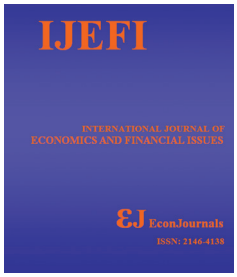

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Measuring the Effect of Income Inequality, Financial Inclusion, Investment, and Unemployment, on Economic Growth in Africa: A Moderating Role of Digital Financial Technology

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ABSTRACT

The significance of understanding the effect of income inequality, financial inclusion, investment, unemployment on economic growth in Africa is imperative in academic literature, and contributes meaningfully to policy decision making. All the variables in the study play important roles in economic growth. This paper, therefore empirically analyses the contribution of income inequality, financial inclusion, investment, unemployment, on economic growth using secondary data spanning 2001-2022. Two-step system generalized method of moments (GMM) estimator is used to analyse the data extracted from the world development indicators (WDI). It was revealed that, income inequality and unemployment have a significant negative relationship with economic growth whilst financial inclusion and investment also have a significant positive relationship with economic growth. Also, financial technology, which is the moderator variable has significant relationship with economic growth. It was concluded that, policy makers should ensure equitable distribution of wealth, stabilize the economy, develop the skills of young entrepreneurs, and invest in financial technology to enhance economic growth in Africa.

Keywords: Income, Inequality, Investment, Unemployment, Economic-Growth, Financial-Inclusion
JEL Classifications: A1, E6, F3, F4

1. INTRODUCTION

Inflation is at its highest level in decades, and the worldwide economic downturn is much more severe than anyone had predicted. Russia's invasion of Ukraine and the continuing COVID-19 outbreak add further weight to the rising cost of living and worsening financial situations across most regions (Blinder, 2023; Topić, Pavković, and Šoja, 2023; Rabbi et al., 2023). The world economy is expected to develop at a slower clip of 3.2% in 2022 and 2.7% in 2023, down from a booming 6.0% in 2021 (Sheng and Potter, 2023). If the global financial crisis and the early stages of the COVID-19 pandemic are excluded, this is the poorest growth profile since 2001 (Gautam and Bhadra, 2023; Obayelu and Oyeyinka, 2021). It is predicted that the worldwide inflation rate will rise from 4.7% in 2021 to 8.8% in 2022, before levelling down to 6.5% in 2023 and 4.1% in 2024 (Drayton et al., 2022). Restoring price stability should be the primary goal of monetary policy, while lowering inflationary pressures and maintaining a fiscal stance consistent with this goal should be the focus of fiscal policy. The fight against inflation can be bolstered by structural improvements that boost productivity and ease supply constraints, while international cooperation is necessary to hasten the transition to green energy and prevent fragmentation (Benton et al., 2022). In present times, the global economy, politics, and the environment are all experiencing significant shifts, which have led to a period of uncertainty. Together with the diminishing financial support related to the COVID-19 epidemic, the multi-decade high rate of inflation has resulted in rapid monetary policy tightening and

increased strain on household budgets. Several countries with low incomes have serious budget problems. Russia's on going battles in Ukraine and tensions elsewhere have simultaneously raised the prospect of widespread global upheaval (Imran and Khan, 2023). Although the pandemic's effects have lessened in most countries, its aftershocks continue to dampen economic activity, especially in China (Wade, 2023; Parchimowicz and Spence, 2020; Ngo et al., 2022). Europe, central and southern Asia have seen intense heat waves and droughts, providing a look into a future made more hostile by global climate change. While there have been some contradicting indicators, recent data releases imply the global economy is in a broad-based slump as downside risks materialize, especially those mentioned in the Global Economic Outlook Update for July 2022 (Guénette et al., 2022).

In the second quarter of 2022, the world's real GDP shrank by 0.1 percentage points on an annualized basis, with negative growth in China, Russia, and the United States and sharp slowdowns in eastern European countries most directly affected by the war in Ukraine and international sanctions intended to pressure Russia to end hostilities (Tank and Ospanova, 2022; Lee, 2022; Astrov et al., 2022). Growth in the Euro Area surprised to the upside in the second quarter, led by economies in Southern Europe that rely heavily on tourism. This was the case despite the fact that some large economies did not shrink. A number of key economic indicators, such as new orders for manufactured products and attitude indices, point to a future decline (Aglietta and Khanniche, 2022; Andersen et al., 2022). But, in some cases, indications are inconsistent with one another, pointing to output contraction even as the labour market strengthens. The rapid withdrawal of monetary accommodation by a number of central banks in an effort to limit persistently rising inflation has been a significant factor supporting the slump in 2022 (Storm, 2022; Reis, 2022; Bonatti and Tamborini, 2022). The expected effect of rising interest rates and the resulting increase in borrowing costs, particularly mortgage rates, is reducing domestic demand, with the housing market displaying the earliest and most pronounced signs of slowdown in some advanced countries.

Generally, monetary policy tightening has been followed by a reduction in fiscal support, which had previously supported household disposable incomes (Bützer, 2023; Vollmer, 2022; Yiu, 2023). In broad terms, nominal policy rates are currently above pre-pandemic levels in both developed and emerging market economies, as well as in developing nations. Due to rising inflation, real interest rates have not yet returned to their pre-pandemic levels. The tightening financial conditions in most regions led to a significant real appreciation of the US dollar (Anas et al., 2022). This has also increased yield spreads, the gap between countries' US dollar or euro denominated government bond yields and US or German government bond yields, for debt-stricken low- and middle-income nations.

Africa's economic growth is projected to slow to 3.8% in 2023, down from 4.1% in 2022, as a result of declining investment and exports (Kurpayanidi, 2022; Hosein et al., 2023). In terms of sub-regional patterns in 2023, it is anticipated that growth will accelerate in West Africa, stable in Central and East Africa, and slow in North and Southern Africa. The continent has been impacted by a convergence of shocks, including decreased external demand, a rapid increase in global prices, increased borrowing rates, and severe weather conditions (Belaïd et al., 2023). They impede its complete recovery from the pandemic. Real output losses relative to pre-pandemic estimates continue to be substantial, with Africa's real output staying a full 2.4 percentage points below its pre-pandemic projections (Gatti, et al., 2022; Choi et al., 2022). In comparison, developed economies have recovered substantially from their output losses in 2020 (Atayah et al., 2022; González-Leonardo et al., 2022). Primarily as a result of supply chain interruptions and the aftermath from the conflict in Ukraine, the costs of key food goods and energy have risen dramatically in African nations (Guan, et al., 2023). Inflationary pressures were exacerbated by weaker national currencies compared to the dollar. Low and decreasing income per capita growth projected to decline to 1.4% in 2023 after averaging 1.6% in 2021 and 2022 will keep poverty entrenched on the continent and prevent governments from accelerating their progress towards the SDGs (Kenworthy et al., 2023; Robles and Wiese, 2023). Around two-thirds of African countries raised policy interest rates in 2022 to battle inflation and exchange rate pressure, while budgetary space remained tight to support economic growth and sustainable development. Sub-Saharan Africa (SSA) economic growth slowed to a projected 3.4% in 2022 due to declining external demand, high inflation, and tightening global financial conditions (Okwoche and Nikoladou, 2022). Due in part to the war in Ukraine, soaring food and energy costs caused dramatic cost-of-living raises throughout the area, resulting in millions more people sliding into food insecurity and poverty (Broadbent et al., 2023). The decline in global demand for non-energy commodities negatively impacted the region's exporters of industrial metals (Yang, 2022). In many nations, the fiscal headroom required to protect the poor has been drained, while rising borrowing costs and sluggish growth prospects have dramatically worsened debt dynamics. Prospects for a swift reversal of recent increases in poverty are dimmed by the regional picture for 2023-2024, which predicts only a moderate pick-up in growth and a slow rise in per capita incomes (Kincaid et al., 2023). The risks are predominantly negative. A more pronounced weakness in major economies, further increases in global interest rates, higher and persistent inflation, fragility, and an increase in the frequency and severity of adverse weather events could further slow growth in the region, exacerbate poverty, and cause debt distress in some nations (Baldwin and Freeman, 2022; Wampler and Touchton, 2023).

Income inequality leads to a widening gap in the availability of basic necessities and a reduction in the number of people who can break out of the trap of poverty. The gap between the rich and poor in terms of education and health care is still very large in many African countries (Abubakar et al., 2022). Children from low-income families are disproportionately affected by poverty, including higher rates of hunger, lower rates of health care utilization, and lower rates of primary school graduation (Abrams et al., 2022). Poor children under the age of five are 2.1 times more likely to be underweight and 1.6 times less likely to be measles-vaccinated than their richer peers. The number of undernourished children in Africa has doubled since 1990, from 24 million to 30

million (Saavedra, 2022; Sharrow, et al., 2022). Because their brains have not fully developed, children who are stunted have a greater chance of having trouble learning and performing in class. The Bank should promote inclusive growth since it can lead to broader participation in economic development and help narrow income gaps. The new Human Development Strategy of the African Development Bank emphasizes the importance of inclusive growth in a time of rising inequalities in the wake of the Arab Spring and elsewhere in Southern Africa (Alemayehu, 2022; Santus and Ansaloni, 2023). Achieving value for money and accountability in service delivery by fighting corruption and promoting voice in decision-making; increasing inclusion and social cohesion by promoting safe and welcoming spaces for all; and reducing income inequality are all key components of this strategy (Dan-Ogosi, 2023; Buhalis, et al., 2023). Broadly speaking, the AfDB will incorporate this inclusive growth aim within its Long Term Plan in order to bring the RMC's attention to the need to take measures to reduce income disparity.

Shah, Stoler, and Young (2023) found that the results of the bivariate causal model indicate a significant positive correlation between financial inclusion, economic growth, poverty, and income inequality in Indonesia. Nsor-Ambala and Amewu (2023) investigated financial innovation and economic growth in Ghana using a non-linear auto regressive distributed lag (ARDL) time series model and found that financial inclusion has no effect on economic growth. This could be due to the strict regulation of the financial technology sector and the general lack of evidence regarding the effect of financial development on economic growth. Similarly, studies conducted by Jungo et al. (2023) on the effect of financial inclusion on the unemployment rate in developing nations found that financial inclusion had an effect on lowering the unemployment rate in developing countries. Ma et al. (2023) evaluated the influence of financial inclusion on poverty, inequality, household expenditure, and unemployment and found a positive correlation between the variables. Sub-Saharan Africa has a positive correlation between financial inclusion and economic inequality, according to Huang et al. (2023). Notwithstanding the existing literature on the subject, little study has been conducted on the effects of income inequality on financial inclusion, investment, unemployment, and the economy in Africa, with the function of financial technology as a moderator. In addition, the vast majority of research on income inequality and economic growth was conducted in the pre-pandemic era, so this study uses contemporary data to test the hypothesis regarding the impact of income inequality on financial inclusion, investment, unemployment, and economic growth in Africa, moderated by financial technology. The remainder of the report is structured as follows: The second section (2) examines theoretical and empirical literature. In section three, the technique and data sources are discussed. Part four contains analysis and discussion of outcomes; the fifth section (5) provides findings, recommendations, and suggestions for future research.

2. LITERATURE REVIEW

Keynesian macro monetary and fiscal policies, implemented after World War II ended in 1945, are widely credited for stimulating economic growth throughout the 1950s and 1960s. The Phillips curve was first introduced to show that mild inflation was all that was needed to keep unemployment at a manageable level (Horváth and Magda, 2017). Financial and social activities like money and banking, organized securities, foreign exchange markets, large corporations, holding companies, business associations, organized labour, are all examples of areas where neoclassical economic theory has attempted to approach Keynesian economics by developing the theory of expectations and the real business cycle. Since its inception in the 1870s, neoclassical economics has provided the framework, emphasizing instead of the qualitative mechanisms inherent to technological transformation, the choice of behaviour in analysing the statistics model's special perspective on the quantitative processes of response (Masoud, 2014; Sarkar, 1998; Kuznets, 1955). Yet, the technological revolution in the decades after World War II moved away from a static quantitative paradigm and toward one that increased factor inputs, as indicated by the rate of economic expansion (Atkeson and Kehoe, 2007; Perez, 1983).

Assuming a constant return to scale, which returns to each input labour and capital, and a smooth elasticity of the connection between the inputs, this framework is based on the neoclassical model of production of rising consumption as a function of the increasing stock of knowledge (Azariadis, 1996; Hulten, 2001). For instance, in his learning-by-doing model, Nerlove and Arrow (1962) stated that the cumulative effect of increased investment in the sector would lead to better new equipment and higher productivity as a result of the discovery of new information. Arrow's model, however, suggested that any model with rising rates of return could face two problems. Learning by doing using, economies of scale, and the principle of division of labour are three examples of technological progress that (Smith, Strahan, and Cadell, 1776) cites as factors in a nation's prosperity. In addition, many studies Conrad and Hedin (1982) have found that experiential learning has expanded the gap between high- and low-income countries. As a result, the quantity and quality of assets like knowledge and human capital, as well as outcomes like yield, were all improved through hands-on experience.

There have been a number of empirical studies that have looked at how income inequality affects economic growth, and they have yielded mixed findings. Income inequality has been linked to slower or faster growth in some studies, depending on the quality of the research as well as other factors like the starting income level of the country (Levin and Bigsten, 2000). A bigger income gap has been linked to lower rates of economic growth by numerous researchers (Perotti, 1996; Wahiba and Mahmoudi, 2023; Raihan, 2023). Using a simple endogenous growth model, Arbia (2023), and Bechlioulis et al. (2023) investigated the connection between politics and economic growth, and they found that more inequality in land and income ownership is inversely connected to economic growth. Talan et al. (2023) analysed data on inequality and discovered a large and significant negative correlation between inequality and economic growth in democracies. This study used panel vector autoregressive (VAR) models and annual data on income inequality at the US state level to show that changes in the Gini index have a sizable and detrimental influence on per

capita income (Zhang and Zhang, 2021; Ilyas and Banaras, 2023). The study also found that the correlation between inequality and GDP per capita has changed throughout time. Using data from OECD countries Raza et al. (2023) found evidence of a positive correlation between income inequality and economic expansion. There is no inconsistency between Galor and Zeira (1993) theory and this narrative. Contrary to the conclusions of Bai et al. (2023) found that income disparity is positively and in most cases strongly connected with economic growth. Using a more comprehensive data set on income inequality, Ali (2023) and Piao et al. (2023) revaluated the association between income disparity and economic growth and found a robust positive correlation between an increase in income inequality and subsequent economic growth in the short and medium term. Peña Proaño, and Schnellbacher (2023) used a cross-country analysis of the impact of income inequality on economic growth in India and found that inequality actually had a large, positive impact on state economies. Using state-level data Androniceanu and Georgescu (2023) examined the dynamic relationship between income inequality and economic growth and found that inequality shocks result in higher economic growth, lending credence to the idea that higher inequality is beneficial to economic growth in low-income nations.

Financial inclusion has received little attention from empirical researchers, despite the fact that policymakers in many countries pay considerable attention to the effects of financial inclusion on the economy (Yao et al., 2022). This is why there hasn't been a lot of research done in the field. Yet, certain panel and cross-sectional studies have advocated that financial inclusion promotes economic growth, suggesting that financial inclusion acts as a growth driver. Many different statistical techniques, including the Generalized Method of Moments (GMM), autoregressive distributed lags (ARDL), vector autoregression (VAR), and ordinary least squares (OLS), were employed in these studies to establish the positive effect of financial inclusion on economic growth (Castillo et al., 2022). The research shows that a strong and well-organized financial system structure is a key driver of economic expansion. A literature overview is presented, with data drawn from both cross-sectional and panel studies. In order to determine if access to financial services boosts economic growth, Ozturk and Ullah (2022) used the generalized estimating equations approach on data from 44 African countries and revealed that there is a significant relationship between access to finance and economic growth. The findings backed up the significance of the effect in fostering expansion. The results also show that a strong banking sector helps in economic expansion (Bakay, 2022). In a similar vein, Ozili et al. (2022) used the same method to assess SSA countries and found that commercial bank branches is a useful indicator of the effect of financial inclusion on economic growth for some countries. A further analysis showed that boosting people's access to financial resources has a positive impact on economic development in the area (Tang and Sun, 2022; Mohsin et al., 2022). Financial inclusion is positively correlated with growth for OIC countries, according to recent research by Mukalayi and Inglesi-Lotz (2023). Furthermore, the study found that a high degree of financial inclusion is a necessary condition for economic expansion. To examine the effect of financial inclusion on economic growth Anthony-Orji et al. (2022) used commercial bank branches per 100,000 adults and ATMs per 100,000 adults as proxies for financial inclusion. The findings confirmed that both proxies had a positive effect on growth. A more recent study by Ansari (2022) and Saliba et al. (2022) used dynamic ordinary least square and fully modified ordinary least square to examine the connection between financial inclusions and economic growth for countries and found that it does, in fact, increase economic growth.

When countries invests in the necessary technological, institutional, and political improvements, it can enhance its economic output and so provide a wider range of goods and services to its citizens over time (Zhang et al., 2022; Rodrik, 2022; Teece, 2022). This phenomenon, which is defined by an increase in the supply of goods, is the result of economic expansion (Dokas, 2023). Several small countries are able to provide a growing income to their population because they have a resource minerals and location that can be exploited by more developed nations and creates a high and rising rent. Notwithstanding the fascinating analytical questions that these fortunate countries present, we are only interested in those countries who have built their prosperity on the backs of technological innovation and not on the backs of exploiting the natural resources of other countries (Geisler, 2022; Arslan et al., 2023; Hussain and Arslan, 2023). Whilst technological progress is the fundamental driver of economic growth, it is only a precondition for this process and not the cause. Institutional and ideological adjustments must be made to assist the right application of innovations generated by the expanding store of human knowledge if technology is to be employed successfully and universally, and if such usage is to promote its own growth (Yin and Yu, 2022; Hirai, 2022).

A correlation between rising unemployment and a flourishing economy was first noted by (Blacëri (2022) who found that if GDP grows rapidly, the unemployment rate drops; if growth is very low or negative, the unemployment rate rises; and if growth is at potential, the unemployment rate is stable. The majority of subsequent research has focused on testing the validity of Okun's law. Sinha (2022) and (Liu, 2022; Sassanelli and Terzi, 2023) examined the correlation between economic growth and unemployment in the G7 countries. Evidence from their study corroborated the consistency between Okun's law and the forecasts of expert economists regarding shifts in the unemployment rate and real GDP growth rate. They also found that the unemployment rate was proportional to the magnitude of the output gap. Sharif et al. (2022) found a similar inverse relationship between economic growth and unemployment for 20 Organisations for Economic Co-operation and Development (OECD) Countries. Rokhim (2023) looked into the connection between the urban unemployment problem and economic growth, with the inflation rate and investment added as random factors. Estimates suggest an inverse relationship between urban unemployment and growth in the economy.

3. METHODOLOGY

The research adopted quantitative methodology in the form of a survey employing convenience sampling technique; 42 African

countries were selected from a total of 54; and data was compiled from the world development indicators (WDI) spanning 2001-2022. Economic growth, income inequality, financial inclusion, investment, unemployment and financial technology are the primary variables of the study. Each of the variables has sub-variables; using factor analysis, the variables were reduced to factors by principal components analysis, and the residuals were forecasted to build an index for each of the primary variables for the purpose of estimation.

The System Generalized Method of Moments (GMM) estimator which is considered as part of a larger historical trend in econometric practice toward estimators that apply more complex methodologies to extract meaningful information while making fewer assumptions about the underlying data-generating process was used for the analysis. Declining processing and software delivery costs have aided this trend. The following data-generating process assumptions are built into the system GMM estimator that has been designed for panel analysis: Generalized Method of Moments is a dynamic estimator, with past realizations of the dependent variable influencing the present realizations, and for fixed individual impacts to be dispersed arbitrarily. A panel setup is preferred over a cross-sectional one because it allows for the identification of parameters via variation over time, some regressors may be endogenous, the idiosyncratic disturbances that make up the fixed effects may exhibit heteroskedasticity and serial correlation that are unique to each individual, and the idiosyncratic disturbances are uncorrelated across individuals. Using a two-stage GMM estimator method, the study investigated the connection between income inequality, financial inclusion, investment, unemployment, and economic growth. This research uses the GMM developed by Arellano and Bond (1991) to control for endogeneity. The GMM approach uses lagged regressors as instruments to get rid of unobserved country-specific fixed effects, leading to more reliable estimations. The asymptotic properties of the estimator may be jeopardized if the unobserved country-specific fixed effect is eliminated through differencing, even though in some cases this impact may be significant. Arellano and Bover (1995) presented system GMM; Blundell and Bond (1998) enhanced difference GMM by combining two systems of equations, a differenced equation and a level equation, to solve the weak instruments problem. Because each variable in the levels equation is instrumented with its own initial differences, more instruments can be obtained and used more effectively. The estimation accuracy of an equation is enhanced by combining the level and differenced forms of the equation, both of which contain moment conditions (Roodman, 2009) using first-differenced instruments for the levels variables in the GMM system relies on the principle that these instruments should not be connected to the unobserved country fixed effects. In developing the GMM system, the following momentary constraints were taken into consideration:

The analysis utilized a dynamic panel definition and system Generalized Methods of Moments (GMM) estimate method from (Beck et al., 2007; Beck et al., 2004). The dynamic panel regression model allows the researcher to add lags of the dependent variable as a predictor variable, as described below:

$$Y_{it} = \alpha Y_{it-1} + \beta X_{it} + \varepsilon_{it} \quad (1)$$

$$\varepsilon_{it} = \mu_t + \lambda_i$$

The Y_{it} represents the dependent variable for the model, Y_{it-1} is the lag of the dependent variable, whereby Y, X_{it}, represent a matrix of the dependent variable (1 × k), δ_0 is the unobserved country effect, α is the coefficient of the lag dependent variable, β is the coefficient of the explanatory variables including the control variables. The unobserved individual effect is denoted by λ_i, μ_t is the time effect, i is the number of variables or observations in the model. N represents the number of countries and T is the time. Ɛ denote the stochastic error term which is correlated with the lagged dependent variable (Y_{it-1}). The introduction of the lag dependent variable enables researchers to address autocorrelation difficulties. In order to ascertain the effect of income inequality, financial inclusion, investment, unemployment, on economic growth, the following models are specified:

$$Econs_{it} = \beta_1 Econs_{it-1} + \forall_2 Incineq_{it} + \partial_3 Fii_{it} + \varnothing_4 Invest_{it} + \ddagger_5 Unemp_{it} + \gamma_6 Unemp * F\,\text{int}\,ech_{it} + \varepsilon_{it} \quad (2)$$

$$Incineq_{it} = \beta_1 Incineq_{it} + \forall_2 Econs_{it} + \partial_3 Fii_{it} + \varnothing_4 Invest_{it} + \ddagger_5 Unemp_{it} + \varepsilon_{it} \quad (3)$$

$$Fii_{it} = \beta_1 Fii_{it-1} + \forall_2 Econs_{it} + \partial_3 Incineq_{it} + \varnothing_4 Invest_{it} + \ddagger_5 Unemp_{it} + \varepsilon_{it} \quad (4)$$

$$Invest_{it} = \beta_1 Invest_{it-1} + \forall_2 Econs_{it} + \partial_3 Fii_{it} + \varnothing_4 Incineq_{it} + \ddagger_5 Unemp_{it} + \varepsilon_{it} \quad (5)$$

$$Unemp_{it} = \beta_1 Unemp_{it-1} + \forall_2 Econs_{it} + \partial_3 Fii_{it} + \varnothing_4 Invest_{it} + \ddagger_5 Incineq_{it} + \varepsilon_{it} \quad (6)$$

Where $Econs_{it}$ represents economic growth, $Econs_{it-1}$ represents the lagged dependent variable, Fii_{it} denotes financial inclusion, $Invest_{it}$ also denotes investment, $Unemp_{it}$ stands for unemployment, $Fintech_{it}$ represents financial technology, also the interaction and represents income inequality in the model. Table 1 below indicates the description and measurement of variables including the source of the data used for the research.

4. RESULTS AND DISCUSSION

The discussion offers an explanation of the results, places them into context, and elucidates the significance of the findings. When presenting qualitative research findings, it is common practice to do so concurrently with the analysis of those findings. In spite of this, it is generally agreed upon that, when conducting quantitative research, you should maintain your individual interpretation of the data separate from the data itself and not combine the two. Below is the results and discussion section that explains the various results and discussion.

There are 420 observations across the data points with no missing values for any of the variables. The mean value for econs is

Table 1: Variable measurement matrix

Variable	Measurement and definition	Data Source	Notation
Economic growth	(i) GDP growth (annual%), (ii) imports of goods and services, (iii) export of goods and services, (iv) manufacturing value added (annual% growth)	World Development Indicators (WDI)	ECONS (GDPgrowth, import, export, manuvalue)
Income inequality	(i) Income share held by highest 10%, (ii) Logistics performance index: quality of trade and trade and transportation-related infrastructure (1=low to 5=high), (iii) Annualized average growth rate in per capita real survey mean consumption or income, bottom 40% of population (%), (iv) Adjusted net national income per capita (constant 2015 US$)	WDI	INCINEQ (income, logistic, percapita, Adjincome)
Financial inclusion	(i) Account ownership at financial institution or with a mobile-money-service provider (%of population ages 15+), (ii) Average transaction cost of sending remittances to a specific country (%), (iii) Automated teller machines (ATM per 100000 adults), (iv) Commercial banks branches (per 100000 adults)	WDI	FII (acctown, Avetrcost, ATM, Cbank)
Investment	(i) Firms using banks to finance investment (% of GDP), (ii) Foreign direct investment, net outflows (% of GDP), (iii) Net investment in nonfinancial assets (% of GDP), (iv) Portfolio investment, net (BOP, current US$)	WDI	INVEST (firm, foreign, assets, portfolio)
Unemployment	(i) Unemployment with basic education (% of total labour force with basic education), (ii) Unemployment with advanced education (% of total labour force with advanced education), (iii) Unemployment with intermediate education (% of total labour force with intermediate education), (iv) Unemployment, total (% of total labour force, national estimate)	WDI	UNEMP
Financial technology	(i) Made a digital in-store merchant payment: using a mobile phone (% age 15+), (ii) Made a digital in-store merchant payment: using a mobile phone, rural (% age 15+), (iii) Made a digital online merchant payment for an online purchase (% age 15+), (iv) Made a digital payment, rural (% age 15+)	Global Financial inclusion Database	FINTECH

2.29, the standard deviation from the sample mean is 0.60, and the lowest and highest values in the series are 1.39 and 3.76, respectively. The skewness among the observations in the series is 0.13, which measures the degree of asymmetry. The value 0.13 indicates that the data is normal, as the value for normality is zero. The data for econs resembles a normal distribution because the skewness value is 0.13 and the kurtosis value is 1.59. For data to be normally distributed the kurtosis threshold should be three, so at 1.59 it indicates that there are more lower values below the threshold. In addition, income inequality has a mean of 2.65 and a standard deviation of 0.77, indicating the spread of the data from the mean; the minimum and maximum values are 1.03 and 4.49, respectively; the degree of asymmetry of 0.02 reflects a normal distribution with a platykurtic kurtosis value of 1.70, standard deviation of 0.65, minimum value of 0.66, maximum value of 3.96, skewness value of 0.27. Financial inclusion has a mean value of 2.75, a standard deviation of 1.21, and a skewness of 1.09, indicating that its values are not normally distributed. The series' kurtosis value is 3.09, which is greater than 3, suggesting that the data is leptokurtic and have a higher value. The mean and standard deviation for investment and financial technology are 13.39 and 11.95, respectively, while the skewness and kurtosis for the two series all correspond to a normal distribution and platykurtic, flattened-curve and lower values.

Each pair of variables' linearity is represented by a numeric value in the correlation matrix. Values of the correlation can fluctuate between −1 and 1. When the two variables tend to rise and fall together, the correlation value is positive. According to Table 3, there is a negative association between income inequality and economic growth of −0.396. There is a connection of 0.335 between unemployment and economic growth, and a correlation of −0.533 between unemployment and income inequality. Financial inclusion has a 0.027 positive association with economic growth, a 0.335 negative link with unemployment, and a −0.533 negative correlation with income inequality. Hence, there is a strong positive relationship between unemployment and financial inclusion. Moreover, investment has a positive connection of 0.193 with economic growth, a negative correlation of −0.517 with income inequality, a positive correlation of 0.717 with unemployment, and a positive correlation of 0.371 with financial inclusion. The association between financial technology and economic growth, unemployment, financial inclusion, and investment, is favourable; however the relationship between financial technology and income inequality is negative. Overall, the correlation matrix value indicates the absence of multicollinearity in the dataset.

Significant economic growth lag indicates that the present value of economic growth is dependent on previous values. So, the present value of economic growth depends on the performance of the economic growth values of the previous time. There is also a considerable negative association between economic growth and income inequality. In the early phases of development, when physical capital returns are higher than human capital returns, inequality is favourable for economic growth. At the final stages of development, inequality inhibits economic growth as a result of credit constraints, as the value of human capital rises. Wang et al. (2023) in recent years, the examined relationship between economic development and income inequality has increased in nearly every region of the world. It is also true that the level of inequality varies

Table 2: Descriptive statistics matrix

Variables	Obs	Mean	SD	Min	Max	p1	p99	Skew	Kurt
econs	420	2.290	0.600	1.390	3.7600	1.430	3.4100	0.130	1.590
gdpgrowth	420	2.392	0.699	1.490	3.860	1.530	3.510	0.230	1.690
import	420	1.22	0.346	0.330	3.800	0.610	4.240	0.473	2.600
export	420	4.180	4.671	0.450	23.730	0.450	20.190	1.744	5.423
manuvalue	420	6.103	3.808	2.720	18.110	2.770	16.850	1.737	4.928
incineq	420	2.65	0.77	1.03	4.49	1.27	4.16	-0.02	2.10
income	420	2.897	0.982	1.200	6.620	1.280	6.060	1.023	4.814
logistic	420	2.096	1.256	0.780	7.000	0.800	5.410	0.925	3.290
percapita	420	1.400	0.542	0.620	4.050	0.420	2.560	0.567	3.477
adjincome	420	1.738	1.151	0.490	6.880	0.610	4.940	1.179	4.261
unemp	420	1.70	0.65	0.66	3.96	0.71	3.24	0.27	2.59
fii	420	2.75	1.21	1.38	6.81	1.40	5.84	1.09	3.09
acctown	420	2.292	0.599	1.390	3.760	1.430	3.410	0.131	1.592
avetracost	420	1.215	0.528	0.430	3.560	0.580	2.670	0.969	3.728
atm	420	2.653	0.774	1.030	4.490	1.270	4.160	-0.024	2.099
cbank	420	1.703	0.646	0.660	3.960	0.710	3.240	0.273	2.588
invest	420	13.17	11.65	1.21	40.75	1.21	39.75	0.61	2.21
firms	420	1.350	0.442	0.720	3.080	0.720	2.860	0.967	4.477
foreign	420	2.453	0.554	0.930	3.690	1.570	5.160	1.024	2.999
assets	420	2.392	0.400	1.490	3.560	1.230	3.310	0.131	1.792
portfolio	420	13.167	11.654	1.210	40.750	1.210	39.750	0.605	2.208
fintech	420	13.39	11.95	1.21	42.00	1.21	40.15	0.63	2.25

Author's computation, 2023

across countries with various income levels, but the two factors are not associated (Pulicherla and Adapa, 2022). Income inequality drives fertility rates and indirectly affects human capital investment and economic growth negatively, according to the differential fertility method. It is anticipated that countries with high fertility rates will experience a drop in economic growth due to declining per capita (Angus and Jhally, 2022). Educational level also helps to explain the association between economic growth and fertility rate. While low-income families have more children and invest less in education, wealthy families will experience the opposite. Thus, it is argued that countries with significant income inequality will have slower economic growth as a result of rising fertility rates (Kosashunhanan, 2023; Sun, 2023; Zhao and Shen, 2023).

On the other hand, there is a positive correlation between economic growth and financial inclusion, such that as financial inclusion increases, so does economic growth. When consumers continue to acquire access to financial services and goods, they become more likely to invest in the economy as they spend or utilize their financial products, hence fostering economic expansion. Financial inclusion also promotes economic growth via capital accumulation and technological advancement by increasing the savings rate, mobilizing and pooling savings, producing investment information, facilitating and encouraging the inflow of foreign capital, and optimizing the allocation of capital. Financial inclusion has a beneficial association with economic growth in both the short and long run, according to Wang and Ning, 2023. In addition, they demonstrated a unidirectional association between financial inclusion and economic growth. Ullah et al. (2022) discovered a negative correlation between financial inclusion and economic growth, indicating that financial inclusion has negative effects on growth and that there is a statistically significant causal link between the two variables. Similarly, Iorember and Usman (2022) found that digital financial inclusion has a considerable positive impact on the economic growth of countries. Economic growth has

Table 3: Pairwise correlations Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) econs	1.000					
(2) incineq	−0.396*	1.000				
(3) Unemp	0.335*	−0.533*	1.000			
(4) FII	0.027	−0.324*	0.250*	1.000		
(5) invest	0.193*	−0.517*	0.717*	0.371*	1.000	
(6) fintech	0.190*	−0.515*	0.715*	0.371*	1.000*	1.000

*shows significance at P<0.01, Author's Computation, 2023

a positive link with investment, investment increases the stock of capital, and the quantity of capital determines the productivity of an economy. Hence, investment contributes to economic expansion. Investment promotes economic growth because it is a component of aggregate demand and, more crucially, because it affects the capacity for economic output. Hence, a rise in investment should stimulate economic growth in Africa.

Investing can also have a multiplier effect on the economy, particularly where excess capacity exists. The initial increase in investment boosts economic growth, but enterprises that have increased sales and profits may be prepared to reinvest the profit (Wesseling and Kieft, 2022). Also, households that get jobs as a result of investment will have higher disposable income. According to the findings in table 4, there is a positive correlation between economic growth and financial technology, indicating that technology plays a significant influence in economic progress. The most essential factor that determines the rate of economic growth is technological progress. It is more significant than capital formation. It is technological advancement that can result in a sustained rise in output per person (Fang et al., 2022). Hence, it is an economic prime mover. Technological transformation refers to the development of new and enhanced production techniques. Hence, technological advancement is a production factor. Unal and Aysan (2022) who analysed the most influential

Table 4: Measuring the effect of income inequality, financial inclusion, investment, unemployment, and economic group in Africa

Variation	(1)	(2)	(3)	(4)	(5)
	Econs	Incineq	Fii	Invest	Unemp
L. econs	0.0815***				
	(0.12)				
econs		−0.0749***	0.132***	0.204***	
		(−0.83)	(1.03)	(0.54)	
Unemp	−0.0262***	−0.000845***	−0.0112***	−0.0564***	
	(−0.11)	(−0.17)	(−0.29)	(−1.45)	
Fii	2.885***	0.109***		0.568***	22.71***
	(0.35)	(0.10)		(0.34)	(1.46)
invest	0.339***	0.0391***	0.0781***		0.313***
	(0.67)	(0.59)	(1.43)		(0.39)
fintech	2.180***	0.126***	0.115***	0.762***	
	(0.48)	(0.52)	(0.38)	(0.78)	
gdpgrowth	0.345**	0.0304***	0.0875**	0.0122*	0.810***
	(0.55)	(0.35)	(1.58)	(0.07)	(3.55)
import	1.511**	0.124***	0.335***	0.0770**	2.247***
	(0.70)	(0.38)	(1.50)	(0.11)	(1.41)
export	0.0915**	0.00662***	0.0236	0.0196	0.0857
	(0.52)	(0.25)	(1.54)	(0.40)	(0.98)
manuvalue	0.226	0.0408	0.0358	0.0573	1.436
	(0.94)	(1.32)	(1.02)	(0.65)	(1.93)
incineq	−2.260***		−0.392***	−0.777	−2.300
	(−0.91)		(−1.04)	(−0.89)	(−0.56)
income	0.0440	0.0309	0.00728	0.0224***	1.286***
	(0.31)	(1.34)	(0.41)	(0.60)	(1.55)
logistic	3.926***	0.295	0.979	0.437	2.624
	(0.56)	(0.29)	(1.52)	(0.22)	(0.88)
percapita	0.158	0.00107	0.0410***	0.00548	0.818
	(0.50)	(0.02)	(1.50)	(0.06)	(1.25)
adjincome	6.950	0.566	1.692	0.582***	
	(0.59)	(0.33)	(1.54)	(0.17)	
acctown	0.756***	0.0284	0.189	0.0711	2.806
	(0.56)	(0.14)	(1.45)	(0.18)	(1.36)
avetracost	1.732***	0.0456***	0.478***	0.391***	4.847***
	(0.46)	(0.09)	(1.76)	(0.40)	(1.09)
atm	0.0181***	0.0137	0.0109***	0.122	0.837
	(0.11)	(0.44)	(0.44)	(1.81)	(0.50)
cbank	2.211***	0.0186***	0.581***	0.297	2.656
	(0.50)	(0.03)	(1.61)	(0.25)	(0.55)
firms	0.255***	0.0519***	0.0883	0.291	0.322
	(0.24)	(0.43)	(1.46)	(1.25)	(0.33)
foreign	0.103**	0.0323	0.0103***	0.0777**	4.012*
	(1.07)	(0.86)	(0.31)	(1.04)	(−2.50)
assets	0.0267***	0.000502***	0.0108*	0.0125	0.0174
	(0.23)	(0.03)	(2.09)	(0.63)	(0.11)
portfolio	2.150***	0.138***	0.0832***	0.865***	1.953***
	(0.44)	(0.49)	(0.26)	(0.87)	(1.06)
L.incineq		−0.698***			
		(−1.59)			
L.fii			0.0870***		
			(0.18)		
L.invest				0.850***	
				(6.27)	
L.unemp					−1.582***
					(−3.76)
_cons	3.424	0.735	0.489	2.270	
	(0.57)	(0.89)	(0.62)	(1.71)	
N	378	378	378	378	378
AR2	0.58	0.29	0.47	0.54	0.78
Sargan	0.57	0.67	0.89	0.78	0.51
Hansen J	0.29	0.23	0.76	0.65	0.34
No of instr	24	27	27	27	27
No of groups	42	42	42	42	42
Prob >chi2	0.000	0.000	0.000	0.000	0.000

Author's computation, 2023

Table 5: The moderating effect of financial technology on income inequality, financial inclusion, investment, unemployment, and economic growth in Africa

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Econs	Econs	Econs	Econs	Econs	Econs
L. econs	0.253***	0.102***	0.0839***	0.304***	0.373***	7.673***
	(0.34)	(0.12)	(0.07)	(0.21)	(0.51)	(0.32)
Unemp	−0.0471***	−0.036***	−0.0793***	−0.0169***	−0.002***	−1.253***
	(−0.02)	(−0.16)	(−0.29)	(−0.07)	(−0.11)	(−0.23)
fii	2.665***	4.874***	5.635	0.603*	1.840**	1.514
	(0.30)	(0.42)	(0.60)	(0.25)	(0.42)	(0.02)
invest	0.372	0.498	0.564***	0.00161***	0.102*	7.091
	(0.67)	(0.66)	(0.72)	(0.01)	(0.24)	(0.07)
fintech	1.188***	0.601***	0.0652***		2.797***	4.292***
	(0.75)	(0.16)	(0.01)		(1.26)	(0.01)
gdpgrowth	0.374*	0.550***	0.614**	0.0365	0.230	2.304
	(0.54)	(0.54)	(0.68)	(0.40)	(0.79)	(0.04)
import	1.461**	2.043	2.395***	0.249**	0.882**	2.912
	(0.66)	(0.67)	(0.76)	(0.57)	(0.83)	(0.51)
export	0.0971***	0.156	0.169	0.0129	0.0578	3.932
	(0.50)	(0.48)	(0.66)	(0.40)	(0.74)	(0.03)
manuvalue	0.230	0.256***	0.283	0.103	0.148***	9.487
	(1.04)	(1.06)	(0.88)	(0.39)	(0.78)	(0.31)
incineq	-2.240	-2.568***	-2.962	-0.872***	-1.488	-4.931***
	(-1.06)	(-1.13)	(-0.86)	(-0.36)	(-1.01)	(-0.34)
income	0.0553	0.0988	0.0290***	0.00661	0.0307	2.829
	(0.40)	(0.34)	(0.30)	(0.05)	(0.20)	(0.06)
logistic	4.119	6.491***	6.915**	0.246	2.868	2.517
	(0.54)	(0.50)	(0.68)	(0.48)	(0.81)	(0.02)
percapita	0.166***	0.228**	0.298**	0.0236	0.0939*	5.954
	(0.47)	(0.62)	(0.67)	(0.32)	(0.66)	(0.08)
adjincome	7.086	11.02	11.95***		4.567**	1.341
	(0.56)	(0.52)	(0.70)		(0.80)	(0.43)
acctown	0.760	1.000	1.362***	0.0423	0.329***	6.458
	(0.52)	(0.69)	(0.70)	(0.15)	(0.45)	(0.11)
avetracost	1.694**	2.150	3.270**	0.248**	0.419**	1.231
	(0.42)	(0.67)	(0.67)	(0.16)	(0.16)	(0.33)
atm	0.0140**	0.0104**	0.0118	0.0208*	0.0179	1.743*
	(0.09)	(0.04)	(0.08)	(0.14)	(0.13)	(0.54)
cbank	2.194*	2.794	4.137***	0.178	0.947	5.194
	(0.45)	(0.69)	(0.69)	(0.14)	(0.39)	(0.32)
firms	0.132*	0.170***	0.596	0.00453	0.282	2.162
	(0.11)	(0.08)	(0.57)	(0.01)	(0.22)	(0.55)
foreign	0.0740**	0.0815	0.147	0.110***	0.0870	6.093***
	(0.55)	(0.73)	(0.78)	(0.46)	(0.66)	(0.51)
assets	0.0281*	0.0456	0.0695**	0.0233***	0.00688	3.301**
	(0.22)	(0.41)	(0.53)	(0.35)	(0.11)	(0.23)
portfolio	1.156***	0.815***	0.159***	0.121***	3.131	4.765
	(0.61)	(0.28)	(0.03)	(0.17)	(1.03)	(0.31)
fintech*gdpgrowth	0.00352***					
	(0.24)					
Fintech*incineq		-0.148***				
		(-0.19)				
fintech*unemp			-0.0263***			
			(-0.34)			
fintech*fii				0.0389***		
				(0.13)		
fintech*invest					0.0888***	
					(0.36)	
fintech*econs						2.20***
						(0.47)
_cons	3.940***	3.893***	3.694***	1.139***	1.750***	6.712***
	(0.67)	(0.83)	(0.73)	(0.22)	(0.40)	(0.23)
N	378	378	378	378	378	378
AR2	0.56	0.63	0.49	0.67	0.41	0.37
Sargan	0.54	0.81	0.71	0.77	0.65	0.43
Hansen	0.25	0.65	0.54	0.50	0.48	0.25
No of Instr	27	27	27	27	27	27
No of Group	42	42	42	42	42	42
Prob >chi2	0.000	0.000	0.000	0.000	0.000	0.000

Author's computation, 2023

articles on the Islamic financial technology model reported that the most cited recent literature focuses on the block chain, bit coin, artificial intelligence, and Islamic financial technology model, as well as the challenges for Islamic finance and banking in the post-Covid-19 era. This assumption was supported by Ifediora et al. (2022) who discovered that financial technology penetration increases financial growth in nations with limited financial access and a low financial development index. These findings indicate that, despite inadequate financial infrastructure and weak financial performance, the financial development of developing nations and countries with emerging market economies can be enhanced through the implementation of policies that encourage innovation in financial technology.

Table 5 evaluates the moderating effect of financial technology on income inequality, financial inclusion, investment, unemployment, and economic growth in Africa. Financial technology is shown to have a significant correlation with income inequality. Jobs that need manual labour are being eliminated because of technological progress. Both technological progress and income inequality have been significantly altered by the advent of artificial intelligence. Financial services and currency are becoming increasingly digitized, which paves the door for the expansion of financial opportunities to more people and greater efficiency in the financial sector (Puxin, 2023). Rapid advancements in financial technology are transforming the financial industry and blurring the lines between financial institutions. Mathrani et al. (2022) report that in the developing world, eight out of ten people have access to a mobile phone, and that more homes have access to mobile phones than to either electricity or clean water. The increased employment and income opportunities created by financial technology benefit the poor most. They also improve government services and revenue collection while reducing corruption (Martínez et al. 2022). Using data from a panel of 49 countries in sub-Saharan Africa, Awad and Albaity (2022) discovered that higher rates of mobile internet and broadband adoption are associated with more inclusive growth.

As can be shown in Table 4, there is a robust correlation between financial technology and unemployment. According to the data, financial technology has a remarkably beneficial effect on the unemployment rate, and the more developed financial technology is, the lower the unemployment rate in this framework, the relationship between financial technology and financial inclusion is also fundamental (Franz, 2022). Financial technology's larger goal is to satisfy the monetary needs of these conventional financial service categories (Basu and Miroshnik, 2023). As a result, the point of financial technology is to aid in the achievement of the overarching goal of financial inclusion. In contrast to the findings of Charfeddine and Zaouali (2022) who showed that financial inclusion had no influence on financial inclusion, this is in line with earlier studies suggesting that financial technology had a positive effect on financial inclusion. Further, the regression analysis shows a strong positive relationship between population and financial inclusion.

The results indicate a positive link between financial technology and investment in the African continent. Over the past two decades, financial technology has reduced the percentage of the world's population without access to banking services by 35%, from 1.2 billion people (Charfeddinei, 2022; Noor and Ayaz, 2023). More people and businesses will have access to financial resources including savings accounts, government benefits, credit, and loans, and commercial and employment opportunities, if financial inclusion is improved. Yet, a shortage of capital is a major challenge for African businesses, alongside unclear regulations. Financial technology has emerged as a growth driver, reshaping not only the financial services value chain but also fostering financial inclusion and igniting progress in critical industries like agriculture and infrastructure (Rodriguez, 2023). Increasing financial inclusion has benefited large swaths of the population, so significantly contributing to economic growth in Africa, where the number of mobile money accounts has just surpassed that of bank accounts on the continent.

5. CONCLUSION AND POLICY IMPLICATIONS

The study examined the relationship between income inequality, financial inclusion, investment, unemployment, and economic growth in Africa, with financial technology playing a moderating effect. According to the evidence, there is a considerable negative association between income inequality and economic growth, and at low income levels, inequality tends to stimulate economic growth through increasing physical capital investment. When income levels rise, human capital overtakes physical capital in importance, and inequality tends to limit economic growth by impeding the accumulation of human capital. High levels of income inequality are associated with economic instability, financial crises, debt, and inflation in societies with less equality. There is also a substantial relationship between financial inclusion and economic growth in Africa; a rise in financial inclusion leads to capital accumulations, which in turn boosts economic growth and investment, which is an efficient method to put money to work and potentially produce wealth. The larger growth potential of investments is primarily attributable to the power of compounding and the trade-off between risk and return. In addition, it was shown that unemployment has a substantial association with economic growth; a high unemployment rate has an effect on economic growth. Unemployed folks tend to spend less and may incur more debt, which may result in increased state payments for certain essentials. As fewer people are employed, businesses will create less goods and services. As a result, economic output of goods and services will decrease. This will also have a detrimental effect on government revenue and spending, and their budget. The government should adopt a policy that expands access to credit, enacts anti-discrimination laws, and subsidize health and education in order to promote income equality and boost economic growth in Africa. To increase financial inclusion and economic progress in Africa, policymakers should also focus on removing obstacles to obtaining loans, promoting financial technology, and enhancing digital literacy.

In order to increase investment in the economy, policymakers in Africa should offer tax breaks to domestic firms and start-ups. The stabilization of the African economy will encourage

investment and boost economic growth. To contribute to economic growth and poverty alleviation in Africa, policymakers may consider implementing youth development programs that teaches unemployed youth technical, business, and entrepreneurial skills and provides them with funding to launch their own firms. Future research should concentrate on the influence of financial technology on poverty alleviation and economic progress in Africa from a country-by-country perspective, given that each African nation has its own economic strengths and shortcomings. Future studies may also investigate the repercussions of digital financial strategy on the financial sector.

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