital accumulation through education and training can lead to technological advancement and innovation, which in turn stimulates economic growth. This is in contrast to the neoclassical view, which treated technology as an exogenous factor. Romer's work highlighted how the non-rivalry of ideas - the concept that the use of an idea by one person does not diminish its utility to others - enables knowledge gained through education and R&D to generate positive spillovers that drive further economic progress.

Building on this, Lucas (1988) argued that investment in human capital, through mechanisms like on-the-job training and formal schooling, can increase the productivity of both individual workers and the economy as a whole. His model showed how the accumulation of human

capital, in addition to physical capital formation, could sustain long-run growth rates that are not subject to the diminishing returns that constrain neoclassical models.

Subsequent endogenous growth theorists, such as Aghion and Howitt (1992), have further developed the role of innovation and technological change as endogenous drivers of economic growth. Their "Schumpeterian" model demonstrates how research and development activities, enabled by human capital development, can lead to a process of "creative destruction" that generates ongoing productivity improvements and economic expansion.In summary, endogenous growth theory has shifted the focus of economic growth analysis from exogenous factors to the internal mechanisms and policies that can be leveraged to promote long-term prosperity.

2.2.3 EDUCATION AS A COMPONENT OF HUMAN CAPITAL

The human capital theory, developed by economists such as Theodore Schultz, Gary Becker, and Jacob Mincer, emphasizes the importance of education and training in the development of an individual's skills, knowledge, and capabilities, collectively known as human capital (Becker, 1964; Mincer, 1974; Schultz, 1961). This theory posits that education is a key investment in human capital, as it equips individuals with valuable knowledge, skills, and abilities sought after in the labor market, ultimately contributing to their overall economic productivity (Schultz, 1961). Through investment in education, individuals can enhance their human capital, potentially leading to improved employment prospects, higher earnings, and greater contributions to the economy (Becker, 1964).

The theory also suggests that the economic benefits of education extend beyond the individual, as the accumulation of human capital within a population can contribute to overall economic growth and development (Becker, 1964; Psacharopoulos & Patrinos, 2018). Educated and skilled individuals can drive technological innovation, improve the efficiency of production processes, and contribute to the development of new products and services, which can lead to increased productivity and economic prosperity (Hanushek & Woessmann, 2015). Moreover, the theory highlights the importance of education in reducing income inequality and promoting social mobility, as investments in human capital can provide individuals from diverse backgrounds with the opportunity to increase their earning potential and improve their standard of living (Becker, 1964; Krueger & Lindahl, 2001).

2.2.4 EDUCATION EXPENDITURE AS A MODERATING FACTOR

Education expenditure plays a moderating role in the relationship between education and economic growth. According to the human capital theory (Becker, 1964; Schultz, 1961), research indicates that the amount and effectiveness of education spending affect the return on educational investments. Determining the optimal distribution of resources among education levels and evaluating their efficacy are critical to comprehending the overall effect on economic growth, as posited by the endogenous growth theory (Romer, 1986; Lucas, 1988).

Astuti and Bawono (2023), drawing on the capabilities approach (Sen, 1999) and the institutional theory of development (North, 1990), found that education spending can moderate the relationship between the Human Development Index (HDI) and regional own-source income. Spending on education is another moderator predictor variable that is found to moderate the relationship between general allocation funds, special allocation funds, and average length of schooling on HDI. It can be inferred from this that education spending has an impact on the relationship between these parameters and HDI, which impacts the regions' overall development outcomes, as suggested by the sustainable development framework (Sachs, 2015 and Todaro & Smith, 2015).

2.2.5 PUBLIC VS. PRIVATE EDUCATION EXPENDITURE

The dynamics of the relationship between education and economic growth can be better understood by differentiating between public and private education spending. Public education expenditure refers to the funds spent by the government on education, while private education expenditure refers to the funds spent by individuals or private institutions on education (Lahiri, 2018).According to human capital theory (Becker, 1964; Schultz, 1961), increased investment in both public and private education can lead to the accumulation of human capital, which in turn drives economic growth. Additionally, endogenous growth theory (Romer, 1990) posits that the interaction between public and private education spending can affect the long-run growth of physical and human capital stocks.

Lahiri's (2018) analysis suggests that increased substitutability between public and private education spending can lead to stronger long-term accumulation of human and physical capital, as well as higher tax rates. Therefore, it is crucial to strike the right balance between these factors in order to fully comprehend the intricate relationship between educational spending and economic expansion.

2.2.6 EDUCATION POLICY AND GOVERNMENT PRIORITIES

Research has shown that well-designed governmental policies are closely related to efficient spending on education (Hanushek & Woessmann, 2011). Optimizing the effect of education on economic growth requires policies that address relevance, quality, and accessibility, in line with human capital theory (Becker, 1964; Schultz, 1961) and endogenous growth theory (Romer, 1990).

Education policy and government priorities may include recommendations to enhance teacher training and professional development, increase investment in education infrastructure, prioritize early childhood education, promote technology integration in schools, strengthen monitoring and evaluation mechanisms, foster partnerships with the private sector and civil society, and ensure inclusivity and equity in education policies (World Bank, 1987). These suggestions aim to guide policymakers in making informed decisions to improve the quality, accessibility, and relevance of education while addressing the diverse needs of learners, as per the capability approach (Sen, 1999) and inclusive growth frameworks (Ianchovichina & Lundström, 2009).

In sub-Saharan Africa, education policies must prioritize several key areas: creating a national education plan with specific targets and a comprehensive accountability approach, informed by public policy implementation theories (Sabatier & Mazmanian, 1980); establishing clear standards for assessing target achievement, aligned with results-based management frameworks (Kusek & Rist, 2004); securing support from stakeholders, as outlined in stakeholder theory (Freeman, 1984); promoting public engagement through effective communication, following theories of public participation and deliberative democracy (Habermas, 1996); implementing the National Education Account based on public financial management principles (Schiavo-Campo & Tommasi, 1999); and improving school accountability via systems that track service quality and student outcomes, guided by organizational performance measurement theories (Kaplan & Norton, 1992 and Personal & Archive, 2021).

2.3 EMPIRICAL LITERATURE REVIEW

2.3.1 EDUCATION AND ECONOMIC GROWTH

The quantitative relationship between expenditure on education and training and changes in per capita GDP has explored in the literature of economic growth models. Numerous studies have been conducted, spanning from the 1950s publication of classical growth models (Solow, 1956) to the so-called endogenous growth models (Romer, 1986; Lucas, 1988) that are still widely used in contemporary empirical research. Both data sets and econometric modeling methods have considerably improved over the past few years, and numerous novel model assumptions have been published and empirically tested. Usually, these models use data from a wide range of countries, sometimes just industrialized nations but occasionally a wider group. It might be challenging to generate consistent series of educational variables over sufficiently long periods to make econometric time series analysis. To make a more in-depth analysis of the relationship between human resources and economic growth in recent years, cross-sectional and time series data from industrialized nations are included in panel sets.

Several researchers highlight the critical role of strong educational practices in economic restructuring. Studies by Valero (2021) pinpoint a positive correlation between human capital and economic growth, especially when focusing on educational quality and differentiated learning stages, rather than simply years of schooling. The research suggests that investments in four-year college education have a particularly positive impact.

The study by Dasci, Sonmez, and Cemaloglu (2021) underscores the vital role of human capital, revealing that education, health, and innovation/technology significantly influence economic growth in both developed and developing nations. Notably, their findings indicate that education and health are more impactful in developing economies, whereas innovation and technology play a larger role in developed countries. Similarly, Sodirjonov (2020) highlights the necessity of continuously modernizing education, asserting that it is a key element of an individual's socioeconomic activities. The study also stresses the need for institutional innovation within the educational system to enhance human capital development and improve competitiveness.

Studies reveal a positive correlation between economic growth and various measures of human capital in Sub-Saharan Africa. Hassan (2008) explores this link, demonstrating a positive relationship between regional per capita income growth rates and human capital, as measured by a range of educational factors. The study examines the impact of education on economic growth using alternative metrics such as life expectancy at birth, literacy rates, and enrollment ratios for primary and secondary schools. The findings support the notion that Sub-Saharan Africa's economic growth is positively linked to its educational attainment, or human capital.

A review by Grimmer (2022) indicates a positive relationship between secondary education and economic growth in Sub-Saharan Africa, though its effect may be less significant than that of primary education. Country-specific research, such as a study on Ghana, reveals a connection between increased secondary school enrollment and rising GDP per capita, suggesting potential long-term economic advantages. In contrast, Matashu (2022) offers a different viewpoint, arguing that the human capital theory— which links education to economic success— may not fully apply in this region. This raises important questions about the effectiveness of education in driving economic benefits across Sub-Saharan African countries.

2.3.2 EDUCATION EXPENDITURE AND ECONOMIC GROWTH

Research on educational expenditure reveals varied outcomes across both developed and developing nations, depending on the timeframe considered. Churchill et al. (2017), using a meta-analysis, identified a positive relationship between government education spending and economic growth in developed countries. However, this relationship was statistically insignificant in less developed countries (LDCs). Similarly, Karacor et al. (2017) examined 19 OECD countries from 1998 to 2012 and found no substantial impact of education spending on GDP in these nations. Their results challenge the widely held belief that increased education expenditure directly leads to economic growth, at least within the context of the developed economies they studied.

Contrary to the previous conclusion, Ömer, Tuğba, and Muhammet (2023) employed the ARDL bounds testing approach and found that public spending on education significantly boosts economic growth in Turkey over the long term. The study intriguingly notes that although education spending might exhibit a minor negative effect on growth in the short term, this impact

is not statistically significant. Their analysis suggests that these short-term fluctuations generally correct themselves within a year, leading to a stable, positive long-term relationship between education spending and economic growth (Ömer et al., 2023).

The relationship between education expenditure and economic growth in developing countries is intricate and multifaceted. Various studies have explored this connection across different nations. For example, Randolph (2020) analyzed five developing countries and discovered a positive correlation between education spending and economic growth. Specifically, a 1% increase in education expenditure correlated with a 0.67% rise in GDP per capita, indicating an enhancement in average income.

However, this relationship is not always clear-cut. Kouton (2018) investigated government education spending in Côte d'Ivoire and found a surprising negative long-term effect on economic growth, despite minimal short-term benefits. This study also revealed a unidirectional causal link, suggesting that economic growth may influence education spending in Côte d'Ivoire rather than the reverse. Additionally, Ayeni (2018) introduced further complexity by examining the effects of different types of spending in Nigeria. Their findings indicated that recurrent spending, such as on teacher salaries and instructional materials, significantly boosts long-term economic growth, whereas capital spending, like constructing new schools, had no noticeable impact.

Recent studies has examined the effects of government education expenditure on educational outcomes in sub-Saharan African (SSA) countries. Farayibi and Oludele Folarin (2020) employed the system GMM estimator technique using panel data, revealing that government spending had a significant impact on primary and secondary school enrollment rates, though its influence on tertiary enrollment was minimal. Similarly, Oseni et al. (2020) applied the GMM approach and found a substantial positive effect of government spending on primary school enrollment in SSA.

Their analysis indicated that increased government educational funding was associated with higher primary school enrollment rates, and that lagged Gross Primary School Enrollment (PSE) positively influenced parental attitudes toward school enrollment. Additionally, government

spending per primary school pupil, expressed as a percentage of GDP per capita, showed a strong positive correlation with primary school enrollment.

Moreover, Chikoko and Mthembu (2020) highlighted that the SSA region risks falling short of the United Nations' Sustainable Development Goal 4 (SDG 4), which aims to provide inclusive and equitable quality education for all, primarily due to inadequate funding.

2.3.3 MEASUREMENT OF EDUCATION AND EDUCATION EXPENDITURE

Previous studies have employed various methods and metrics to quantify education and education spending. The literature frequently utilizes a diverse array of indicators to assess different dimensions of educational success, accessibility, and quality. For instance, Karacor et al. (2017) measured education through variables such as literacy rates and secondary school enrollment rates. In contrast, Addis (2018) used the Human Development Index (HDI) as a proxy for education, reflecting the level of human capital and the education and skills present in a population. Meanwhile, Tawfik et al. (2020) focused on enrollment ratios for primary and secondary education as proxies for education in their analysis, integrating these variables into their model to evaluate the impact of education on economic growth.

Studies in sub-Saharan Africa have employed various metrics to quantify education, including literacy rates, enrollment ratios for primary and secondary schools, and life expectancy at birth as a proxy for human capital. These indicators have been used to assess the impact of education on the region's economic development (S. Hassan & Ahmed, 2008; Matashu, 2022; Farayibi & Folarin, 2021).

In measuring educational expenditure, many researchers have analyzed government budgets to understand the allocation of funds to education. They focus on specific expenditure line items related to education, such as salaries for teachers and administrators, infrastructure development, instructional materials, and student support services. Churchill et al. (2017) and Karaçor et al. (2017) utilized government spending on education as a percentage of GDP as a primary indicator of educational expenditure.

Suwandaru et al. (2021) and Ayeni (2018) differentiated between capital and recurrent educational expenditures. Capital expenditures refer to investments in long-term assets, while recurrent expenditures involve ongoing or regular costs associated with the education sector.

Farayibi and Folarin (2020) measured government spending on education by calculating the total amount spent over a specific time frame, expressed as a percentage of GDP. Overall, the literature employs a variety of indicators and methodologies to assess education and educational expenditure, highlighting the complex nature of these concepts and their potential effects on economic and social development.

2.3.4 INTERACTIVE EFFECT OF EDUCATION AND EDUCATION EXPENDITURE ON ECONOMIC GROWTH

There is increasing interest in how education and education spending interact to drive economic growth. A recent study by Oseni et al. (2020) in sub-Saharan Africa underscores the significance of both elements. They contend that education and educational spending are crucial for economic growth, influencing it in the short term through immediate productivity gains and in the long term via human capital development and innovation. However, the relationship between education spending and learning outcomes is complex. Hassan et al. (2022) note that while some studies indicate a positive correlation, others find little to no connection. Nonetheless, the combined impact of educational development and spending is essential for fostering growth and preventing stagnation in sub-Saharan Africa.

Supporting this perspective, Ogbu & Gallagher (2023) assert that both education, as measured by enrollment rates, and education expenditure have a significant positive effect on economic growth. They warn against overlooking either factor, emphasizing that "ignorance may be deceiving" regarding their importance. Their findings suggest that enhancing the efficiency of public education spending through improved resource allocation strategies is vital.

The study types carried out in SSA and other countries across the world are summarized in the following table as follows.

2.1 SUMMARIES OF EMPIRICAL LITERATURES

Title	Author and Year	Sample	Objectives	Variables Employed	Methodology	Findings
Impact of educational expenditure on economic growth in major Asian countries: Evidence from econometric analysis	Mallick , L. (2016)	Balanced panel data from 1973 to 2012.	To examine the dynamics of expenditure on education and its impact on economic growth in selected major Asian countries.	Expenditure on education and GDP per capita.	Panel data framework and utilized econometric techniques.	Long-run equilibrium rel between expenditure on ed economic growth in all Asian countries include analysis.
Making the Grade: The Contribution of Education Expenditure to Economic Growth	(Frank, 2017)	Panel data ranging from 1970 to 2014 across 179 countries	To examine the impact of education expenditure on economic growth across 179 countries from 1970 to 2014.	Government expenditure (%GDP).	General Least Squares regression model	Government expenditure towards education fundi positive and statistically s impact on GDP across th
Does government education expenditure affect educational outcomes? New evidence from sub-Saharan African countries	Farayibi and Folarin (2020)	From 2000 to 2019. Used 31 SSA countries	To investigate the relationship between government education expenditure and economic growth in SSA	Government education expenditure and economic growth	GMM estimator.	Government education ex had a significant positive primary and secondary enrolment rates in sub-African countries
Government spending and school enrollment in SSA:a system GMM approach	(Oseni, et al 2020)	24 sub-Saharan African countries o ver a period from 2000 to 2016	To assess the effect of government educational spending on primary school enrollment in the region	Government spending on education ,primary school enrollment, number of primary school teacher, and population growth rate	A system GMM approach	Government spending on had a significant and positi primary school enrollme region
The Impact of Human Capital on the Economic Growth: An Education Approach	(Purmiyati,2018)	From 2013 to 2017	To understand the human capital factors that determine economic growth, specifically focusing on the impact of education	Gross Domestic Regional Product per capita, Government Expenditure on Education, % of households owning/using cellphones, School enrollment rate aged 16-18 years, Domestic investment and %	Panel data regression analysis.	Positive and statistically sig relationship between Gross Regional Product (GDRP) and government expenditur education (EXP), domestic (INV), and technological li (PHN).

				of illiterate population aged 45+		
Empirical Analysis on Public Expenditure for Education, Human Capital and Economic Growth: Evidence from Honduras	(Paredes, 2022)	From 1990 to 2020	To evaluate the relationship between public spending on education and human capital on economic growth in Honduras.	GDP per capita growth (annual %) , GDP per capita (constant USD) , GDP growth (annual %) , Inflation (annual %) ,Unemployment (% of total labor force) Gross fixed capital formation , Trade openness , Financial depth & Inequality	Instrumental variables (IV) method and The two-stage OLS technique	There was no correlation public expenditure for edu economic growth in Ho
Education, Human Capital Formation and Economic Growth in Sub-Saharan African Countries: A Conceptual Analysis	(Matashu, 2022)	25 African countries	To conduct a conceptual analysis of the r/ship between education, human capital formation, and economic growth in SSA countries.	Human capital-related variables, economic growth indicators, and potentially other factors such as FDI and environmental quality.	Empirical analysis, econometric modeling, and theoretical frameworks.	Government education ex had a significant positive primary educatio
Education as the most important factor of human capital development	Karaçor , Güvenek, Ekinci, & Konya (2017)	1998–2012 19 of OECD countries	To highlight the role of education systems in the development of human capital.	Education, health care, mobility, and finding pricing and income information as key components of human capital formation	Fixed effect model	Education expenditures had on economic growth
The Effect of Education as a Component of Human Capital on Economic Growth:A Panel VAR Analysis	Dasci Sonmez , Elif; Cemaloglu, Necati , . (2021)	1999-2015 In 31 developed and developing economies.	To examine the effects of education, health, and innovation/technology as components of human capital on economic growth	Education, health, innovation/technology, real GDP, labor, and physical capital.	A panel vector auto regression (PVAR)	Real GDP had two-way relationships with labor, capital, education, and heal developing countries, real causality relationships with and health.
Does education expenditure has a positive impact in economic growth? A panel data estimation of five developing countries	(Randolph,2020)	From 1973 to 2012 five developing countries	To investigate the relationship between education expenditure and economic growth, specifically focusing on five Asian developing countries	Education expenditure, gross domestic product (GDP)per-capita,labor and capital inputs and human capital variables,	Random effect model	A positive and statically s relationship between ed expenditure and GDP p
Revisiting the human capital–economic growth nexus in Africa	(Muhamadu Awal Kindzeka	from 2000 to 2019	To investigate the impact of human capital development on economic growth in African countries.	GDP per capita as a proxy for economic growth, human capital index, foreign direct	Generalized Method of Moment (GMM)	Economic growth measured Domestic Product (GDP) p Africa is significantly amel growth in human capital

	Wirajing1 • Tii N. Nchofoung1, 2023)			investment, gross savings, trade openness, inflation rate, and internet penetration		
The Effect of Education Expenditure as a Moderating Variable on Factor Influence HDI	(Putri Aditya Astuti1, 2023)	(2018-2020)	To examine the significant impact of owned local government revenue, general allocation funds, special allocation funds, and the average length of schooling on the Human Development Index with education expenditure as a moderating variable.	Owned Local Government Revenue , General Allocation Funds , Special Allocation Funds , Average Years of Schooling , Human Development Index & Education Expenditures (as a moderating variable	Quantitative approach and tested hypotheses	The variables used in the s significant effect on the Development Index (HDI which is less than 0

2.4 THE GAP IN THE LITERATURE

Although the interaction effect of education and education spending is more productive than their individual effects, early studies has examined the effects of education and education spending on economic growth separately. Education spending can effect growth through its interaction with education, but in cross-country research, the literature seems to have largely ignored the combined interactive impact of education and education expenditure on economic growth. In SSA nations, there has not been enough attention paid to this empirical study on how education affects economic growth using education spending as a moderator variable. By exploring the moderating role of education expenditure, the current study goes beyond the traditional approaches that have tended to analyze the independent impacts of education and education spending.

The existing literature acknowledges the potential significance of tertiary education enrollment rates as an indicator of a population's human capital and its link to economic growth, particularly in the context of research and innovation (Muresan & Gogu, 2012; Sebki, 2021). However, a gap exists in research on Sub-Saharan Africa (SSA) as many studies tend to focus on primary and secondary enrollment rates as education indicators (Chikoko & Mthembu, 2020; Grimmer, 2022). This study aims to address this gap by incorporating the tertiary enrollment rate as an additional indicator of educational attainment in the analysis of the education-growth

relationship within SSA. By including this variable, the study seeks to generate new Intuition into the impact of a more highly educated population on economic growth in the region.

To address the endogeneity concerns in the relationship between education, education expenditure, and economic growth, this study utilized the Generalized Method of Moments (GMM) estimation technique, as recommended by Arellano and Bond (1991) and Blundell and Bond (1998). The GMM approach effectively manages potential endogeneity issues, such as reverse causality and omitted variable bias, frequently encountered in macroeconomic analysis (Roodman, 2009). Furthermore, the study incorporates a representative sample of sub-Saharan African nations, including many previously overlooked due to missing data.

Although data is unavailable for six countries, mean imputation is applied to leverage the nearly complete dataset of 41 out of 47 countries. This method preserves sample size and dataset integrity by avoiding the removal of observations with missing values, thus retaining valuable information. Additionally, mean imputation provides a standardized approach to handling absent values in panel data, facilitating the convergence of necessary statistical models (Jamshidian & Mata, 2007; Grace-Martin, 2023).

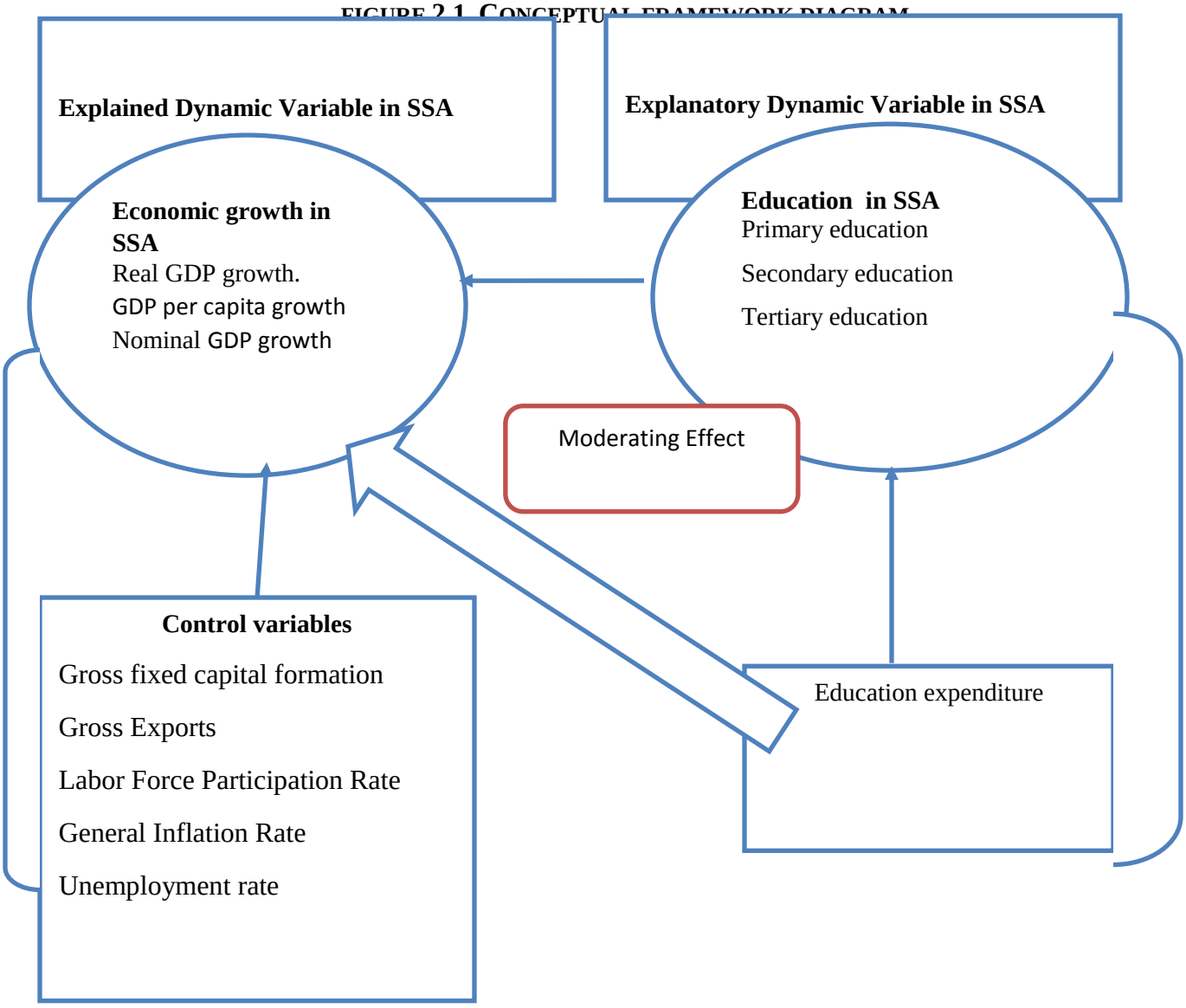
2.5 CONCEPTUAL FRAME WORK

The existing theoretical literature, such as human capital theory and endogenous growth theory, suggests a positive relationship between education expenditure and economic growth. However, the empirical evidence on this relationship has been mixed and context-dependent. For instance, Churchill et al. (2017) found a positive effect of government education expenditure on economic growth in developed countries, while the association was statistically insignificant in less developed countries (LDCs). Conversely, Glewwe et al. (2014) reported that government spending on education as a percentage of GDP did not have a strong explanatory power in relation to economic growth in sub-Saharan Africa.

In contrast, Randolph (2020) revealed that education expenditure has a long-run equilibrium relationship with economic growth in selected developing countries. The findings suggested that increasing education expenditure in developing countries have a positive and significant impact on economic growth, leading to improved human capital, job opportunities, and sustainable development. Similarly, Amaghionyeodiwe (2018) found a positive and significant relationship between government spending on education and economic growth in West African countries. Building on these diverse findings, the conceptual

framework diagram for this study (Figure 2.1) posits that education expenditure directly affects economic growth, and its interaction with education influences economic growth. This interaction effect is central to the objectives of the current investigation, as it aims to uncover the nuanced relationships between these key variables of interest.

FIGURE 2.1 CONCEPTUAL FRAMEWORK DIAGRAM



Source: Author's construction (2024) based on existing theoretical and empirical literature

CHAPTER THREE

3. RESEARCH METHODOLOGY

The research methodology employed in this study outlines the procedures and techniques utilized by study to describe, explain, and predict various phenomena. As defined by Goundar (2019), research methodology also encompasses the study of the methods by which knowledge is acquired. The primary objective of this chapter is to provide the work plan for the study, detailing the data to be collected, the sources of that data, the methods of data collection, and the analytical techniques that has been employed.

3.1 RESEARCH DESIGN AND APPROACH

A research design is a step-by-step approach used by a researcher to conduct a scientific study. It includes various methods and techniques to conduct research so that a research problem can be handled efficiently (Bhasin, 2023). The study's design is determined by the researchers' objectives. The objective of this study was to analyze the relationships between education, education expenditure and economic growth. Quantitative research methods were selected as the appropriate analytical approach to test these relationships empirically.

This study utilizes an explanatory research design, ideal for investigating causal relationships between variables (Browne et al., 2019). This design is particularly appropriate because it allows us to examine how education expenditure moderates the influence of education on economic growth across Sub-Saharan African countries. Explanatory research excels at establishing cause and effect, building and testing theories, and informing interventions and policies – all crucial aspects of this investigation. Therefore, the study focuses on the causal links between economic growth, education (the dependent variable), and education expenditure (the moderator) in these countries.

3. 2 DATA TYPE AND SOURCES

The study employed secondary data obtained from the World Bank, utilizing various sources including the Development Research Group databases, World Development Indicators, and International Financial Statistics. To ensure the research question remained relevant and to encompass a wide range of Sub-Saharan African countries, the final dataset included information from 41 SSA nations and spanned a 22-year period from 2001 to 2022.

3.2.1 MEAN IMPUTATION METHOD FOR MISSING DATA VALUE

Missing observations are a common challenge in panel data analysis. Inappropriately handling missingness can lead to biased estimates. This study addresses this issue using mean imputation, a technique that replaces missing values with the average value of the variable (Wentzell, 2009). Mean imputation offers several advantages. First, it avoids discarding observations with missing data, preserving the sample size and dataset structure. This helps retain valuable information. Second, it provides a consistent approach for handling missing values across time periods in panel data. Finally some statistical models and algorithms require complete data for convergence while mean imputation helps in creating a complete dataset, facilitating model fitting and convergence (Jamshidian & Mata, 2007:Grace-Martin, 2023).

3.3 SELECTION OF COUNTRIES

This study utilizes a panel data analysis focused on Sub-Saharan African countries, drawing from the World Bank's database for categorization. A purposive sampling method was employed to select the countries included in the analysis: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo (Democratic Republic), Congo (Republic), Côte d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. These countries were chosen based on the availability of consistent and reliable data on key variables such as education indicators, education expenditure, and economic growth metrics for the period from 2001 to 2022.

3.4 THEORETICAL FRAMEWORK

A theoretical framework is a foundational review of existing theories that serves as a roadmap for developing the arguments that has been used in the proposed study. It helps ensure that the research design aligns with the theoretical concepts and objectives of the study (Vinz, 2022).The theoretical foundation for this study is the Solow (1956) neoclassical growth model, with the addition of human capital as a key input to production. The Solow model posits that economic growth is driven by the combined contributions of labor, physical capital, and technological progress within an economy. However, as noted by Mankiw et al. (1992), the model's shortcoming is its inability to fully explain the significant variations in wealth observed across countries.

To address this limitation, numerous studies have demonstrated the important influence of factors beyond just labor and physical capital on economic growth. Among these determinants, human capital - encompassing the education and skills of the workforce - has been increasingly recognized as a critical driver of economic growth (Mincer, 1983; Mankiw et al., 1992; Wang & Liu, 2016; Kartal et al., 2017; Keji, 2021). The human capital theory emphasizes the central role of human capital formation in driving economic growth.

This theory views education as a key investment that increases a nation's stock of human skills and knowledge. This, in turn, leads to a more productive workforce and fosters economic prosperity. The theory posits that education and skills are valuable assets that contribute to increased efficiency in utilizing labor and capital resources. By investing in education, nations can build their human capital stock, leading to a more productive workforce and ultimately, sustainable economic growth (Jaiyeoba, 2012& Ojima, 2021).

Mankiw et al. (1992) addressed the limitations of the Solow model by incorporating human capital into the conventional Cobb-Douglas production function. This modification is expressed in the following general growth regression model:

$$\frac{Y}{L}=\mathrm{A}(K/L)^{\alpha}(H/L)^{\beta}\ (\mathrm{e})^{\varepsilon \mathrm{t}} \quad (1)$$

Where,Y/L represents per capita output (economic growth),A signifies total factor productivity, K/L represents capital per worker,H/L represents human capital per worker,α and β are coefficients estimated through regression analysis and εt represents the error term capturing omitted variables.

We adopt the Solow model modified by Mankiw et al. (1992) to investigate the relationship between education expenditure, education, and economic growth in our panel data context. The equation is reformulated as follows:

$$In\mathrm{Y}_{it}=\alpha i+\beta 1\ In(\mathrm{EDU})_{it}+\beta 2 In(\mathrm{EXPE})_{it}+\gamma'\mathrm{X}_{it}+\varepsilon_{it} \quad (2)$$

$$\alpha i=\alpha+\eta i \quad (3)$$

Here, Iny_t represents the natural log of GDP per capita in country i at time t,αi represents the country-specific effect.β1 and β2represent the coefficients to be estimated for education and education expenditure, respectively.lnEDU$_{it}$ and lnEXPE$_{it}$represent the logarithm of proxies that compose the variable for the education indicators (primary, secondary and tertiary education) and education expenditure of each country, respectively, serving as our focal variables. $\gamma' X_{it}$represents a vector of control variables included in the regression analysis, ε_{it} represents the error term,ηi represents the idiosyncratic error component specific to country i and t represents time period.

3.5 METHODS OF DATA ANALYSIS

This study has utilized both descriptive and econometric ways of data analysis. Firstly, descriptive statistics are utilized to understand the basic characteristics of the variables employed in the study for the Sub-Saharan African (SSA) countries. To gain a comprehensive understanding of the relationship between education, education expenditure, and economic growth in SSA countries, the analysis employed descriptive statistics. This included calculating measures like means, standard deviations, minimums, and maximums for each variable.

The primary focus of this analysis lies in econometric methods. To address the dynamic nature of panel data, this study employed the System Generalized Method of Moments (GMM) estimator, particularly the popular approach developed by Arellano and Bover (1995) and Blundell and Bond (1998).A key advantage of the System GMM estimator is its ability to address the issue of endogeneity, a common challenge in static panel data models.

3.6 MODEL SPECIFICATION

Panel data models have become increasingly prominent in contemporary macroeconomic research. This approach leverages panel data, which consists of observations on the same entities (e.g., countries) across multiple time periods (Wooldridge, 2010). Compared to traditional methods relying solely on time series or cross-sectional data, panel data offers several advantages. Firstly, panel data allows researchers to account for heterogeneity, or variation, among individual units in the analysis. This is a significant benefit compared to single cross-sectional studies, which treat all units as identical.

Secondly, panel data provides a richer source of information by incorporating both time-series and cross-sectional dimensions. This leads to greater variability in the data, which can help

reduce issues like multicollinearity (perfect or exact relationship between independent variables). Furthermore, panel data provides additional degrees of freedom (the number of observations minus the number of estimated parameters) and potentially enhanced efficiency in estimates compared to single time series or cross-sectional analyses (Gujarati & Econometrics, 2004; Wooldridge, 2010).

3.6.1 PANEL DATA SYSTEM GMM ESTIMATOR

In our study, given that we are working with panel data, we utilize system GMM to address the issues of endogeneity and country-specific characteristics. GMM estimators are recognized for their consistency, asymptotic normality, and efficiency among all estimators that rely solely on the information provided by the moment conditions.

The econometric specification for the system GMM model can be expressed as follows:

$$\text{First} - \text{Difference System GMM: Yit} = \beta_1 \Delta Xit + \gamma 1 Zit + \varepsilon it \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\text{First} - \text{LEVEL Difference System GMM: } GDP_{it} = \beta_0 + \beta_1 Xit + \gamma 0 Zit + uit \ldots\ldots\ldots\ldots\ldots (2)$$

Where: GDP_{it} represents the dependent variable (GDP percapita). Xit represents the vector of endogenous and exogenous variables .Z(it) represents the vector of instrumental variables. Delta denotes the first-difference operator. β_0, β_1, and gamma0 are the coefficients to be estimated. Varepsilon(it) and u(it) represent the error terms.

The theoretical econometric equation for the Arellano-Bond model can be represented as follows:

$$Y(it) = \alpha + \beta 1 \text{L. Y(it} - 1) + \beta 2\, \text{X}_{\{1it\}} + \beta 3\, \text{X}_{\{2it\}} + \beta \text{k}\, \text{X}_{\{kit\}} + \in it \ldots\ldots\ldots\ldots\ldots\ldots (2.1)$$

Where:Y(it) is the dependent variable for entity i at time t. L.Y(it-1) represents the lagged dependent variable. X(1it) and X(kit} are the explanatory variables. alpha is the intercept. β 1, β 2, $\beta 3$ and βk the coefficients of the lagged dependent variable and the explanatory variables, respectively. epsilon_(it) is the error term.

The Arellano-Bond estimator aims to address endogeneity and serial correlation in panel data models. Its assumptions and theoretical foundations are as follows: The instrumental variables used in the model are assumed to be exogenous, meaning they are uncorrelated with the error term in the regression equation. This assumption allows for consistent parameter estimation.The

instruments should be sufficiently correlated with the endogenous explanatory variables to improve efficiency without being too highly correlated, which can lead to weak instrument bias.

The lagged dependent variable included in the model is assumed to be uncorrelated with the error term, ensuring that it serves as a valid instrument. The error terms are assumed to be serially uncorrelated over time, which allows for efficient estimation using the GMM approach.

The econometric system GMM specification model can be represented as follows:

$$\mathrm{GDP}_{(\mathrm{it})} = \beta 0 + \beta 1\mathrm{L.GDP}_{\{\mathrm{it}\}} + \beta 2\mathrm{PEE}_{\{\mathrm{it}\}} + \beta 3\mathrm{SEE}_{\{\mathrm{it}\}} + \beta 4\mathrm{TEE}_{\{\mathrm{it}\}} + \beta 5\, EXPE\mathrm{t}_{\mathrm{it}} + \beta 6\, GFCF_{\mathrm{it}} + \beta 7\, LFPR_{\mathrm{it}} + \beta 8\, INF_{\mathrm{it}} + \beta 9\, \mathrm{EXPO}_{\mathrm{it}} + \beta 10\mathrm{GDS}_{\mathrm{it}} + \beta 11\mathrm{IMP}_{\mathrm{it}} + \beta 12\mathrm{CONSUMP}_{\mathrm{it}} + \in (it) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.2)$$

Where GDP_{it} represents dependent variable real GDP per-capita, measuring economic growth for country i in time period t. The intercept, $\beta_0 = InB,$ the coefficient of $lnGDP_{i,t-1}$,β_1 denotes the speed of conditional convergence of real GDP per capita to its long-run or steady-state level. PEE is primary education, SEE is secondary education, TEE is tertiary education. $EXPE$ is education expenditure, $GFCF$ is gross fixed capital formation, $LFPR$ is labour force participation, INF is gross inflation, EXPO is gross export, GDS is gross domestic saving, IMP is import and $\in (it)$ represent the error terms.

The above model can be expressed as follow after the inclusion of interaction terms :

$$\mathrm{GDP}_{(\mathrm{it})} = \beta 0 + \beta 1\mathrm{L.GDP}_{\{\mathrm{it}\}} + \beta 2\mathrm{PEE}_{\{\mathrm{it}\}} + \beta 3\mathrm{SEE}_{\{\mathrm{it}\}} + \beta 4\mathrm{TEE}_{\{\mathrm{it}\}} + \beta 5(\mathrm{PEE} * \mathrm{EXPE})_{\{\mathrm{it}\}} + \beta 6(\mathrm{SEE} * \mathrm{EXPE})_{\{\mathrm{it}\}} + \beta 7(\mathrm{TEE} * \mathrm{EXPE})_{\{\mathrm{it}\}}$$

$$+\beta 8\, EXPE\mathrm{t}_{\mathrm{it}} + \beta 9\, GFCF_{\mathrm{it}} + \beta 10\, LFPR_{\mathrm{it}} + \beta 11\, INF_{\mathrm{it}} + \beta 12\, \mathrm{EXPO}_{\mathrm{it}} + \beta 13\mathrm{GDS}_{\mathrm{it}} + \beta 14\mathrm{IMP}_{\mathrm{it}} + \beta 15\mathrm{CONSUMP}_{\mathrm{it}} + \in (it) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.3)$$

In this model, PEE×EXPE represents the interaction between primary education and education expenditure, SEE×EXPE denotes the interaction between secondary education and education expenditure, and TEE×EXPE captures the interaction between tertiary education and education expenditure. The coefficients β5, β6, and β7 can be either positive or negative, depending on the nature of their effects.

The model's theoretical and empirical foundations are established as follows: To account for the potential impact of past economic performance on current growth, we include lagged GDP per capita, reflecting the concept of autocorrelation. This implies that a country's economic performance in the previous year can influence its current GDP growth (Bond et al., 2001). The study emphasizes education by examining its effects through primary, secondary, and tertiary enrollment rates, recognizing that each level of education may have distinct impacts on economic growth. Empirical evidence supports that moderate increases in human capital, particularly through enhanced educational attainment, often lead to improved economic outcomes (Hanushek & Woessmann, 2015).

Education expenditure is a vital variable in this analysis for two primary reasons. Education expenditure is a pivotal variable in this study for two main reasons. First, it serves as an explanatory variable, allowing a direct assessment of its impact on economic growth in SSA countries (Psacharopoulos & Patrinos, 2018). Second, we investigate its potential moderating role in the relationship between educational attainment and economic growth—examining whether education expenditure amplifies or diminishes the effect of educational attainment on economic growth. Additionally, the study incorporates control variables including gross capital formation, gross domestic saving, exports, imports, inflation, consumption, and labor force participation, based on their documented effects on economic growth (ALI, 2015; Öncel et al., 2023; Kargi, 2014; Haque et al., 2019; Adaramola & Dada, 2020; Mignamissi et al., 2023).

3.6.2 PRE-ESTIMATION TESTS

Unit root test for panel data

First, the nature of the data has been examined by panel-based unit root tests of the first and second generation (cross-sectional augmented IPS) by Pesaran (2007). These tests, which are based on Pesaran's CADF provide accurate results in the presence of heterogeneity and cross-sectional dependence. In order to find hidden qualities, the analysis also takes estimates with a constant positive trend into consideration. Because of the cross-sectional residual dependencies, the order of the variables' integration was ascertained using the CADF unit root tests. According to this test, it is not possible to rule out non-stationarity of the variables at any level for any nation group, but it is dismissed when the variables exhibit their first difference. This demonstrates that certain variables have a unit root at levels, whereas others do not.

Panel Data Co- Integration Test

When analyzing non-stationary variables in panel data, it is essential to assess whether cointegration exists between the dependent and independent variables. This study utilized the Westerlund cointegration test, which is generally preferred over other tests like the Kao test or the Augmented Dickey-Fuller (ADF) test for panel data exhibiting cross-sectional dependence (Westerlund, 2007). The Westerlund test employs both group-mean and panel statistics approaches, effectively addressing this issue and yielding more reliable outcomes.

Moreover, it accommodates heterogeneous cointegrating coefficients among panel members, an important aspect when considering cross-sectional dependence, as the effects of independent variables on the dependent variable may differ across units. Additionally, the Westerlund test allows for the inclusion of various deterministic components, such as intercepts and time trends, which enhances the accuracy of the data modeling and improves the reliability of the test results.

3.6.3 DIAGNOSTIC TESTS

Testing the model's accuracy is the most important step in any empirical investigation. To identify model misspecification and direct model improvement, diagnostic tests are utilized. The serial correlation, multicollinearity, heteroskedasticity, and instrument validity tests are among them.

Arellano-Bond test for serial correlation

The current study conducted the serial correlation test using the Arellano-Bond test. The Arellano-Bond test is a statistical test used to detect serial correlation in the errors from a GMM model (Arellano & Bond, 1991). In GMM models, the presence of serial correlation in the errors can lead to biased and inconsistent estimates. The Arellano-Bond test is a Lagrange multiplier test that assumes the errors in the GMM model are serially uncorrelated. The null hypothesis of the Arellano-Bond test is that there is no serial correlation in the errors.

The multicollinearity test

Multicollinearity occurs when two or more independent variables used in a regression analysis highly or strongly correlate. This correlation between the exploratory variables is one of the major problems in linear regression analysis because independent variables should be independent. This problem can lead to misleading results when a researcher attempts to determine how well each explanatory variable can be used most effectively to predict the

dependent variable in the model (Gujrati 2004). Multicollinearity has been measured using the variance inflation factor (VIF), in this study.

Instruments Validity Test

The Sargan test of over-identifying restrictions is applied to check the validity of the instruments used in the study. It was proposed by John Denis Sargan in 1958, and several variants were derived by him in 1975. The Sargan test is based on the assumption that model parameters are identified via a priori restrictions on the coefficients, and tests the validity of over-identifying restrictions under the null hypothesis of the over-identifying restrictions are valid. The test statistic can be computed from residuals from instrumental variables regression by constructing a quadratic form based on the cross-product of the residuals and exogenous variables (Sargan, 1988).

Dynamic Panel Data Causality Testing

One of the main objectives of this study is to examine whether there is a dynamic causal relationship between education, education expenditure, and economic growth in sub-Saharan African countries. To this end, the study employs Granger causality testing, also known as causality testing, which is a statistical technique used to determine whether one time series variable can be used to predict another (Granger, 1969). The basic idea behind Granger causality is that if a variable X Granger-causes a variable Y, then changes in X should precede changes in Y. In this study, pairwise Granger causality tests, has been utilized which provide a flexible and robust framework to investigate the dynamic causal linkages between variables, while accounting for the cross-sectional and time-series dimensions of the panel data. The main advantage of using pairwise Granger causality tests in a panel data context is that it allows for the examination of causal relationships between individual pairs of variables, while controlling for unobserved heterogeneity and addressing potential endogeneity issues (Dumitrescu & Hurlin, 2012).

3.7 VARIABLES DESCRIPTION AND EXPECTED SIGNS

TABLE 3.1. VARIABLES DESCRIPTION AND EXPECTED SIGNS

variable/Category	Label	Label	Expected Signs	References
Dependent Variable	GDP per capita Growth	GDP per capita growth (annual %)	-	Zouheir & Imen (2014), Sobiech (2015),and Olayungbo & Quadri (2019),
Regressor variables				
Education	Education as proxied by primary , secondary and tertiary education enrollment (% gross)	+/-	The expected sign and influence of primary, secondary, and tertiary education enrollment on economic growth may differ based on the analysis's dimension, the study's methodology, and a nation's level of development.	(Papageorgiou ,2003) (Barro & Sala-i-Martin ,1995) , and (Uyar et al., 2022)
Education expenditure(the moderator variable)	Government education expenditure(% GDP)	+/-	While a general studies shows a positive association between government education expenditure and economic growth, the specific effects varied based on the country's development level,and methodology used.	Churchill et al. (2015),and (Ömer et al., 2023)
Gross fixed capital formation (GFCF)	Gross fixed capital formation (% of GDP)	+/-	Gross fixed capital formation is generally expected to have a positive and significant impact on economic growth	Ali, 2015, and Dessie,2023
Gross export (EXPE)	Export of goods and services (% of GDP)	+/-	It is expected to have a positive and significant relationship with economic growth	Oyebanjo, 2017 and Öncel et al., 2023
Labor force participation rate (LFPR)	Labor force participation rate total(% of total population age 15^{+}(Modeled by ILO)	+/-	Studies indicate that there is a complex relationship between the labor force participation rate (LFPR) and economic growth, with differing short- and long-term effects.	Kargi, 2014 and Haque et al., 2019
General inflation (INF)	Inflation ,GDP deflator (annual%) data	+/-	Several studies have documented a negative and significant r/ship between inflation and economic growth.. Thus, the present study expects to find a similar negative and significant effect of inflation on economic growth.	Adaramola & Dada, 2020 and Mignamissi et al., 2023

Gross imports(IMPO)	Gross Imports of goods and services (current US$)	+/-	This study expects a negative sign, building on the established negative association between imports and economic growth.	Oyebanjo, 2017,and Oseni et.,2023
Gross domestic saving(GDS)	Gross domestic saving (% of GDP)	+/-	Higher GDS can lead to increased investment in physical capital and human capital .These investments can enhance productivity and economic output in the long run. This theoretical framework suggests that we would expect a positive sign for the effect of GDS on economic growth in Sub-Saharan Africa (SSA).	(Elias & Abebe, 2015) and (Van Wyk & Kapingura, 2021)
Final consumption expenditure(CONSUMP)	Final consumption expenditure Measured by current US$	+/-	This study expects a positive and significant relationship between consumption and economic growth.	Valli, 2008,and Alper, 2018
Interaction effect	Primary education* Education expenditure (PEE*EDUEXP), Secondary education*education expenditure(SEE*EDUEXP)and Tertiary Education *education expenditure(TEE*EDUEXP)	+/-	This study investigates how education, measured by primary, secondary and tertiary educational enrollment, interact with education expenditure to influence economic growth. We expect the interaction of education and education expenditure to have a positive impact on economic growth.	----
Instrumental variable		+/-		
Government Expenditure on Health per Capita	Current health expenditure per capita (current US$)	+/-	**Scenario 1**: If increased GHE leads to improved health outcomes, it might free up household resources and allow for higher education spending. **Scenario 2:** If increased GHE comes at the expense of education spending due to budget constraints, the positive effect of education on economic growth might be dampened.	Oyebanjo,2017,and Anvari et al., 2020

3.8. THE CONCEPT OF MODERATING ROLE VIA INTERACTION EFFECT

This study goes beyond a direct examination of how education affects economic growth in Sub-Saharan African (SSA) economies. It delve into the concept of a moderating role, where a third variable (education expenditure) can influence the existing relationship between two other variables (education and economic growth) (Bhandari, 2023).Prior studies often focuses on the

direct impact of education on economic growth (Glewwe et al., 2014& Irughe et al., 2018). However, the moderating role suggests that education expenditure might strengthen or weaken this relationship (Zaman et al., 2021). For instance, high levels of effective education spending may enhance the positive effect of education on economic growth, whereas low spending might diminish it.

This study takes the analysis a step further by examining interaction effects. This concept explores how the combined influence of two variables (education and education expenditure) produces an outcome greater than the sum of their individual effects (Frost, 2022). In simpler terms, high education expenditure paired with high education levels could significantly boost economic growth. This synergy suggests that increased spending alongside a well-educated population has a more substantial impact than either factor alone. To capture this interaction effect, we follow the approach used by Abeka et al. (2021) and introduce an interaction term in our model. This term captures the combined influence of education spending and education level on economic growth. We also address the statistical complication of multicollinearity by centering the education and education-spending variable before multiplying them. This centering technique ensures a more robust analysis by reducing the correlation between the interaction term and the individual variables (Desie, 2023).

CHAPTER FOUR

4. RESULT AND DISCUSSIONS

This chapter provides panel data analysis results and corresponding discussions. It comprises on the influence of education on economic growth across countries, with a specific focus on the moderating effect of education expenditure on this relationship. A sample of 41 Sub-Saharan African countries was selected for the period 2001-2022 to capture regional diversity and data availability. The data are cleaned from World Bank development indicators data base. To address potential biases arising from missing data, this study employed mean imputation, a common technique for handling for incomplete data (Wentzell, 2009; Grace-Martin, 2023).

The first section provides comprehensive summary statistics for all variables incorporated into the model. Moving forward, the subsequent section provides panel data regression models results, including the results of one-step GMM, and two-step GMM approaches, model that answered the research question. The second section delves into diagnostic tests to ensure the robustness of our models and identify any potential issues. The fifth section presents the estimated model results, accompanied by a detailed discussion of their interpretation in light of the research question.

4.1. Overview of Education, Education Expenditure, Economic Growth, and Relevant Control Variables in Sub-Saharan African Countries by Descriptive Statistics.

TABLE 4.1: SUMMARY OF EDUCATION, EDUCATION EXPENDITURE, ECONOMIC GROWTH, AND RELEVANT CONTROL VARIABLES IN SSA COUNTRIES BY DESCRIPTIVE STATISTICS

Variables		mean	Std. Dev.	Min	max
Economic growth(Econgr~t)	overall	2128.549	3108.166	110.46	19849.72
	between		2918.687	204.9491	12648.12
	within		1157.804	-6358.634	11459.67
Primary Education(PEE)	overall	349.6	182.9827	2	695
	between		104.6886	124.6182	539.8
	within		150.9252	-185.2	904.5727
Secondary Education(SEE)	overall	247.6595	106.5284	2	496
	between		68.97122	92.96905	462.1509
	within		81.86661	-15.77954	553.8278
TertiaryEducation(TEE)	overall	230.1322	97.77362	2	448
	between		40.66589	95.53605	324.5601
	within		89.13198	-23.95872	475.2145
Education Expenditure(EDUEXP)	overall	432	242.9693	2	862
	between		86.981	249.2727	610.3182
	within		227.2548	-127.0455	1037.727
Exports(EXPO)	overall	365.2263	199.3718	2	733
	between		148.7569	90.04545	631.7727
	within		134.671	-220.5919	972.4536
Gross Domestic Saving(GDS)	overall	357.434	228.7139	2	783
	between		149.3936	59.77273	618.1364
	within		174.6763	-62.97513	932.2521
Gross Fixed Capital	overall	391	209.0994	2	780
Formation(GFCF)	between		93.2226	198.0909	576.2273
	within		187.709	-135.3182	948.9091
Imports(IMPO)	overall	347.2465	185.1652	2	707
	between		140.6539	60.72727	650.2273
	within		122.3263	-134.208	818.792
Inflation(INF)	overall	337.3248	206.3044	1	702
	between		89.93545	178.0455	484.0455
	within		186.1763	-110.7206	861.2794
Labor force participation	overall	384.3386	213.908	2	763
rate(LFPR)	between		210.8523	12.27273	745.7727
	within		48.31333	224.7023	568.3386
Consumption(CONSMP)	overall	2093.895	3120.02	37	19849.72
	between		2927.521	322.7523	12648.12
	within		1167.86	-6393.288	11425.01
Health Expenditure(Health~p)	overall	237.8619	118.2587	2	491
	between		82.94314	60.94199	399.7147

	within	85.24021	-105.171	565.056
Observations				N = 902 n = 41 T = 22

Source: Own computation (2024) in Stata using the panel Data from Our world development indicator Data

Overviewing Economic Growth in SSA

The data of Economic growth (Econgr~t) is proxided by GDP per capita growth in SSA. This data is used as it appear in World Bank database by SSA countries. The average economic growth across all observations is 2128.55, but there is a high standard deviation (3108.17) indicating significant variation in growth patterns .This suggests that some countries have experienced much higher or lower economic growth than others. Interestingly, the "between" country averages show a higher economic growth (2918.69) compared to "within" country averages over time (1157.80). This implies that a substantial portion of the variation in economic growth may be due to factors specific to individual countries rather than global trends over the 22-year period.

Overviewing Primary education (PEE) in SSA

Primary education enrollment (PEE) serves among key indicators of educational attainment in SSA. Examining the data for selected African countries, we find an average enrollment rate of approximately 349.6, with a notable standard deviation of 182.98. This suggests significant variation in Primary education enrollment rates across SSA countries. Furthermore, the even larger within-group standard deviation of 150.93 highlights a substantial disparity in access to primary education within individual countries.This implies the uneven distribution of educational opportunities across countries(Delprato, Marcos, et al., 2023).Adding to this complexity; the between-group standard deviation of 104.69 suggests distinct enrollment patterns between countries. Factors like poverty and unequal resource distribution likely contribute to these variations (World Bank&World Development Report 2020).

Secondary education (SEE) in SSA

Secondary education enrollment rates (SEE) serve as a vital indicator of a nation's educational attainment, akin to primary education enrollment (Chikoko & Mthembu, 2020). Our analysis of SEE data from Sub-Saharan African countries also reveals significant variation. While the overall average enrollment stands at 247.66, the high standard deviation 106.5284 suggests substantial heterogeneity across countries in secondary education provission. Further exploration through the decomposition of "between" and "within" means (68.97. vs. 81.87) highlights disparities within individual countries over time.

Tertiary education (TEE) as one of the indicator of education

Tertiary education enrollment (TEE) serves as a crucial indicator of a nation's educational attainment, with a direct impact on economic growth, innovation, and the development of a skilled workforce (Psacharopoulos, 1997; World Bank, 2020). An analysis of TEE data from Sub-Saharan African countries reveals a seemingly promising average enrollment 230.132, However, this statistic masks a concerning reality – significant variation across countries, as evidenced by the high standard deviation of 97.77. This suggests that some countries have much higher or lower TEE rates compared to the average. These findings highlight the critical need to address the uneven distribution of educational opportunities across the region. Higher TEE rates are linked to a more skilled workforce, potentially driving innovation, productivity, and attracting foreign investment (Psacharopoulos, 1997). By contrast, limited access to tertiary education can hinder economic growth and development (Salmi ,2003).

Education expenditure (EDUEXP) in SSA

Education expenditure (EDUEXP) is a key another explanatory variable included in this study. It serves as an important indicator of a country's investment in educational human capital development (Barro, 1991; Hanushek & Woessmann, 2020). According to the data, the mean EDUEXP value across the 41 SSA countries for 22 periods is 597.2609, with a between-group standard deviation of 173.83 and a within-group standard deviation of 232.8. This suggests there are significant differences in education expenditure levels both across the countries as one of the indicator of education as well as over time within each group. The wide range between the

minimum value of 4 and maximum of 1191 further shows the substantial variation in education spending observed in the data.

Overview of Control Variables of the Study in SSA

Gross fixed capital formation varies significantly between nations, with minimums of $2 million and maximums of $780 billion. Given that capital creation is essential for economic development, this difference in investment levels may have an impact on economic growth ((Valli, 2008;World Bank, 2024). Inflation fluctuates greatly between observations, ranging from 1% to a worrisome 150%, with a mean of around 337.3248% and a standard deviation of 206.3% (IMF, 2024). The dataset's wide range of inflationary pressures, which have a substantial effect on economic performance, are highlighted by this high variability (Desai et al., 2003).

The import figures exhibit significant variability among the observations, ranging from $2 million to an astounding $707 billion. According Hausmann et al., (2005), this diversity points to variations in economic structures and trade openness that may have an impact on economic dynamics. With a standard deviation of $199.3718 billion, the average export value is around $365.2263 billion. $2 million to $733 billion is the range of exports. The significant fluctuations highlight the significance of global commerce within the economic framework and its capacity to impact economic expansion in sub-Saharan African countries (Yuni et al., 2020).

SSA exhibit significant variation in both saving behaviors and workforce participation. Gross Domestic Saving (GDS) averages $357.4 billion but ranges from negative -$2 billion to a high of $783 billion (standard deviation $228.7139 billion), highlighting diverse saving patterns that can impact economic growth(Van Wyk & Kapingura, 2021) . Similarly, the Labor Force Participation Rate shows substantial disparity, averaging 384.34% but ranging from 12.27% to 745.8%. This variability suggests differences in workforce engagement across countries, potentially influencing economic activity and future growth (Clemens & Montenegro, 2014). Additionally, Consumption displays a large variation across groups with mean of 2093.9, potentially reflecting income disparities (Keynes, 1936& Friedman, 1957).

4.2 Econometric Analysis

4.2.1 Pre Estimation Test

Cross-sectional dependency test

Panel data analysis frequently encounters cross-sectional dependency because the units (such as nations, etc.) in the panel may be correlated with one another. Possible explanations for this include spatial spillovers, unobserved common factors, or other sources of interdependence among the cross-sectional units (Pesaran, 2004; Sarafidis & Wansbeek, 2012). The Pesaran CD test was employed in this investigation to assess cross-sectional dependency.

TABLE 4.2.PESARAN CD TEST

Pesaran's test of cross sectional independence = 43.370, Pr = 0.0000
Average absolute value of the off-diagonal elements = 0.398

Source: Author's computation, 2024

The results of the Pesaran CD test are presented in Table 4.2, The Pesaran's test of cross-sectional independence has a test statistic of 43.370 with a p-value of 0.0000. This indicates that the null hypothesis of no cross-sectional dependence is strongly rejected at any conventional significance level. The average absolute value of the off-diagonal elements is 0.398, further confirming the presence of significant cross-sectional dependence in the panel data. Which needs the consideration of unit root and cointegration test.

Unit Root Test

TABLE 4.3. PANEL UNIT ROOT TEST USING CADF

Variable	Trend specification	CADF		
		Levels	First difference	Decision
ln_Econgrowt	Inercept	-2.328**	-3.184***	I(0)
	Intercept and trend	-3.006***	-3.313***	I(0)
ln_PEE	Inercept	-2.603***	-3.668***	I(0)
	Intercept and trend	-2.920***	-3.746***	I(0)
ln_SEE	Inercept	-2.602*	-3.476*	I(0)
	Intercept and trend	-2.721*	-3.683*	I(0)
ln_TEE	Inercept	-2.664*	-4.038 *	I(0)
	Intercept and trend	-2.824*	-4.305*	I(0)
ln_EDUEXP	Inercept	-2.320	-3.485*	I(1)
	Intercept and trend	-2.433	-3.485***	I(1)

ln_EXPO	Inercept	-1.717	-2.870***	I(1)
	Intercept and trend	-2.102	-2.982***	I(1)
ln_IMPO	Inercept	-1.380	-2.714**	I(1)
	Intercept and trend	-2.052	-2.714** *	I(1)
ln_GFCF	Inercept	-2.250***	-3.015***	I(1)
	Intercept and trend	-2.404***	-3.151***	I(10

, ** & * denotes the statistically significance at 10%, 5% and 1% level respectovely.*
Source: Author's computation, 2024

Table 4.3 results show that of the mixed results, some are non-stationary at level [I(0)], but they all become stationary after being transformed into the first difference [I(1)]. Once the unit roots at each level were confirmed, the variables were found to be stable at their initial difference, and a panel cointegration test was employed to see whether a long-term relationship existed between them.

Panel Data Co- Integration Test

TABLE 4.4.THE WESTERLUND PANEL COINTEGRATION TEST

Westerlund test for cointegration		
Ho: No cointegration	Number of panels = 41	
Ha: Some panels are cointegrated	Number of periods = 22	
Cointegrating vector: Panel specific		
Panel means: Included		
Time trend: Not included		
AR parameter: Panel specific		
	Statistic	p-value
Variance ratio	20.7696	0.0000

Source: Author's computation, 2024

The Westerlund panel cointegration test is designed to assess whether there is a long-run equilibrium relationship among the variables in a panel data setting. The null hypothesis (H0) of the test is that there is no cointegration, while the alternative hypothesis (Ha) is that some panels are cointegrated. Given the p-value of 0.0000, which is less than the typical significance level of 0.05 (or 5%), we can reject the null hypothesis of no cointegration. This result provides evidence that there is at least one cointegrating relationship among the variables (Econgrowt, PEE, SEE, TEE, EDUEXP, EXPO, GDS, and GFCF) in the panel data.

Correlation analysis

TABLE 4.5 .CORRELATION AMONG VARIABLES

	ln_Eco~t	ln_PEE	ln_SEE	ln_TEE	ln_EDU~P	ln_GFCF	ln_IMPO	ln_LFPR	ln_CONSMP	ln_EXPO
ln_Econgrowt	1									
ln_PEE	-0.2007	1								
ln_SEE	0.3287	-0.1247	1							
ln_TEE	0.151	-0.0656	0.1691	1						
ln_EDUEXP	0.0485	-0.0232	0.0235	0.091	1					
ln_GFCF	0.0309	-0.0811	-0.0278	-0.0139	0.085	1				
ln_IMPO	0.0315	-0.0581	0.0409	0.0979	-0.0393	-0.0112	1			
ln_LFPR	-0.3589	0	-0.1644	-0.1274	-0.0052	0.1181	-0.0174	1		
ln_CONSMP	0.9284	-0.1879	0.2917	0.1254	0.0454	0.0676	0.0259	-0.1761	1	
ln_EXPO	0.3018	-0.1214	0.1408	0.0492	-0.0124	0.1096	0.3092	-0.0938	0.2879	1

Based on the data presented in Table 4.5, there exists a significant positive correlation between the rate of economic growth (ln_Econgrowth) and several key variables, including secondary education (SEE), tertiary education (TEE), expenditure on education (EDUEXP), gross fixed capital formation (GFCF), imports (IMPO), consumption (CONSMP), and exports (EXPO). Conversely, there is a negative correlation observed between economic growth and primary education (PEE) as well as the labor force.

Further analysis reveals that primary education demonstrates a positive correlation with the labor force while exhibiting negative associations with secondary education, tertiary education, education expenditure, gross fixed capital formation, imports, consumption, and exports. Conversely, secondary education displays positive correlations with tertiary education, education expenditure, imports, consumption, and exports, but negative correlations with gross fixed capital formation and the labor force. Likewise, tertiary education shows positive correlations with education expenditure, imports, consumption, and exports, but negative correlations with gross fixed capital formation and the labor force.

Moreover, education expenditure, acting as a moderator variable in this study, exhibits a positive correlation with gross fixed capital formation and consumption, while displaying negative correlations with imports, the labor force, and exports. Gross fixed capital formation is positively correlated with the labor force, consumption, and exports, but negatively correlated with imports.

Import variables show positive correlations with consumption and exports but negative correlations with the labor force. The labor force, in turn, negatively correlates with consumption and exports, while consumption positively correlates with exports.

4.2.2 Panel data regression and diagnostic test results

This section presents the results obtained from the system GMM (Arellano and Bover, 1995; Blundell and Bond, 1998) analysis of the effect of education on economic growth, with the moderating role of education expenditure, in SSA countries over the period 2021-2022.First, the system GMM (step one and step two) was estimated using the xtabond2 STATA module (Roodman, 2009) without the interaction effect of education and education expenditure. Subsequently, the study analyzed the moderating role of education expenditure on the economic growth effect of education in SSA countries. This involved including the interaction terms (primary education * education expenditure, secondary education*education expenditure and tertiary education *education expenditure) in the GMM model.

TABLE 4.6. SYSTEM GMM MODELS RESULTS FOR DYNAMIC PANEL ESTIMATION, REGRESSION RESULTS FOR THE EFFECT OF EDUCATION (PRIMARY, SECONDARY AND TERTIARY) ON ECONOMIC GROWTH WITHOUT THE INTERACTION VARIABLES.

	GMM one step	GMM two step
VARIABLES	Econgrowt	Econgrowt
L.Econgrowt	0.0938***	0.0464
	(0.00408)	(0.0494)
LFPR	-0.459***	0.0101
	(0.0285)	(0.214)
PEE	0.0606***	-0.00282
	(0.0177)	(0.0615)
EDUEXP	-0.0764***	-0.0353
	(0.0128)	(0.0512)
GDS	0.0519***	0.00671
	(0.0155)	(0.0575)
IMPO	-0.191***	-0.119
	(0.0210)	(0.110)
INF	-0.0568***	-0.00640
	(0.0150)	(0.0424)
TEE	0.0968***	0.0239
	(0.2318)	(0.100)

SEE	0.172***	0.118
	(0.0336)	(0.112)
EXPO	0.243***	0.128
	(0.0195)	(0.121)
GFCF	-0.0542***	-0.0343
	(0.0148)	(0.0457)
CONSMP	0.889***	0.948***
	(0.00393)	(0.0534)
Constant	196.8***	16.15
	(22.82)	(108.0)
Observations	861	861
R-squared		
Number of id	41	41

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Arellano-Bond test for AR(1) in first differences: z = -0.92 Pr > z = 0.360
Arellano-Bond test for AR(2) in first differences: z = -0.09 Pr > z = 0.925

Sargan test of overid. restrictions: chi2(263) = 461.72 Prob > chi2 = 0.000
(Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(263) = 11.59 Prob > chi2 = 1.000
(Robust, but weakened by many instruments.)
Difference-in-Hansen tests of exogeneity of instrument subsets:
GMM instruments for levels
Hansen test excluding group: chi2(172) = 11.90 Prob > chi2 = 1.000
Difference (null H = exogenous): chi2(91) = -0.31 Prob > chi2 = 1.000
iv(PEE LFPR GDS IMP INF TEE SEE EXPO GFCF)
Hansen test excluding group: chi2(254) = 12.29 Prob > chi2 = 1.000
Difference (null H = exogenous): chi2(9) = -0.69 Prob > chi2 = 1.000

Sources: Own computation using STATA 16.2

The provided table presents the regression results for the effect of education on economic growth, as estimated using one-step and two-step GMM models. As can be seen from the one-step model results, these exclude the interaction variables. The annual panel data includes 41 Sub-Saharan African (SSA) countries, and the panel is strongly balanced (see Appendix).

The one-step and two-step system GMM estimations reveal that all twelve explanatory variables significantly affected the economic growth of SSA countries over the study period. The coefficient of the lagged economic growth variable is positive and statistically significant, with a magnitude of 0.094 at the 1% level. This implies that the real GDP per capita of SSA countries

largely depends on the previous year's real GDP per capita, or in other words, the pattern of GDP is path-dependent.

The analysis of the data in Table 4.6 reveals a significant and positive effect of primary education on economic growth in Sub-Saharan Africa, demonstrated at a strong 1% level of significance. Specifically, a 1% increase in primary education enrollment correlates with a 0.061% increase in economic growth, when controlling for other variables. These findings align with the core principles of Human Capital Theory as proposed by Becker and Schultz (1964), which asserts that education equips individuals with skills that enhance their economic value. Additionally, they support empirical evidence from studies by Psacharopoulos and Patrinos (2018), Hanushek and Woessmann (2010), and Birdsall and Lederman (2007). While these results meet expectations, they contrast with findings from Rao and Jani (2008), likely due to methodological differences and the characteristics of the samples studied.

Similarly, the above finding shows that the positive and statistically significant impact of secondary education on economic growth, evident at a 5% level of significance. According to the findings, a 1% increase in secondary school enrollment is associated with a 1.72% boost in economic growth, holding all other relevant variables constant. This result confirms the generally accepted belief that investing in secondary education is essential for developing human capital, which in turn promotes economic growth (Psacharopoulos & Patrinos, 2018: Hanushek & Woessmann, 2008 and However, these findings contradict the results of earlier studies, such as those by Mincer (1974), and Rao & Jani (2007).

Contrary to the findings of Farayibi and Oludele Folarin (2020), this study's first-step Generalized Method of Moments (GMM) analysis reveals a noteworthy and favorable influence of tertiary education enrollment on GDP per capita growth. A 1% increase in tertiary school enrollment is associated with a significant 0.0968% rise in GDP per capita growth, holding other variables constant. This finding is consistent with the work of Barro and Sala-i-Martin (1995) and Uyar et al. (2022).

Our analysis reveals a negative and statistically significant relationship between educational expenditure and economic growth at the 1% level of significance. A 1% increase in education expenditure is associated with a 0.0764% decrease in GDP per capita growth, while holding other variables constant. This finding contradicts the prevailing view in the literature, which

generally suggests that educational expenditure has a positive impact on economic growth (Churchill et al., 2017; Kouton, 2018& Randolph, 2020).

The study's first-stage GMM estimation revealed a negative and statistically significant association between labor force participation and GDP per capita growth in Sub-Saharan African countries. Specifically, a 1% increase in the labor force participation rate was found to be associated with a 0.459% decrease in GDP per capita growth, holding other factors constant. This result is inconsistent with previous studies by Kargi (2014) and Haque et al. (2019) who found a positive association between labor force participation and economic growth. On the other hand, the analysis showed that greater gross domestic saving has a positive and significant effect, indicating that a 1% increase in gross domestic savings leads to a 0.0519% rise in economic growth, while keeping other factors constant. This positive impact of saving on growth is statistically significant at the 1% level, though it does diverge from a recent study by Adjei et al. (2020).

The study also uncovered a negative and statistically significant relationship between gross fixed capital formation (GFCF) and economic growth in the region, where a 1% increase in GFCF corresponds to a 0.0542% decline in real GDP per capita growth. This result is inconsistent with what is typically observed in the literature, where GFCF is expected to have a positive impact on economic growth (Adjei et al., 2020; ALI, 2015).

Further analysis revealed that exports have a substantial, positive, and statistically significant (at the 1% level) association with economic growth, such that a 1% rise in exports translates to a 0.243% increase in real GDP per capita. Conversely, imports were found to have a negative and statistically significant (at the 5% level) correlation with growth, where a 1% increase in imports is linked to a 0.191% decrease in real GDP per capita growth. These trade-related findings are consistent with the theoretical underpinnings of international commerce and with previous empirical studies (Rodrik,2006 : Önel et al. ,2023& Oyebanjo ,2017).

Finally, the analysis revealed a statistically significant positive relationship between consumption and economic growth, along with a statistically significant negative relationship between general inflation and economic growth. These results support the theories put forth by Keynes (1936) and Friedman (1957), as well as the empirical findings of Adaramola and Dada (2020) and Mignamissi et al. (2023).

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TABLE 4.7. SYSTEM GMM MODELS RESULTS FOR DYNAMIC PANEL ESTIMATION, REGRESSION RESULTS FOR THE MODERATING ROLE OF EDUCATION EXPENDITURE ON THE RELATION BETWEEN EDUCATION AND ECONOMIC GROWTH (WITH THE INTERACTION VARIABLES).

	Step one GMM result (1)	Step two GMM result(2)
VARIABLES	Econgrowt	Econgrowt
L.Econgrowt	0.0935***	0.0450
	(0.00410)	(0.0504)
PEE	0.106***	0.0179
	(0.0355)	(0.0855)
LFPR	-0.458***	-0.309
	(0.0286)	(0.337)
GDS	0.0491***	0.0196
	(0.0156)	(0.0755)
IMPO	-0.183***	-0.0999
	(0.0211)	(0.118)
INF	-0.0559***	0.0265
	(0.0150)	(0.0819)
SEE	-0.00497	-0.0394
	(0.0655)	(0.225)
EXPO	0.245***	0.107
	(0.0196)	(0.141)
GFCF	-0.0513***	0.00121
	(0.0149)	(0.0604)
CONSMP	0.889***	0.944***
	(0.00395)	(0.0559)
EDUEXP	-0.162***	-0.0313
	(0.0563)	(0.160)
TEE	0.0700	0.0704
	(0.0677)	(0.331)
PEEE*duexp	-0.000112	-2.41e-07
	(6.98e-05)	(0.000228)
SEEE*duexp	0.000429***	0.000301
	(0.000139)	(0.000515)
TEEE*duexp	6.89e-05	-0.000102
	(0.000135)	(0.000395)
Constant	228.4***	122.2
	(32.16)	(204.9)
Observations	861	861
Number of id	41	41

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Autocorrelation and the instrumental validity tests are reported in the table.

Sources: Author's computation using STATA 16

Arellano-Bond test for AR(1) in first differences: z = -0.52 Pr > z	0.600
Arellano-Bond test for AR(2) in first differences: z = -1.31 Pr > z	0.189
Sargan test of overid. restrictions: chi2(635) =3750.82 Prob > chi2	0.000
(Not robust, but not weakened by many instruments.)	
Hansen test of overid. restrictions: chi2(635) = 17.54 Prob > chi2	1.000
(Robust, but weakened by many instruments.)	
Difference-in-Hansen tests of exogeneity of instrument subsets:	
GMM instruments for levels	
Hansen test excluding group: chi2(405) = 5.72 Prob > chi2	1.000
Difference (null H = exogenous): chi2(230) = 11.81 Prob > chi2	1.000
gmm(L.Econgrowt, lag(1 1))	
Hansen test excluding group: chi2(595) = 7.93 Prob > chi2	1.000
Difference (null H = exogenous): chi2(40) = 9.60 Prob > chi2	1.000
gmm(PEE LFPR GDS IMPO INF TEE SEE EXPO GFCF CONSMP, lag(1 2))	0.989
Hansen test excluding group: chi2(25) = 11.70 Prob > chi2	1.000
Difference (null H = exogenous): chi2(610) = 5.84 Prob > chi2	
iv(mean_EDUEXP)	1.000
Hansen test excluding group: chi2(634) = 5.41 Prob > chi2	0.000
Difference (null H = exogenous): chi2(1) = 12.13 Prob > chi2	

Table 4.7 presents the regression results that explore the moderating effect of education expenditure on the relationship between education and economic growth. This analysis incorporates interaction terms (PEE*EDUEXPE, SEE*EDUEXPE& TEE*EDUEXPE) to capture potential non-linear effects.

The interaction effect of primary education and education expenditure (step one system GMM)

The results presented in the table for the step one GMM model show that the interaction effect between primary education (PEE) and education expenditure (EDUEXP) has no significant impact on GDP per capita growth.

The interaction effect of secondary education and education expenditure (step one system GMM)

The results shown in Table 4.7 indicate that the interaction effect between secondary education (SEE) and education expenditure (EDUEXP) significantly and positively influences GDP per

capita growth at the 1% significance level. Increased investment in education expenditure enhances the quality and effectiveness of secondary education, fostering better human capital development and boosting economic output. Specifically, a 1% increase in the interaction between EDUEXP and SEE results in a 0.00043% increase in GDP per capita growth, holding other factors constant.

This empirical evidence aligns with previous studies, including those by Asongu and Odhiambo (2019), Chikoko and Mthembu (2020), and Grimmer (2022). Asongu and Odhiambo (2019) further emphasize that effective education expenditure such as investments in teacher training, curriculum development, learning materials, and educational infrastructure can enhance educational quality and ultimately drive productivity and economic growth.

In conclusion, these findings highlight a clear connection between education and economic growth in Sub-Saharan African countries. Firstly, they confirm a statistically significant positive effect of education on economic growth. Secondly, the interaction effect between secondary education and education expenditure reveals that countries investing heavily in education, particularly at the secondary level, experience a significantly enhanced impact on economic growth.

From the step 1 and step 2 GMM estimated regressions without the interaction effect in Table 4.6 and with it in Table 4.7 the study concludes that the step 1 GMM model fits well. The estimated regression successfully passed both specification tests (autocorrelation and instrumental validity). As indicated in Tables 4.6 and 4.7, the absence of serial correlation was confirmed at the 5% level in both models. Additionally, there is no endogeneity bias, as the overall validity of the instruments could not be rejected at the 5% level. This suggests that the model is adequately specified and that the instruments used are valid.

4.2.2.1 Diagnostics Tests

Diagnostic tests are essential for validating the results obtained from system GMM estimation and their applicability for policy implications. Key tests typically conducted on system GMM models include assessments for multicollinearity, autocorrelation, instrument validity, and panel data causality.

Multicollinearity Test This study used the variance inflation factor (VIF), a metric used to evaluate multicollinearity among predictor variables in regression analysis, to test for the presence of multicollinearity between independent variables.

TABLE 4.8.VARIANCE INFLATION FACTOR (VIF) TEST FOR MULTICOLLINEARITY

vif		
Variable	VIF	1/VIF
ln_CONSMP	1.41	0.710214
ln_EXPO	1.27	0.787072
ln_GDS	1.17	0.852591
ln_SEE	1.14	0.874263
ln_IMPO	1.13	0.883799
ln_LFPR	1.11	0.899125
ln_TEE	1.07	0.936414
ln_PEE	1.06	0.943434
ln_GFCF	1.05	0.950562
ln_INF	1.03	0.969942
ln_EDUEXP	1.02	0.976688
Mean VIF	1.13	

The independent variables in the regression model exhibit VIF values between 1.02 and 1.41, with an average of 1.13. These results indicate that multicollinearity is not a significant concern for the model. The tolerance values for each variable, calculated as 1/VIF, range from 0.710214 to 0.976688, further supporting the conclusion that there are no problematic levels of multicollinearity affecting the model.

Auto-correlation Test

The study tested for second-order autocorrelation of the residuals to determine the presence of autocorrelation in the model. The Arellano-Bond test was employed, with the null hypothesis stating that autocorrelation does not exist. As shown in Tables 4.6 and 4.7, the results indicate that we fail to reject the null hypothesis of no second-order serial correlation. This suggests that the error term is serially uncorrelated and that the moment conditions are correctly specified, as evidenced by the AR(2) values being greater than 0.05 in both specifications.

Panel Data Causality Testing

This study utilized pairwise Granger dynamic panel causality tests to explore the causal relationships among the variables of interest. A significant advantage of employing pairwise Granger causality tests in a panel data context is that it facilitates the examination of causal linkages between specific pairs of variables while controlling for unobserved heterogeneity and addressing potential endogeneity issues (Dumitrescu & Hurlin, 2012). The results of this

causality analysis involving education, education expenditure, and economic growth are presented in the following table.

TABLE 4.9. PAIRWISE GRANGER CAUSALITY TESTS

Null Hypothesis:	Obs	F-Statistic	Prob.
EDUEXP does not Granger Cause ECONGROWT	894	1.27262	0.2542
ECONGROWT does not Granger Cause EDUEXP			
PEE does not Granger Cause ECONGROWT	894	2.50467	0.0108
ECONGROWT does not Granger Cause PEE		0.28895	0.9697
SEE does not Granger Cause ECONGROWT	894	1.07861	0.3757
ECONGROWT does not Granger Cause SEE		2.61320	0.0079
TEE does not Granger Cause ECONGROWT	894	0.68921	0.7014
ECONGROWT does not Granger Cause TEE		1.46758	0.165
PEE does not Granger Cause EDUEXP	894	1.14215	0.3322
EDUEXP does not Granger Cause PEE		0.69025	0.7004
SEE does not Granger Cause EDUEXP	894	0.97262	0.4559
EDUEXP does not Granger Cause SEE		0.62932	0.7536
TEE does not Granger Cause EDUEXP	894	1.50838	0.1501
EDUEXP does not Granger Cause TEE		0.51523	0.8456
SEE does not Granger Cause PEE	894	1.68315	0.0985
PEE does not Granger Cause SEE		1.27548	0.2526
TEE does not Granger Cause PEE	894	0.60737	0.7722
PEE does not Granger Cause TEE		0.61249	0.7679
TEE does not Granger Cause SEE	894	2.67367	0.0066
SEE does not Granger Cause TEE		2.03539	0.0398

The results indicate a unicausal relationship between primary education (PEE) and economic growth (ECONGROWT). Specifically, PEE Granger causes ECONGROWT, with a p-value of 0.0108, suggesting that primary education has a causal influence on economic growth, but not vice versa. In contrast, the analysis reveals a bicausal relationship between economic growth (ECONGROWT) and secondary education (SEE). The p-value of 0.0079 indicates that ECONGROWT Granger causes SEE, while the p-value of 0.0398 suggests that SEE also Granger causes ECONGROWT.

Furthermore, the results show a bi causal relationship between tertiary education (TEE) and secondary education (SEE). The p-value of 0.0066 indicates that TEE Granger causes SEE, while the p-value of 0.0398 suggests that SEE also Granger causes TEE.

CHAPTER FIVE

5. SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter presents a summary and conclusion drawn from the findings of the study. Based on the major findings, the chapter provides policy recommendations. Finally, it suggests areas for further research.

5.1 SUMMARY

The impact of education on economic growth remains a complex issue with ongoing debate. While some studies find a positive association between education and economic growth due to increased productivity (Wilfred and Bokana (2017), others argue that resources invested in schooling divert from immediate economic activities, potentially hindering growth (Psacharopoulos & Arriagada, 2009).Additionally, some research suggests no clear relationship (World Bank, 2018). This paper delves deeper, examining the moderating role of education expenditure on the economic growth effect of education in Sub-Saharan African (SSA) countries.

To address this primary objective, the study set out the following specific objectives; Estimate the effect of education on economic growth within the Sub-Saharan African (SSA) context. Estimate the effect of education expenditure on economic growth in the SSA continent. Investigate whether education expenditure moderates the relationship between education and economic growth, and investigate the dynamic causality between education, education expenditure, and economic growth.

To achieve the stated objective, this study conducted both descriptive and inferential analyses on data collected from forty-one Sub-Saharan African countries covering the period from 2001 to 2022. In this context, GDP per capita served as the dependent variable, acting as a proxy for economic growth. The explanatory variables included education, education expenditure, gross fixed capital formation, gross domestic saving, imports, exports, consumption, and labor force, with education expenditure also functioning as a moderator variable in the model.

In the descriptive analysis, the average economic growth across all observations is 2128.55, but there is a high standard deviation indicating significant variation in growth patterns for the period 2021-2022.This suggests that some countries have experienced much higher or lower economic growth than others. Interestingly, the "between" country averages show a higher economic growth (2918.69) compared to "within" country averages over time (1157.80). This implies that a substantial portion of the variation in economic growth may be due to factors specific to individual countries rather than global trends over the 22-year period.

There exists a significant positive correlation between the rate of economic growth (ln_Econgrowth) and several key variables, including secondary education (SEE), tertiary education (TEE), expenditure on education (EDUEXP), gross fixed capital formation (GFCF), imports (IMPO), consumption (CONSMP), and exports (EXPO). Conversely, there is a negative correlation observed between economic growth and primary education (PEE) as well as the labor force.

The econometric analysis utilized the system-generalized method of moments (system-GMM) within the framework of the neoclassical growth model. This approach was applied to investigate the hypothesis that education significantly impacts economic growth in Sub-Saharan African (SSA) countries, as well as to assess the role of education expenditure in enhancing the effectiveness of education in promoting economic growth in the region. Prior to estimating the relationships among the variables, panel data were tested for stationarity using both first and second-generation panel unit root tests (specifically, the cross-sectional augmented IPS test by Pesaran, 2007). The results of these unit root tests revealed that some variables were stationary while others were not.

The presence of cointegration among the panel series was subsequently assessed using the Westerlund panel cointegration test, which confirmed the existence of long-run relationships between the stationary variables in the study. Additionally, various post-estimation tests, including diagnostic checks, were performed to validate the analysis's reliability. The results of these diagnostic tests indicated no issues with serial correlation, multicollinearity, or the integrity of the collected data. Furthermore, the instruments employed in the study were found to be valid and suitable for the analysis.

The findings from the system GMM estimation results revealed significant positive impacts of primary education, secondary education, gross domestic saving, exports, and consumption on the economies of Sub-Saharan African (SSA) countries. Conversely, gross fixed capital formation, inflation, and labor force participation were found to exert negative and significant effects on economic growth in the region. Additionally, the analysis explores the moderating role of education expenditure in the relationship between education and economic growth.

The study found that education expenditure plays a moderating role in the relationship between education and economic growth in sub-Saharan African (SSA) economies. Specifically, the research revealed that higher levels of education expenditure amplify the positive impact of education on economic growth in SSA countries. Overall, these results underscore the critical importance of certain factors, such as education spending, in driving economic growth in SSA nations, while also confirming the expected directional effects of the variables examined in the analysis.

Furthermore, the study found a unidirectional relationship between primary education (PEE) and economic growth (ECONGROWT), where PEE Granger causes ECONGROWT (p-value: 0.0108), but not vice versa. Conversely, a bidirectional relationship was observed between economic growth (ECONGROWT) and secondary education (SEE), with ECONGROWT Granger causing SEE (p-value: 0.0079) and SEE also Granger causing ECONGROWT (p-value: 0.0398). Additionally, the analysis revealed a bidirectional relationship between tertiary education (TEE) and secondary education (SEE), where TEE Granger causes SEE (p-value: 0.0066) and SEE also Granger causes TEE (p-value: 0.0398).

5.2 CONCLUSION

This study examined the impact of education on economic growth in 41 Sub-Saharan African (SSA) countries from 2021 to 2022, while also exploring the influence of education expenditure on this relationship. A key finding is that both primary and secondary education positively affect economic growth, indicating that education—especially at the secondary level—plays a crucial role in enhancing SSA economies.

Additionally, the findings emphasize the moderating role of education expenditure in the relationship between education and economic growth in SSA countries. The results indicate that increased education expenditure improves the effectiveness of educational initiatives.

This implies that sufficient investment in education, beyond simply increasing enrollment rates, functions as a precondition for education to demonstrably stimulate economic growth. This finding aligns with the understanding that increased education expenditure can improve the quality of education. Such expenditures can finance initiatives such as enhanced teacher training, reduced class sizes, and the provision of up-to-date learning materials. These improvements, in turn, contribute to a more effective learning environment that fosters the development of a skilled workforce, ultimately leading to higher productivity and economic growth.

Moreover, the positive correlation between gross domestic savings (GDS) and economic growth aligns with theoretical frameworks that highlight the importance of saving in promoting investment (Carroll, 2023). This investment is crucial for long-term and sustainable economic expansion, facilitating the creation of new capital stock and driving technological advancements (Aghion et al., 2009). Similarly, our analysis indicates a statistically significant positive relationship between exports and economic growth, reinforcing the well-established theoretical and empirical arguments that international trade enhances economic growth (Rodrik, 2006; Önel et al., 2023).

In contrast, our results reveal a negative and statistically significant relationship between imports and economic growth. This finding supports Oyebanjo's (2017) research, suggesting that high levels of imports can impede growth, especially in resource-constrained economies. Additionally, the labor force participation rate appears to hinder economic expansion in Sub-Saharan African (SSA) countries. An increase in the labor force in nations with limited capital and low levels of technological advancement leads to a reduction in capital per worker. This, in turn, decreases labor productivity and stifles economic progress.

5.3 POLICY RECOMMENDATION

The results of the study show that during the sampled period, economic growth and education in Sub-Saharan African (SSA) countries were positively correlated. Interestingly, when education spending is taken into account, this relationship is reinforced, suggesting even stronger improvement in economic growth. Based on these findings, governments in SSA countries should prioritize increasing education budgets to strengthen the positive impact of education on economic growth. Specifically, the policy attention should be directed at achieving the following to maximize the benefit of education:

1. The governments in SSA countries should significantly increase public investment in education, especially for secondary education.
2. The study finding showed that education expenditure moderates the relationship between education and economic growth. Along with boosting education expenditure, governments should implement robust monitoring and evaluation frameworks to ensure these funds are utilized efficiently and effectively.

5.4 AVENUE FOR FUTURE RESEARCH

The study analysis the role of education expenditure in the relationship between education and economic growth for only SSA economies, which made the findings of the study one sided. This study suggests that future studies could focus on a comparative study for both developing and developed countries. Besides, this paper did not consider the development status of countries in the analysis. Future studies in this area may consider development status of countries in the relationship between education and economic growth. Finally, while this study suggests that education expenditure moderate the association between education and economic growth, further investigation is necessary to elucidate the specific mechanisms through which this moderation occurs.

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APPENDIX

```
. xtsum Econgrowt PEE SEE TEE EDUEXP EXPO GDS GFCF IMPO INF LFPR CONSMP HealthEXp
```

Variable		Mean	Std. Dev.	Min	Max	Observations
Econgr~t	overall	2128.549	3108.166	110.46	19849.72	N = 902
	between		2918.687	204.9491	12648.12	n = 41
	within		1157.804	-6358.634	11459.67	T = 22
PEE	overall	349.6	182.9827	2	695	N = 902
	between		104.6886	124.6182	539.8	n = 41
	within		150.9252	-185.2	904.5727	T = 22
SEE	overall	247.6595	106.5284	2	496	N = 902
	between		68.97122	92.96905	462.1509	n = 41
	within		81.86661	-15.77954	553.8278	T = 22
TEE	overall	230.1322	97.77362	2	448	N = 902
	between		40.66589	95.53605	324.5601	n = 41
	within		89.13198	-23.95872	475.2145	T = 22
EDUEXP	overall	432	242.9693	2	862	N = 902
	between		86.981	249.2727	610.3182	n = 41
	within		227.2548	-127.0455	1037.727	T = 22
EXPO	overall	365.2263	199.3718	2	733	N = 902
	between		148.7569	90.04545	631.7727	n = 41
	within		134.671	-220.5919	972.4536	T = 22
GDS	overall	357.434	228.7139	2	783	N = 902
	between		149.3936	59.77273	618.1364	n = 41
	within		174.6763	-62.97513	932.2521	T = 22
GFCF	overall	391	209.0994	2	780	N = 902
	between		93.2226	198.0909	576.2273	n = 41
	within		187.709	-135.3182	948.9091	T = 22
IMPO	overall	347.2465	185.1652	2	707	N = 902
	between		140.6539	60.72727	650.2273	n = 41
	within		122.3263	-134.208	818.792	T = 22
INF	overall	337.3248	206.3044	1	702	N = 902
	between		89.93545	178.0455	484.0455	n = 41
	within		186.1763	-110.7206	861.2794	T = 22
LFPR	overall	384.3386	213.908	2	763	N = 902
	between		210.8523	12.27273	745.7727	n = 41
	within		48.31333	224.7023	568.3386	T = 22
CONSMP	overall	2093.895	3120.02	37	19849.72	N = 902
	between		2927.521	322.7523	12648.12	n = 41
	within		1167.86	-6393.288	11425.01	T = 22
Health~p	overall	237.8619	118.2587	2	491	N = 902
	between		82.94314	60.94199	399.7147	n = 41
	within		85.24021	-105.171	565.0563	T = 22

```
.
```

Pesaran crossectional dependency test

```
Random-effects GLS regression                   Number of obs     =         902
Group variable: id                              Number of groups  =          41

R-sq:                                           Obs per group:
     within  = 0.0528                                         min =          22
     between = 0.4657                                         avg =        22.0
     overall = 0.1871                                         max =          22

                                                Wald chi2(7)      =       52.84
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =      0.0000
```

Econgrowt	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PEE	.5041947	.2613843	1.93	0.054	-.0081092	1.016499
SEE	1.037545	.4801088	2.16	0.031	.0965492	1.978541
TEE	-.0916024	.4440085	-0.21	0.837	-.9618431	.7786383
EDUEXP	-.3822673	.1744107	-2.19	0.028	-.724106	-.0404286
EXPO	.8548532	.2932463	2.92	0.004	.2801009	1.429605
GDS	.7429459	.2280245	3.26	0.001	.2960262	1.189866
GFCF	.9094876	.214622	4.24	0.000	.4888362	1.330139
_cons	948.1663	401.6409	2.36	0.018	160.9646	1735.368
sigma_u	1956.1092					
sigma_e	1157.004					
rho	.74082232	(fraction of variance due to u_i)				

```
. . xtcsd, pesaran abs

Pesaran's test of cross sectional independence =    43.370, Pr = 0.0000

Average absolute value of the off-diagonal elements =     0.398

.
```

Co-integration test

```
. xtcointtest westerlund Econgrowt PEE SEE TEE EDUEXP EXPO GDS GFCF

Westerlund test for cointegration
---------------------------------

Ho: No cointegration                        Number of panels       =     41
Ha: Some panels are cointegrated            Number of periods      =     22

Cointegrating vector: Panel specific
Panel means:          Included
Time trend:           Not included
AR parameter:         Panel specific
```

	Statistic	p-value
Variance ratio	20.7696	0.0000

One step GMM regression result without interaction effects

```
System dynamic panel-data estimation            Number of obs     =        861
Group variable: id                              Number of groups  =         41
Time variable: Year
                                                Obs per group:
                                                              min =         21
                                                              avg =         21
                                                              max =         21

Number of instruments =    995                  Wald chi2(12)     =  738043.80
                                                Prob > chi2       =     0.0000
One-step results
```

Econgrowt	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Econgrowt						
L1.	.0938229	.0040761	23.02	0.000	.0858339	.1018118
PEE	.0606429	.0177042	3.43	0.001	.0259433	.0953425
LFPR	-.4592855	.028546	-16.09	0.000	-.5152348	-.4033363
IMPO	-.1905307	.0209555	-9.09	0.000	-.2316028	-.1494586
INF	-.0568047	.0150179	-3.78	0.000	-.0862394	-.0273701
TEE	.0967511	.0318394	3.04	0.002	.034347	.1591553
SEE	.1722998	.0335747	5.13	0.000	.1064947	.238105
EXPO	.2434892	.019528	12.47	0.000	.2052151	.2817633
GFCF	-.0542266	.01485	-3.65	0.000	-.083332	-.0251212
CONSMP	.8893162	.0039322	226.16	0.000	.8816093	.8970231
EDUEXP	-.0764014	.0127578	-5.99	0.000	-.1014062	-.0513966
GDS	.0518937	.0155083	3.35	0.001	.021498	.0822895
_cons	196.8046	22.82047	8.62	0.000	152.0773	241.532

```
Instruments for differenced equation
        GMM-type: L(2/.).Econgrowt L(2/.).PEE L(2/.).LFPR L(2/.).GDS
                  L(2/.).IMPO L(2/.).INF L(2/.).TEE L(2/.).SEE L(2/.).EXPO
                  L(2/.).GFCF L(2/.).CONSMP
        Standard: LD.Econgrowt D.LFPR D.PEE D.EDUEXP D.GDS D.IMPO D.INF
                  D.TEE D.SEE D.EXPO D.GFCF D.CONSMP
Instruments for level equation
        GMM-type: LD.Econgrowt LD.PEE LD.LFPR LD.GDS LD.IMPO LD.INF LD.TEE
                  LD.SEE LD.EXPO LD.GFCF LD.CONSMP
        Standard: _cons
(est1 stored)
```

Two step GMM regression result without interaction effects

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       861
Time variable : Year                            Number of groups   =        41
Number of instruments = 651                     Obs per group: min =        21
Wald chi2(12) = 398113.60                                      avg =     21.00
Prob > chi2   =     0.000                                      max =        21
------------------------------------------------------------------------------
             |              Corrected
  Econgrowt  |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  Econgrowt  |
         L1. |   .0464274   .0493838     0.94   0.347    -.0503631     .143218
             |
        LFPR |   .0101334   .2139417     0.05   0.962    -.4091846    .4294513
         PEE |  -.0028194   .0614672    -0.05   0.963    -.1232928     .117654
      EDUEXP |  -.0353409   .0511754    -0.69   0.490    -.1356429    .0649611
         GDS |    .006708   .0574819     0.12   0.907    -.1059545    .1193704
        IMPO |  -.1186044   .1095245    -1.08   0.279    -.3332684    .0960597
         INF |  -.0064009   .0423768    -0.15   0.880    -.0894579    .0766561
         TEE |   .0239261   .1003759     0.24   0.812    -.1728071    .2206594
         SEE |    .118176   .1119795     1.06   0.291    -.1012998    .3376519
        EXPO |    .128138   .1210402     1.06   0.290    -.1090964    .3653724
        GFCF |  -.0343167   .0456671    -0.75   0.452    -.1238226    .0551892
      CONSMP |   .9478162   .0534193    17.74   0.000     .8431163    1.052516
       _cons |   16.14505   107.9992     0.15   0.881    -195.5295    227.8196
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.mean_EDUEXP
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/2).(PEE LFPR GDS IMPO INF TEE SEE EXPO GFCF CONSMP)
    L.L.Econgrowt
Instruments for levels equation
  Standard
    mean_EDUEXP
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(PEE LFPR GDS IMPO INF TEE SEE EXPO GFCF CONSMP)
    D.L.Econgrowt
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -0.62  Pr > z =  0.533
Arellano-Bond test for AR(2) in first differences: z =  -1.32  Pr > z =  0.187
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(638)  =3738.60  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(638)  =  14.24  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(408)  =   5.17  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(230)  =   9.07  Prob > chi2 =  1.000
  gmm(L.Econgrowt, lag(1 1))
    Hansen test excluding group:     chi2(598)  =  16.80  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(40)   =  -2.55  Prob > chi2 =  1.000
  gmm(PEE LFPR GDS IMPO INF TEE SEE EXPO GFCF CONSMP, lag(1 2))
    Hansen test excluding group:     chi2(28)   =  20.86  Prob > chi2 =  0.831
    Difference (null H = exogenous): chi2(610)  =  -6.62  Prob > chi2 =  1.000
  iv(mean_EDUEXP)
    Hansen test excluding group:     chi2(637)  =   8.12  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(1)    =   6.13  Prob > chi2 =  0.013
```

One step GMM regression result with interaction effects

```
System dynamic panel-data estimation            Number of obs     =         861
Group variable: id                              Number of groups  =          41
Time variable: Year
                                                Obs per group:
                                                              min =          21
                                                              avg =          21
                                                              max =          21

Number of instruments =    998                  Wald chi2(15)     =  735758.79
                                                Prob > chi2       =     0.0000
One-step results
```

Econgrowt	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Econgrowt						
L1.	.0935322	.0041011	22.81	0.000	.0854942	.1015701
PEE	.1060417	.0354905	2.99	0.003	.0364815	.1756018
LFPR	-.4584546	.0285941	-16.03	0.000	-.514498	-.4024112
GDS	.0490573	.015601	3.14	0.002	.0184798	.0796347
IMPO	-.1834508	.0210653	-8.71	0.000	-.224738	-.1421636
INF	-.0558967	.0150397	-3.72	0.000	-.085374	-.0264193
SEE	-.0049725	.065482	-0.08	0.939	-.1333149	.12337
EXPO	.2454996	.0195599	12.55	0.000	.207163	.2838363
GFCF	-.0512805	.014928	-3.44	0.001	-.0805389	-.0220221
CONSMP	.8890657	.0039452	225.35	0.000	.8813332	.8967982
EDUEXP	-.1617568	.0562561	-2.88	0.004	-.2720168	-.0514968
TEE	.0700234	.0676711	1.03	0.301	-.0626095	.2026563
PEEEduexp	-.0001119	.0000698	-1.60	0.109	-.0002487	.0000249
SEEEduexp	.0004289	.0001387	3.09	0.002	.000157	.0007008
TEEEduexp	.0000689	.0001351	0.51	0.610	-.000196	.0003338
_cons	228.3707	32.16213	7.10	0.000	165.3341	291.4073

```
Instruments for differenced equation
        GMM-type: L(2/.).Econgrowt L(2/.).PEE L(2/.).LFPR L(2/.).GDS
                  L(2/.).IMPO L(2/.).INF L(2/.).TEE L(2/.).SEE L(2/.).EXPO
                  L(2/.).GFCF L(2/.).CONSMP
        Standard: LD.Econgrowt D.LFPR D.PEE D.EDUEXP D.GDS D.IMPO D.INF
                  D.TEE D.SEE D.EXPO D.GFCF D.PEEEduexp D.SEEEduexp
                  D.TEEEduexp D.CONSMP
Instruments for level equation
        GMM-type: LD.Econgrowt LD.PEE LD.LFPR LD.GDS LD.IMPO LD.INF LD.TEE
                  LD.SEE LD.EXPO LD.GFCF LD.CONSMP
        Standard: _cons
(est7 stored)
```

Two step GMM regression result with interaction effects

```
.   eststo: xtabond2 Econgrowt L.Econgrowt LFPR PEE EDUEXP GDS IMP INF TEE SEE EXPO GFCF PEEEduexp SEEEduexp TEEEduexp CONS
> MP, gmm(L.Econgrowt, lag(1 1)) gmm(PEE LFPR GDS IMP INF TEE SEE EXPO GFCF CONSMP, lag(1 2)) iv(mean_EDUEXP) twostep robus
> t ar(2)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       861
Time variable : Year                            Number of groups   =        41
Number of instruments = 651                     Obs per group: min =        21
Wald chi2(15) = 362811.84                                      avg =     21.00
Prob > chi2   =      0.000                                     max =        21
------------------------------------------------------------------------------
             |              Corrected
   Econgrowt |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   Econgrowt |
         L1. |   .0450061   .0503937     0.89   0.372    -.0537637    .1437759
             |
        LFPR |  -.3088688   .3371867    -0.92   0.360    -.9697426    .3520049
         PEE |   .0179076   .0855098     0.21   0.834    -.1496886    .1855038
      EDUEXP |  -.0312735   .1595277    -0.20   0.845     -.343942    .2813951
         GDS |   .0195747   .0754698     0.26   0.795    -.1283433    .1674927
        IMPO |  -.0999173   .1179994    -0.85   0.397    -.3311919    .1313572
         INF |   .0264704   .0819445     0.32   0.747     -.134138    .1870787
         TEE |   .0704052   .3310647     0.21   0.832    -.5784698    .7192802
         SEE |  -.0394039   .2252567    -0.17   0.861    -.4808988     .402091
        EXPO |   .1074043   .1412748     0.76   0.447    -.1694891    .3842977
        GFCF |   .0012119   .0603822     0.02   0.984     -.117135    .1195588
   PEEEduexp |  -2.41e-07   .0002276    -0.00   0.999    -.0004464    .0004459
   SEEEduexp |   .0003011    .000515     0.58   0.559    -.0007083    .0013106
   TEEEduexp |  -.0001018   .0003954    -0.26   0.797    -.0008767    .0006731
      CONSMP |   .9444505   .0559052    16.89   0.000     .8348783    1.054023
       _cons |    122.245   204.8779     0.60   0.551    -279.3084    523.7983
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.mean_EDUEXP
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/2).(PEE LFPR GDS IMPO INF TEE SEE EXPO GFCF CONSMP)
    L.L.Econgrowt
Instruments for levels equation
  Standard
    mean_EDUEXP
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.(PEE LFPR GDS IMPO INF TEE SEE EXPO GFCF CONSMP)
    D.L.Econgrowt
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -0.52  Pr > z =  0.600
Arellano-Bond test for AR(2) in first differences: z =  -1.31  Pr > z =  0.189
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(635)  =3750.82  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(635)  =  17.54  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(405)  =   5.72  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(230)  =  11.81  Prob > chi2 =  1.000
  gmm(L.Econgrowt, lag(1 1))
    Hansen test excluding group:     chi2(595)  =   7.93  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(40)   =   9.60  Prob > chi2 =  1.000
  gmm(PEE LFPR GDS IMPO INF TEE SEE EXPO GFCF CONSMP, lag(1 2))
    Hansen test excluding group:     chi2(25)   =  11.70  Prob > chi2 =  0.989
    Difference (null H = exogenous): chi2(610)  =   5.84  Prob > chi2 =  1.000
  iv(mean_EDUEXP)
    Hansen test excluding group:     chi2(634)  =   5.41  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(1)    =  12.13  Prob > chi2 =  0.000

(est8 stored)
```

Multicollinearity Test

```
. vif
```

Variable	VIF	1/VIF
ln_CONSMP	1.41	0.710214
ln_EXPO	1.27	0.787072
ln_GDS	1.17	0.852591
ln_SEE	1.14	0.874263
ln_IMPO	1.13	0.883799
ln_LFPR	1.11	0.899125
ln_TEE	1.07	0.936414
ln_PEE	1.06	0.943434
ln_GFCF	1.05	0.950562
ln_INF	1.03	0.969942
ln_EDUEXP	1.02	0.976688
Mean VIF	1.13	

Causality test

Pairwise Granger Causality Tests
Date: 05/27/24 Time: 16:55
Sample: 1 1122
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
EDUEXP does not Granger Cause ECONGROWT	894	1.27262	0.2542
ECONGROWT does not Granger Cause EDUEXP		1.31151	0.2339
PEE does not Granger Cause ECONGROWT	894	2.50467	0.0108
ECONGROWT does not Granger Cause PEE		0.28895	0.9697
SEE does not Granger Cause ECONGROWT	894	1.07861	0.3757
ECONGROWT does not Granger Cause SEE		2.61320	0.0079
TEE does not Granger Cause ECONGROWT	894	0.68921	0.7014
ECONGROWT does not Granger Cause TEE		1.46758	0.1650
PEE does not Granger Cause EDUEXP	894	1.14215	0.3322
EDUEXP does not Granger Cause PEE		0.69025	0.7004
SEE does not Granger Cause EDUEXP	894	0.97262	0.4559
EDUEXP does not Granger Cause SEE		0.62932	0.7536
TEE does not Granger Cause EDUEXP	894	1.50838	0.1501
EDUEXP does not Granger Cause TEE		0.51523	0.8456
SEE does not Granger Cause PEE	894	1.68315	0.0985
PEE does not Granger Cause SEE		1.27548	0.2526
TEE does not Granger Cause PEE	894	0.60737	0.7722
PEE does not Granger Cause TEE		0.61249	0.7679
TEE does not Granger Cause SEE	894	2.67367	0.0066
SEE does not Granger Cause TEE		2.03539	0.0398

CADF unit root tests

```
. pescadf ln_Econgrowt , lags(1)

Pesaran's CADF test for ln_Econgrowt
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant

t-bar test, N,T = (41,22)         Obs = 820
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -2.328   -2.040    -2.110    -2.230   -3.747     0.000



.  pescadf ln_Econgrowt , lags(1)trend

Pesaran's CADF test for ln_Econgrowt
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (41,22)         Obs = 820
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -3.006   -2.540    -2.610    -2.730   -4.789     0.000


. pescadf ln_PEE , lags(1)

Pesaran's CADF test for ln_PEE
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant

t-bar test, N,T = (41,22)         Obs = 820
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -2.603   -2.040    -2.110    -2.230   -5.563     0.000


. pescadf ln_PEE , lags(1)trend

Pesaran's CADF test for ln_PEE
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (41,22)         Obs = 820
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -2.920   -2.540    -2.610    -2.730   -4.199     0.000


.  pescadf ln_SEE , lags(1)

Pesaran's CADF test for ln_SEE
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant

t-bar test, N,T = (41,22)         Obs = 820
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -2.602   -2.040    -2.110    -2.230   -5.558     0.000
```

```
.  pescadf ln_SEE , lags(1)trend

Pesaran's CADF test for ln_SEE
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (41,22)         Obs = 820
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -2.721   -2.540    -2.610    -2.730   -2.831     0.002

. pescadf ln_TEE , lags(1)

Pesaran's CADF test for ln_TEE
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant

t-bar test, N,T = (41,22)         Obs = 820
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -2.664   -2.040    -2.110    -2.230   -5.965     0.000


. pescadf ln_TEE , lags(1)trend

Pesaran's CADF test for ln_TEE
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (41,22)         Obs = 820
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -2.824   -2.540    -2.610    -2.730   -3.537     0.000


. pescadf D.ln_EDUEXP , lags(1)

Pesaran's CADF test for D.ln_EDUEXP
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant

t-bar test, N,T = (41,21)         Obs = 779
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -3.485   -2.040    -2.110    -2.230  -11.390     0.000


. pescadf d.ln_EDUEXP , lags(1)trend

Pesaran's CADF test for D.ln_EDUEXP
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (41,21)         Obs = 779
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -3.689   -2.540    -2.610    -2.730   -9.498     0.000
```

```
. pescadf d.ln_EXPO , lags(1)

Pesaran's CADF test for D.ln_EXPO
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant

t-bar test, N,T = (41,21)         Obs = 779
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -2.870   -2.040    -2.110    -2.230   -7.327     0.000

. pescadf d.ln_EXPO , lags(1)trend

Pesaran's CADF test for D.ln_EXPO
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (41,21)         Obs = 779
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -2.982   -2.540    -2.610    -2.730   -4.629     0.000


. pescadf ln_GDS , lags(1)

Pesaran's CADF test for ln_GDS
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant

t-bar test, N,T = (41,22)         Obs = 820
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -2.017   -2.040    -2.110    -2.230   -1.697     0.045


.  pescadf d.ln_GDS , lags(1)trend

Pesaran's CADF test for D.ln_GDS
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (41,21)         Obs = 779
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -3.263   -2.540    -2.610    -2.730   -6.559     0.000

. pescadf d.ln_GFCF , lags(1)

Pesaran's CADF test for D.ln_GFCF
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant

t-bar test, N,T = (41,21)         Obs = 779
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -3.015   -2.040    -2.110    -2.230   -8.286     0.000
```

```
. pescadf d.ln_GFCF , lags(1)trend

Pesaran's CADF test for D.ln_GFCF
Cross-sectional average in first period extracted and extreme t-values truncated
Deterministics chosen: constant & trend

t-bar test, N,T = (41,21)         Obs = 779
Augmented by 1 lags (average)

    t-bar     cv10      cv5       cv1   Z[t-bar]    P-value
   -3.151   -2.540    -2.610    -2.730   -5.790     0.000
```