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A Dynamic Panel and Quantile Approach to the Financial Innovation-Economic Growth Nexus in Sub-Sahara Africa

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Abstract
This study examines the impact of financial innovation on economic growth of 15 selected countries of Sub-Saharan Africa (SSA) countries from 2003 to 2022. According to the findings of the Pooled Mean Group (MG) result, financial innovation enhances economic growth in SA countries. Then, the outcome of the panel quantile regression shows that the positive impact of financial innovation on growth differs at different quantile with higher impact at the higher quantile than the lower quantile. The study suggests that SSA countries should consider financial innovation as a crucial factor for a sustainable economic growth.
Keywords: Financial Innovation, Growth, Panel data, Quantile, and Sub-Saharan Africa.

1. Introduction and literature Review

1.1 Introduction

Numerous empirical studies have examined and documented the links between economic growth and the growth of the financial sector in great length. The financial sector influences the pursuit of ongoing financial innovation in the financial system and makes a significant contribution to the economic growth of both developed and emerging economies, according to Arestis and Demetriades (1997) and Demetriades and Luintel (1996). Moreover, financial innovation opens doors for the financial sector to flourish, which accelerates growth in the economy. By developing new financial institutions, financial instruments, financial reporting, technology, and market information, financial innovation also makes financial services more widely available (Michalopoulos et al. 2009). According to Merton (1992) and Tufano (2003), financial innovation reacts to asymmetric knowledge as well as market possibilities and problems.

The financial innovation fragility perspective, in contrast to traditional approach, emphasizes the murky side of financial innovation. Financial innovation, in particular, is regarded to be a causal component that may contribute to a financial crisis since it expands credit opportunities and risk, which catalysed the economy's boom and bust (Yinusa et al., 2021). Although scholars from both wealthy and developing countries like Attanasio et al. (2002), Yinusa et al. (2021), and Lippi and Secchi (2009), have found a connection between financial innovation and economic growth, very few have examined this relationship in countries in Sub-Saharan Africa (SSA). Despite significant financial innovation in SSA, notably in the recent decade, this remains the case. Among those who focus on SSA countries, the majority employ individual countries or a micro panel analysis, which has drawbacks as compared to a macro panel analysis. Furthermore, despite the fact that the majority of economic data is not normally distributed, these studies primarily focus on determining the mean consequence of the financial innovation-economic growth nexus

Analysing whether financial innovation may boost economic growth in SSA countries and how the effects of innovation growth change at different quantiles is crucial since financial innovation has the capacity to affect economic growth. Consequently, the objective of this study is to examine the impact of financial

innovation on economic growth in selected SSA countries and assess its distribution effects at various quantiles. After the introduction, this work is structured into four sections. A review of the literature is included in the second section. The methodology is covered in part three; the results and discussion are covered in section four; and the conclusion is covered in section five.

1.2 Literature Review

Conceptual review

Economic growth involves sustained increase in productivity. A rise in national income per capita is known as economic growth. This process is analyzed, particularly in quantitative terms, with an emphasis on the functional relationships between the endogenous variables. In a broader sense, according to Haller (2012) economic growth refers to an increase in Gross Domestic Product, and National Income, which in turn increases national wealth and includes the production capacity, expressed in both absolute and relative size, per capita, as well as structural changes to the economy. On the other hand, the process of developing new financial or investment products, procedures, or services is referred to as financial innovation. In addition to numerous other developments, these changes may involve improved technology, managing risk, the transfer of risks, and the creation of credit and equity. Tamer and Keren (2018) opined that financial innovation is the process by which any financial institution can create, market, and garner traction for new products, platforms, and procedures, including radical as well as incremental ones. It also involves acting as a catalyst for technologies that bring about creative changes in the way its financial operations are carried out.

Theoretical perspective

The theory of financial intermediation holds that financial intermediaries are essential to the process of economic growth because they move financial capital from net savers to net borrowers, encouraging investment and subsequently economic growth. This theory holds that financial intermediaries can change the risk characteristics of assets to avoid market failure and resolve the information asymmetry issue. These inequalities in credit market knowledge arise from the fact that borrowers typically possess greater knowledge about their diverse investment endeavors than do lenders (Benston & Smith, 1976). Effective financial intermediaries may increase overall economic efficiency, according to Schumpeter (1934). Financial innovation and entrepreneurship are fostered by financial intermediation and are essential to the growth of the economy. According to Gurley and Shaw (1956), financial intermediaries give borrowers an opportunity to improve their financial capacity while they save and make investments. Because of this, the financial sector's level of intermediation and innovation increases the mobilization of savings and potential investments, which in turn raises economic growth. Insofar as it makes it easier to allocate resources to the most advantageous user, an economy's overall financial structure (as part of financial innovation) speeds up economic performance (Muhammad et al., 2018).

Empirical Review

Empirical financial studies have offered several theories for why financial innovation and economic growth are related. As to Beck (2010)'s supply-leading theory, financial innovation might potentially contribute positively to a country's economic growth. Financial innovation, under this theory, accelerates the process of capital accumulation, boosts the effectiveness of financial intermediation, improves the efficiency of financial institutions, and improves financial services. Shittu (2012) asserts that Nigeria's economic growth is significantly influenced by efficient finance intermediation.

Ndlovu (2013), Asghar & Hussain (2014), and Kyophilavong et al. (2016) all validated the findings that financial innovation fosters economic growth. The positive and substantial impact of financial innovation on growth was demonstrated by the findings of Qamruzzaman1 & Jianguo (2018), Muhammad et al (2020), Nittayakamolphun & Pholkerd (2022), and other studies that supported the enhanced effect of financial innovation on growth. The previous studies indicate that financial innovation offers an avenue for investment in high-tech initiatives in situations when traditional resources are unfeasible because of risk. On the other hand, financial markets push businesses to adapt their methods to incorporate different risk

variables and to reorganize in line with market demands, even when high-tech and economic development increase the complexity of business operations.

This implies that countries' wealth would decrease and macroeconomic and high-tech growth would halt in the absence of financial breakthroughs. This type of innovation, according to Sood and Ranjan (2015), introduces and supports new technologies, tools, and financial institutions for this system. On the other hand, it has also been shown that the relationship between financial innovation and economic growth is not entirely positive. For example, Ansong et al. (2011) and Adu-Asare Idun & Aboagye (2014) claimed that new financial products have a negative impact on saving behavior, induce savings to leave banks, and thus create a liquidity problem for banks.

3. Methodology

3.1 Data

The study's data contains a panel data set of fifteen selected SSA nations spanning the years 2003 to 2022. The world development indicators data were used to calculate the Gross Domestic Product (GDP), Automated Teller Machine (ATM), a proxy for financial innovation; Gross Fixed Capital Formation (GFCF), and Trade Openness (TO). The 15 African countries were chosen based on the availability of data. The selected countries include: Nigeria, Ghana, Bennin, South Africa, Sudan, Kenya, Ethiopia, Senegal, Zambia, Central African Republic, Tanzania, Uganda, Togo, Cameroon and Angola.

3.2 *Empirical model*

In accordance with the Solow growth model presented by Yinusa et al. (2021) and the empirical studies of Qamruzzaman & Jianguo (2020), this study constructs the following functional model:

$$GDPG = f\ (ATM, GFCF, TOP, EYS) \quad (1)$$

Equation 1 is transformed into econometrics form as:

$$GDPG_{it} + \beta_1 ATM_{it} + \beta_2 GFCF_{it} + \beta_3 TOP_{it} + \beta_4\, EYS_{it} \quad (2)$$

where GDPG is the GDP-growth, ATM represent the number of ATM machines, GFCF is the growth fixed capital formation, TOP is the symbol of trade openness and EYS is the expected year of schooling. Although subscript *t* stands for years and *I* stand for countries, the ε is a stochastic error word.

3.3 Estimation Technique

The unit root, the Pesaran and Smith (1995) mean group (MG), the Pesaran, Shin, and Simith (1999) pooled mean group (PMG), the dynamic fixed effect (DFE), and panel quantile regression analysis are all being strategically tested in this study. The panel ARDL techniques can be applied if the variables are I (0), I (1), or both, which makes the methods favorable. The capacity of PMG and MG models to control endogeneity issues by incorporating good lags of all variables is a critical feature (Pesaran, Shin, and Simith, 1999; Asteriou and Pilbeam, 2021). A correlation test is run to identify multicollinearity problems.

The nonlinearity in the relationship between financial innovation and economic growth in SSA is estimated using panel quantile regression (PQR). To determine several financial innovation indicators, the study uses quantile regression (Koenker, 2005). The nonlinear approach was selected because of the spread of financial innovation, which may be recorded using a range of quantiles. Areas with nonlinear and uneven conditional variable effects on the dependent variable can be displayed using the PQR. Additionally, it can identify how unexpected shifts in financial innovation affect the signal and intensity of economic development at various quantiles (Law, Sarmidi and Goh, 2020). The conditional mean function E(y|x) is used in regular linear regression procedures to recapitulate the average association between a set of independent variables (x) and the dependent variable (y). As this study examines the association at different points in the conditional spreading of economic growth, the quantile regression provides such capability in investigating the association between financial innovation and economic growth of SSA countries.

4. Results and Discussion

The correlation matrix and descriptive data are displayed in Tables 1 and 2. The variables being studied in SSA are shown in Tables 1 with their descriptive statistics. Table 2 presents the results of the independent variable correlation test as a matrix. Based on the rule of thumb, the analysis concludes that there is no

multicollinearity problem amongst our explanatory variables given the range of absolute values (-0.0098 to 0.4193) in all the models. These numbers are less than the criteria of 0.80 (Prodan, 2013).

Table 1. Descriptive statistics

Variables	Observations	Mean	St. Deviation	Min.	Max.
GDPG	315	4.84	4.5	-36.39	19.68
ATM	315	1.72	3.2	2.13	5.53
EYS	315	8.78	3.1	.46	19.24
TOP	315	48.35	14.55	19.1	95.91
GFCF	315	20.46	7.62418	2 .78	59.72

Source: Author's computation using STATA (2023)

Table 2. Correlation Matrix

VARIABLES	GDPG	ATM	EYS	TOP	GFCF
GDPG	1.0000				
ATM	-0.0744	1.0000			
EYS	-0.0444	-0.2027	1.0000		
TOO	0.3722	-0.0054	-0.0213	1.0000	
GFCF	0.1579	-0.0736	-0.1243	0.1266	1.0000

Source: Author's computation using STATA (2023)

Table 3 displays the pooled Hausman test statistic and the corresponding p-values of the coefficients. The null hypothesis, which states that there is a long-run homogeneity limitation, is tested against the alternative hypothesis. It has been determined that the Hausman test result, which validates the applicability of the PMG estimates in both scenarios, is inadequate to reject the long-run homogeneity constraint at the conventional significant levels. The values of 0.46 and 1.49, respectively, indicate that the prob > chi2 is more than 0.05. The PMG is suggested since the P-value is significant. Since the PMG estimates are supported by the Hausman tests, the significance of the PMG estimators for data interpretation will be highlighted. An enduring partnership is necessary for the ARDL paradigm to work.

The requirement for this is that the error correction term's coefficient must be negative and not lower than -2. The validity, consistency, and effectiveness of a long-term relationship between the variables of interest depend primarily on this. The error coefficient and associated standard error are displayed in Table 3. We see that the error correction term is significant for the PMG, MG, and DFE estimates and is within the range of dynamically stable terms. However, the PMG as advised by the Hausman test is the fundamental issue at hand.

While the PMG estimates for the computed parameters are the main focus of the study, we also provide the MG and DFE estimations. Table 3 shows that financial innovation, as determined by ATMs in the short term, is positive and statistically significant at the 10% level. Over the long term, the coefficient value is positive and significant at the 1% level, suggesting that financial innovation stimulates the economy of SSA nations. The banking sector's latest innovations stimulate investment and financial transactions, which will strengthen the economy. This is consistent with the research findings of Qamruzzaman & Jianguo (2020) and Yinusa et al. (2021). The expected year of education, which serves as a stand-in for human capital, has little bearing on the expansion of the SSA economy. This defies both our predictions and the Suleiman et al. (2015) study. Trade openness has a long-term, 1% impact on the growth of SSA nations. This suggests

Table 3. MG, PMG and DFE Regression Results. Dependent variable GDPG

Independent Variables	**MG**	**PMG**	**DFE**
Long-run coefficients			
ATM	2.069(-1.22)	0.253(3.13)***	-0.354(-1.04)
EYS	1.341(1.91)*	1.320(1.37)	0.318(1.76)*
TOP	1.371(1.11)	0.144(1.98)**	0.200(2.82)***
GFCF	0.036(0.41)	0.126(3.26)***	0.067(1.73)*
Speed of adjustment (ECT)	-0.246(-1.87) *	-0.377(3.40)***	-0.776(-3.72)***
Short-run Coefficients			
Δ ATM	1.941(0.93)	0.455(0.66)	0.165(0.40)
Δ EYS	-2.204(-1.02)	0.242(0.43)	0.460(0.80)
Δ TOP	-0.211(-1.91)*	0.027(0.40)	-0.254(-3.88)
Δ GFCF	-0.098(-0.98)	-0.009(-0.22)	0.018(0.47)
CONSTANT	-8.265(-0.76)	0.701(2.24)**	1.191(0.78)
Hausman Test		0.46(0.7993)	1.46(0.6973)
No. of countries	15	15	15
Observations	300	300	300

that a considerable degree of trade openness is the reason why the economies of the SSA are trending upward. The result is in line with Muhammad et al.'s (2020) finding that trade liberalization considerably accelerates economic growth.

The panel quantile results are shown in Table 4, and the findings indicate that ATMs significantly contribute to the economic growth of SSA. The findings demonstrated a discernible variation in the significance level, which significantly and significantly affects economic growth at a higher quantile (Q-75). This indicates that the nations of SSA are more affected by the higher quantile than by the lower quantile. It is found that at none of the quantiles does the human capital-specific variable (EYS) have any importance. Both trade openness and gross fixed capital creation show

significant beneficial benefits at the higher quantile. The PQR is used to estimate the nonlinearity of the relationship between financial innovation and economic development. Given that a variety of quantiles can be used to measure the diffusion of financial innovation, the quantile technique was used. Locations with uneven and nonlinear impacts of nonlinear conditional variables on the dependent variable are highlighted by the PQR. It also establishes the impact of unforeseen changes in financial innovation on the signal and strength of economic development across different quantiles. (Sarmidi, Goh, and Law, 2020).

The figures in parenthesis are the z-values except those for Hausman Test which are p-values. ***, ** and * represent 1%, 5% and 10% levels of significance, respectively. ARDL (1,2,1,1,2).

Source: Author's computation using STATA, (2023)

Table 4. Panel Quantile Regression Result.

Independent Variable	Panel Quantile Regression		
	Q-25	**Q-50**	**Q-75**
ATM	0.342	0.153	0.278
	(0.78)	(-2.23) **	(3.92) ***
EYS	0.191	0.157	0.313
	(2.32) **	(2.47) **	(4.21) ***
TOP	0.009	0.081	0.291
	(1.73) *	(2.05) **	(3.94) ***
GFCF	0.762	0.379	0.275
	(1.91) *	(2.69) ***	(3.08) ***
No. of countries	15	15	15

Observations.	483	483	483

Notes: The dependent variable for the panel quantile is GDPG. The figures in parenthesis are the t-values. ***, ** and * represent 1%, 5% and 10% levels respectively.

Source: Author's computation using STATA, (2023)

5. Conclusion

This study analyzes the impact of financial innovation on economic growth in SSA from 2003 to 2022 using the panel ARDL and panel quantile tests. SSA and global in particular, following the financial crisis, the majority of nations have encountered economic catastrophes. It has brought attention to the necessity of examining the relationship between financial innovation and economic expansion in order to shield nations from potential issues arising from the financial sector's market imperfections. One of the essential components of financial innovation that the SSA countries embrace and reap as a benefit of the global economy is this, according to Turner (2014). This study is the first to evaluate the impact of financial innovation on economic growth in SSA using both a nonlinear panel quantile model and a linear panel ARDL model, allowing for the capture of both mean results and results at different quantiles. The report could be a helpful place to start or a point of reference for future studies on other emerging market economies.

Our results support the findings of Muhammad et al. (2020) and Qamruzzaman & Jianguo (2020), which show the long-term positive benefits of financial innovation on economic growth. The study's premise was that any innovation to strengthen the financial system would benefit economic development through institutions, skillfully distributed capital, and well-organized financial intermediation—all of which would eventually spur growth. Policymakers should encourage the positive relationship between financial innovation and economic growth, according to the report. More competitive financial conditions are needed in Sub-Saharan Africa, and regulatory bodies need to support this. In addition to driving overall economic growth, the economy's financial innovation also drives financial growth. The regulatory agencies ought to encourage the use of this innovation to accelerate the SSA nations' economic development. The regulatory authorities should also support and communicate the financial policy in a way that permits it to grow and improve in order to promote financial innovation.

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