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Financial innovation, financial development, and economic growth: empirical evidence on Sub-Saharan African countries

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ABSTRACT

This study investigates the relationship between financial innovation, financial development, and economic growth in eight Sub-Saharan African countries from 2011 to 2021. Using panel data analysis, the study incorporates financial innovation indicators such as internal credit to the private sector, openness to international trade, gross capital formation, and information and communication technology, while financial development is measured through the size of financial intermediaries and stock market capitalization. The findings reveal that internal credit, capital formation, and stock market development do not significantly influence economic growth in the region, whereas information and communication technology and openness to trade show a positive impact. These results suggest that technology-driven and trade-related financial innovations play a more critical role in driving economic growth than traditional financial metrics. Accordingly, the study provides practical implications for policymakers in Sub-Saharan Africa, emphasizing the need to support financial innovation through ICT investment and trade openness to enhance the efficiency of financial markets and stimulate sustainable economic development.

Contribution/Originality: This study is among the few that empirically explore the relationship between financial innovation, financial development, and economic growth in Sub-Saharan Africa. It is the first to combine indicators such as ICT, trade openness, and financial intermediation using panel data analysis from 2011 to 2021 to provide region-specific policy implications.

1. INTRODUCTION

Financial innovation and financial development are key factors in stimulating a country's economic growth (McKinnon & Shaw, 1973; Schumpeter, 1991). Financial innovation refers to the use of digital technologies such as artificial intelligence, big data, and blockchain to create new financial products and services (Nguyen & Dang, 2022; Nicoletti, 2017). Financial development refers to improving access to financial services for businesses and individuals, as well as deepening financial markets (King & Levine, 1993a, 1993b; Levine, 1997). The emergence of new technologies has significantly contributed to the improvement of financial development in sub-Saharan Africa and has reduced the financial gap. Offering innovative financial solutions accessible to millions of people who previously did not have access to traditional financial services, such as bank accounts, loans, insurance, and electronic means of

payment, are the main measures taken by African countries (Gelbard, Gulde, & Maino, 2014). The financial gap can be explained by various factors such as poverty, geography, lack of financial education, and regulatory and institutional barriers.

Many empirical studies have explored the link between financial innovation and economic growth. Their results confirm the positive impact of financial innovation on economic growth (Banday, Murugan, & Maryam, 2021; Kumari & Singh, 2024; Musakwa & Odhiambo, 2024; Nazir, Tan, & Nazir, 2021; Qamruzzaman & Jianguo, 2018; Reddy & Ramaiah, 2020; Verma, Dandgawhal, & Giri, 2023; Zahonogo, 2016). However, there is no consensus on the indicators of financial innovation: some studies use domestic credit to the private sector to measure financial innovation, while others focus on trade openness, gross capital formation, and information and communication technologies as indicators of financial innovation. This study aims to eliminate the ambiguity by selecting an appropriate indicator of financial innovation.

Moreover, the nexus between financial development and economic growth has attracted the attention of numerous empirical studies. These studies show a general consensus on the existence of a positive relationship between financial development and economic growth. Some studies have used the size of financial intermediaries as an indicator of financial development (Guru & Yadav, 2019; Konstantakopoulou, 2023; Nguyen, Le, Ho, Nguyen, & Vo, 2022) while other studies have used the stock market capitalization as a proxy of financial development (Abbas, Afshan, & Mustifa, 2022; Bhattarai, Gautam, & Chettri, 2024; El Aouam, 2022; Gizaw, Getachew, & Mancha, 2024; Kim & Park, 2023). This study aims to investigate the impact of financial development on economic growth in sub-Saharan Africa from a broad perspective that controls for several proxies of financial development.

Investigating Sub-Saharan African countries is important for many reasons. First, there is a lack of empirical evidence on the effect of new technologies and financial development on economic growth. Sub-Saharan Africa is a diverse region comprising many countries, each with its own challenges and opportunities for economic growth, financial innovation, and financial development. Second, the impact of financial innovation and financial development can vary from country to country depending on many factors, including the size of the economy, political stability, financial infrastructure, and the level of economic development. Moreover, identifying and measuring the contribution of financial development and financial innovation to economic growth in Sub-Saharan African countries is of paramount importance to decision-makers and economic policymakers.

Studying this relationship is essential to understanding whether countries in Sub-Saharan Africa can benefit from new trends in financial innovation, digitalization of the financial sector, and improvements in financial development to enhance their economic growth. By improving access to finance, increasing the efficiency of financial markets, and promoting financial inclusion, financial innovation and financial development can contribute to economic and social progress in these countries, which face many structural challenges. Our research aims to examine the impact of financial innovation and financial development on the economic growth of countries in Sub-Saharan Africa. This study makes significant contributions to the existing literature in several areas. First, very few studies have investigated the relationship between financial innovation, financial development, and economic growth simultaneously in Sub-Saharan African countries; this research gap motivated the exploration of how financial innovation and financial development positively influence economic growth in the region. Second, unlike previous studies, this research examines various economic indicators that reflect financial innovation and financial development to gain a broader and deeper understanding of their relationship with economic growth. Additionally, the present study aims to provide practical recommendations to support financial and economic policies in Sub-Saharan Africa, an aspect that previous studies have not emphasized. Finally, this research offers future scholars a better understanding of the development challenges and opportunities faced by Sub-Saharan African countries.

This study pursues two main objectives. First, it aims to construct a theoretical and conceptual framework that captures the interconnectedness between financial innovation, financial development, and economic growth. Second, it seeks to empirically assess how financial innovation and financial development influence economic growth in sub-

Saharan African countries. Using panel data analysis, the empirical results show a significant positive impact of trade openness and information and communication technologies on economic growth. On the other hand, the size of financial intermediaries has a negative impact on the economic growth of sub-Saharan African countries. Furthermore, internal credit to the private sector, gross fixed capital formation, and market capitalization have no significant effect on the economic growth of sub-Saharan African countries.

The rest of the paper is structured as follows. Section 2 presents a conceptual framework. Section 3 examines the theoretical framework and develops our main hypotheses. Section 4 outlines the models used and describes the data. Section 5 summarizes our principal findings. The last section emphasizes the conclusion and recommendations for further investigation.

2. CONCEPTUAL FRAMEWORK

2.1. Financial Innovation

Schumpeter (1934) defines financial innovation as the implementation of new combinations, including the introduction of new goods, new methods of production, new markets, new sources of supply, and new forms of organizing production. Recent analyses emphasize the role of certain factors and processes, such as the creation of new financial products by combining or separating specific features of existing ones. In other words, financial innovation involves forming new combinations, producing and distributing money through new methods enabled by computer and telecommunication technologies, developing new markets like the Euromarkets, and promoting the global integration of domestic and international financial markets. The primary goals of financial innovation are to deliver faster, more affordable, and more accessible financial services that are also sustainable, especially for consumers without access to traditional financial services, as well as for businesses and financial markets.

Financial innovation aims to improve the efficiency, accessibility, flexibility, and profitability of financial services, as well as to optimize the mobilization of economic resources through efficient payment mechanisms, reduce investment risks, and accelerate capital formation. It also seeks to foster competition, stimulate economic growth, promote financial inclusion, and ensure financial system stability. Financial innovation is based on artificial intelligence, blockchain, and big data. Nguyen and Dang (2022) found that financial technology has experienced significant growth in recent years and has garnered considerable attention regarding its impact on economies and financial systems. Nicoletti (2017) states that financial innovation refers to the application of new technologies and/or innovative business models that leverage existing information technology and communications to provide financial services.

2.2. Financial Development

Levine (1997) demonstrates that financial development occurs when financial instruments, markets, and intermediaries reduce, but do not eliminate, the costs of obtaining information, executing contracts, and conducting transactions. The financial system develops when there is: (a) accumulation of financial assets, (b) an increase in the variety of financial instruments (i.e., diversification of financial assets), (c) improved efficiency and competition within the financial sector, and (d) increased public access to financial services. Financial development can help protect investors and consumers and stimulate economic growth by making it easier for firms and households to access finance, which can encourage investment and job creation. It can also enable better allocation of financial resources, more effective risk management, and greater resilience to economic shocks.

The five main functions identified by Levine (1997), whose improvement involves financial development, are.

- The ex-ante production of information on possible investments.
- Oversight of investments and enforcement of corporate governance practices.
- Execution of trading activities, diversification strategies, and risk management.
- Mobilization and aggregation of savings.

- Facilitation of goods and services exchange.

2.3. Economic Growth

McKinnon (1973) defines economic growth as an increase in a country's total output (goods or services). This is an increase in the capacity of an economy to produce goods and services from one period to another. Economic growth occurs whenever people take resources and rearrange them in a more meaningful way. Economic growth refers only to the quantity of goods and services produced. It is considered a key indicator of the progress and development of a country. It signifies an improvement in the standard of living, employment, income, investment, and economic opportunities for the population.

The performance of an economy is generally assessed based on the achievement of economic objectives. These goals can be long-term, such as growth and sustainability, or short-term development, such as stabilizing the economy in response to sudden and unpredictable events, such as economic shocks. The objectives of economic growth vary depending on the priorities and policies of each country, but they are generally related to the improvement of living conditions, the reduction of poverty, job creation, increased income, improved infrastructure, and public services, as well as the promotion of overall well-being. Shahbaz, Rehman, and Amir (2010) notably identified the determinants of economic growth. They also reported that foreign direct investment, financial development, public investment, human capital, openness to trade, and inflation have positive effects on economic growth.

2.4. Financial Development in Sub-Saharan Africa

Since the 1990s, Sub-Saharan Africa (SSA) has experienced rapid growth, accompanied by the development of financial services, particularly in terms of access to deposit services of commercial banks. However, this development is not significant enough to ensure the sustainability of growth. Most countries have insufficient financial instruments. The level of access to financial products and services by the majority of the population is still limited (Gelbard et al., 2014). Gelbard et al. (2014) demonstrate that, although reforms must be tailored to the specific issues of each country, several actions should be prioritized in key areas:

2.4.1. Removing Structural Barriers to Credit and Improving Market Structures

The limitation of credit is generally explained by the insufficiency of rights for creditors or by a lack of information on the solvency of borrowers. In many SSA countries, this problem requires specific reforms of the systems, legal and judicial, particularly to improve the recovery of security, and in some cases, to establish a risk center or enhance its functioning.

2.4.2. Improving Conditions for Non-Bank Financial Institutions

The legal and regulatory frameworks that govern the essential roles played by non-bank establishments such as insurance companies, credit unions, and other hybrid financial service providers, including leasing companies, are very important in certain countries for the continued development of the financial sector.

2.4.3. Strengthening Governance and Regulations

It is essential to improve governance in the public and/or financial sectors in many SSA countries. Governance reforms should be supported at all levels of the economy by clearly and fairly applying legal structures and regulations in the financial sector.

2.4.4. Strengthening Supervision

In some SSA countries, supervision practices, methods, and techniques need to be further improved, particularly on-site and off-site inspections, to better identify new risks at both the company level and across the entire sector.

2.4.5. Developing Financial Integration

Stronger integration of monetary unions (and their implementation in the community of East Africa) would help expand the market size and lower costs, thereby facilitating the development of financial sectors. To achieve such financial integration, it is necessary to extend the regulatory framework to all institutions of systemic importance and harmonize regulatory processes. This would reduce barriers to market entry, enabling financial companies to achieve economies of scale and scope.

2.4.6. Promoting Financial Inclusion

Technological progress in mobile banking offers new possibilities for boosting financial inclusion in SSA countries by reducing intermediation costs. However, SSA countries still face a financial infrastructure deficit, as the number of agencies, banks, and ATMs remains comparatively low. Online banking services could play a key role in deepening the financial sector and overcoming obstacles that slow entrepreneurial activity, while creating an environment that reduces transaction costs. The regulatory framework must be strengthened to facilitate collaboration between telecommunications operators and financial institutions.

2.5. Sub-Saharan African Countries Facing the Challenge of Digital Transformation

The International Monetary Fund (2020) states that the rapid digital revolution promises to transform economies and people's lives. Moreover, its importance is accentuated by the unprecedented health and socioeconomic impacts of the COVID-19 pandemic on sub-Saharan countries. The digital revolution helps to provide rapid, flexible, and inclusive solutions to the pandemic. In the future, the evolution of digital technologies and culture will present new opportunities for development and inclusion: greater efficiency and resilience, better access to international markets, improved public services, greater transparency and accountability, and the creation of new employment opportunities. However, digital transformation also brings its share of new challenges, including the risk of the disappearance of certain traditional jobs, the need to rethink public policies, and concerns related to cybersecurity and data confidentiality.

Digital transformation is indeed a multidimensional and rapidly evolving concept. It is, therefore, difficult to assess and track its progress, particularly due to the lack of data, both in terms of coverage and time series. In many respects, it is undeniable that Sub-Saharan Africa is catching up with the rest of the world in terms of digitalization. Internet penetration is growing rapidly, particularly thanks to mobile connectivity. As a result, some countries in the region, such as Cabo Verde, Ghana, Rwanda, and Seychelles, are at the top of the ranking within their income groups. However, significant gaps remain, both within the region and within individual countries. Rural areas are less connected, and the gender gap is widening.

3. THEORETICAL FRAMEWORK

3.1. Theories of Financial Innovation

3.1.1. The Theory of the Schumpeterian Approach

Schumpeter (1991) outlined three key stages in the development process: invention, innovation, and diffusion. Invention represents the initial creation or demonstration of a new idea. Innovation refers to the first successful commercial application of that invention in the marketplace. It involves the formation of new combinations, such as introducing a new product or one with unique characteristics, developing a new method of production, entering new geographic markets, sourcing raw materials or intermediate goods from new suppliers, or implementing new organizational or managerial practices within an industry. Diffusion is the stage where the technology or process spreads and becomes widely adopted in the market.

Schumpeter (1911) attributed the central role in economic growth first to entrepreneurs as disruptive agents, then to large firms, both of which fueled a process of creative destruction by causing ongoing disruptions in the

economic system. These disruptions were driven by innovation, which, as Schumpeter stated, created competition based on new goods, new technologies, new sources of supply, and new types of organization. This competition brought significant qualitative costs or benefits and affected not only the profit margins and achievements of existing businesses but also their foundations and survival.

According to Schumpeter (1911), financial innovation plays a central role in the process of economic development. He argues that financial innovation is a key factor that disrupts the existing economic balance, stimulates economic growth, and promotes technological progress. Financial innovation is a force of creative destruction; it disrupts the established economic order by replacing old financial methods and institutions with new ones. This creative destruction results in economic benefits by promoting efficiency, stimulating investment, encouraging entrepreneurship, and facilitating the efficient allocation of financial resources.

Schumpeter (1911) considers that financial innovation is closely linked to technological innovation. He argues that technological innovation creates new economic opportunities that require adequate financing. Financial innovation then plays a crucial role in mobilizing the financial resources necessary to support technological innovation and promote economic growth.

3.1.2. Theory of Transaction Cost of Innovation Approach

Chondough (2021) prove that the transaction cost theory of innovation was mainly developed by Hicks (1983). This theory supports the need for organizations to reduce transaction costs while increasing economic value, necessitating the development and adoption of financial technology. In other words, reducing service costs and increasing profits for service delivery are at the heart of financial innovation. Thus, it can be inferred that financial sector innovation was triggered by the need to improve the net present value of expected shareholder returns. Financial innovation is the product of technological advancement generated by the desire to improve the profit prospects of shareholders in the financial industry. Furthermore, this theory states that a reduction in transaction costs leads to a significant improvement in the quality of financial services, which results in increased financial patronage and profits. Although this theory is based on microscopic economic structural change, it is suitable for this study because improvements in financial innovation will sympathetically lead to decreased operating costs, improved revenues, other performance indicators, and an increase in both the quantity and quality of service delivery.

3.1.3. Disruptive Innovation Theory

Yu and Hang (2010) state that Disruptive Innovation, developed by Christensen (1997), is a type of technological innovation that takes on strategic importance in practice. Disruptive innovation is a powerful way to expand and develop new markets and offer new capabilities, which, in turn, can disrupt existing market linkages (Adner, 2006; Charitou & Markides, 2003; Christensen, 1997). This category of (disruptive) innovation is introduced in a managerial approach by Christensen (1997), who shows that leaders are in difficulty not because of major advances by their competitors but because newcomers on the market position themselves by offering inferior solutions. These newcomers are not considered dangerous; they take advantage of the leaders' inadvertence, then eat away at market share and endanger the leaders (Badillo, 2013).

Fintechs, as new and innovative firms, are also seen by many as disrupting the financial services industry (Bower & Christensen, 1995; Christensen, McDonald, Altman, & Palmer, 2018; Christensen, Raynor, & McDonald, 2015; Zalan & Toufaily, 2017). Christensen et al. (2015) state that disruption caused by an innovation like fintech occurs when a new entrant with fewer resources successfully challenges established incumbents. Disruptive companies have different business models than incumbent companies, such as fintech, and offer services that are cheaper, faster, more flexible, and less complex (Christensen et al., 2015). Christensen et al. (2015) theorize that disruptors begin by targeting low-end (less sophisticated) customers or new markets, and as disruptive technologies improve and gain

popularity, they absorb the core (highly sophisticated) markets. Therefore, with the advantages of efficiency and low cost, disruptors have the ability to displace incumbents.

Table 1 resumes the main theories of Financial Innovation.

Table 1. The main theories of financial innovation.

Theory	Contribution
Schumpeterian approach theory	- The entrepreneurs are considered disruptive agents in economic growth. - The role of big firms in the process of creative destruction is important. - This process is characterized by continued disruptions in the economy. - These disruptions are triggered by innovation, which drives competition based on new goods, technologies, sources of supply, and organizational models.
Theory of transaction cost of innovation approach	- Reducing transaction costs is considered the main driver of financial innovation and the improvement of financial services. - The profit is the fundamental motivation for financial institutions to innovate.
Disruptive innovation theory	- Disruptive innovation opens up new markets and introduces new features. - Market leaders are not necessarily threatened by major advances by their competitors but rather by the arrival of new players offering lower-quality solutions.

3.2. Theories of Financial Development

3.2.1. The Financial Liberalization Theory

McKinnon and Shaw (1973) present the liberalization of the financial sector as an effective and straightforward means to accelerate the economic growth of developing countries. This theory quickly received a favorable response from major international organizations (IMF and World Bank) and some developing countries. If we consider that financial development promotes economic growth, then it is essential to remove restrictions that hinder the development of the financial system. The theory of financial liberalization advocates for abandoning dirigiste credit policies and limits on interest rates, aiming to improve the efficiency of the financial system, stimulate investment, and promote economic growth.

Financial liberalization theory is a perspective that argues that financial sector liberalization and deregulation can promote economic growth and development. According to this theory, removing restrictions and controls in financial markets allows financial resources to flow more freely, which facilitates the efficient allocation of resources, encourages investment, and stimulates economic growth. The theory of financial liberalization is often associated with the idea that financial markets must be open, competitive, and transparent to be effective. It advocates the reduction of barriers to entry for financial institutions, the liberalization of interest rates, the lifting of exchange controls, and the removal of restrictions on capital movements. According to proponents of this theory, greater freedom and flexibility in the financial sector can improve effectiveness, innovation, and overall economic efficiency.

However, the theory of financial liberalization is subject to debate and controversy. Some critics point out that financial liberalization can also lead to increased risks, such as the volatility of financial markets, the fragility of banking systems, and the possibility of financial crises. Therefore, the implementation of financial liberalization policies must be accompanied by appropriate regulatory, supervisory, and risk management measures to avoid potential negative consequences.

3.2.2. The Financial Intermediation Approach

The relationship between financial development and economic growth was re-examined in the 1990s by King and Levine (1993a) and King and Levine (1993b) which revived interest in this theory. Financial intermediaries play a key role in resource allocation. They evaluate entrepreneurs and provide funding only to the most promising ones. Financial intermediaries assess entrepreneurs, mobilize savings to finance the most productive projects, and enable diversification of the risks associated with these innovative activities, all at a lower cost than that of individual

investors. Through the evaluation and selection of entrepreneurs, the cost of investment is reduced, the productivity of capital is increased, and this promotes economic growth.

Levine (1997) summarizes the main functions of financial intermediaries into five distinct categories.

1) Acquisition of information on projects and allocation of resources to the most profitable projects.

2) Improving risk management and facilitating financial and commercial transactions.

3) Monitoring of investment projects and oversight of the management of financed companies.

4) The mobilization of savings and.

5) Facilitation of exchanges of goods and services.

The model developed by King and Levine (1993b) examines the effect of financial development on economic growth by focusing on the productivity of production factors. In this model, the authors consider an economy where potential entrepreneurs have an unknown capacity to carry out innovative projects that can increase productivity.

Table 2 summarizes the main theories of financial development.

Table 2. Main theories of financial development.

Theory	Contribution
Theory of financial liberalization (McKinnon & Shaw, 1973)	- Financial liberalization can boost economic growth and development. - Removing restrictions on financial markets promotes the circulation of financial resources, leads to a more efficient allocation of resources, encourages investment, and stimulates economic growth.
The financial intermediation approach (King & Levine, 1993b)	- Financial intermediaries are essential in allocating resources and evaluating entrepreneurs. - Only the most promising entrepreneurs receive funding. - Financial intermediaries mobilize savings to finance the most productive projects. - The evaluation and selection of entrepreneurs reduce the cost of investment, which increases capital productivity and promotes economic growth.

4. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

4.1. The Role of Financial Innovation on Economic Growth

Chipeta and Muthinja (2018) demonstrate that the role of financial innovation in the financial sector is crucial for improving banking performance, financial efficiency, and effective financial intermediation. The authors conclude that financial innovations have played a vital role in enhancing the performance of banks in Kenya, particularly in terms of profitability, efficiency, and customer outreach. This underscores the importance of ongoing innovation in the financial industry, supported by appropriate regulatory frameworks, to sustain economic growth and promote financial inclusion in Kenya. Although the study offers valuable insights into the Kenyan banking sector, the findings may not be applicable to other countries in Sub-Saharan Africa. Furthermore, Napier (2014) finds that financial innovation offers opportunities for growth in the financial sector, which stimulates economic growth. The case studies presented in the study show the different ways in which various African countries use financial innovation to promote economic growth. However, the study does not sufficiently examine the impact of financial innovation on economic growth. Michalopoulos, Laeven, and Levine (2009) demonstrate that financial innovation facilitates the expansion of financial services through the development of new financial institutions, financial instruments, financial reporting, technology, and markets.

Michalopoulos et al. (2009) measured financial innovation through the growth of financial development, specifically using the growth rate of the ratio of domestic credit to the private sector relative to GDP. Kane and Diandy (2019) explain that domestic credit to the private sector represents the financial resources made available to private entities. This indicator reflects the volume of credit extended to the private sector in proportion to the overall economy. Its key advantage lies in the exclusion of public sector credit, offering a clearer picture of private sector financing. More precisely, it highlights the role of financial intermediaries in channeling funds to market participants.

The authors provide some empirical evidence that financial development and innovation are correlated with higher economic growth rates, especially in countries with more mature financial markets. However, the exclusive use of domestic credit to the private sector cannot fully capture the relationship between financial innovation and economic growth.

Qamruzzaman and Jianguo (2017) and Qamruzzaman and Jianguo (2018) examine the nexus between financial innovation and economic growth in Bangladesh during the period 1980-2016 using autoregressive distributed lag (ARDL) bound testing and Granger causality-based Error Correction Model (ECM). The authors use Domestic Credit to the Private Sector and Broad-to-Narrow Money as proxies for financial innovation. The empirical findings show a long-run positive and significant relationship between financial innovation and economic growth. Similarly, Nazir et al. (2021) find a long-run positive effect of financial innovation on economic growth. The empirical results confirm that monetary management and credit flow to the private sector play a crucial role in economic growth in Asian countries.

In a more recent study, Nwamen (2006) found a negative relationship between financial innovation and economic growth in both developing and developed countries. The study confirms that domestic credit to the private sector banks is the best proxy for financial innovation.

The relationship between financial innovation and economic growth has also been examined in several empirical studies, using openness to international trade, gross capital formation, and information and communication technologies as proxies for financial innovation. The empirical results of these studies find that financial innovation contributes considerably to economic growth. Rajan and Zingales (2003) recommend that openness to international trade push governments to launch reform programs that stimulate the country's economic growth to compete in the international market. Qamruzzaman and Jianguo (2018) argue that openness to trade indicates how much an economy depends on international trade. It is calculated by taking into account both imports and exports in relation to GDP. A higher ratio implies a deep dependence on international trade. Openness to trade positively influences an economy's output level by creating opportunities to serve foreign markets rather than domestic ones. It also helps to increase productivity through technological advancement, knowledge sharing, and increased labor productivity. Zahonogo (2016) investigates the nexus between trade openness and economic growth in sub-Saharan Africa using a Pooled Mean Group estimation technique. The findings indicate that there is a trade threshold below which greater trade openness has a positive effect on economic growth, and above which the trade effect on growth diminishes. Additionally, numerous recent studies suggest that openness to international trade is a key determinant of economic growth. Banday et al. (2021) and Hao (2023) find a long-term positive relationship between trade openness and industrial economic growth using the Autoregressive Distributed Lag method.

Gross capital formation is a key factor in economic growth. Dahmani (2021) found that gross fixed capital formation, which is an indicator of investment, has a positive and statistically significant relationship with economic growth, as expected. The positive and significant relationship between gross fixed capital formation and real GDP growth suggests that investment in Tunisia stimulates economic growth. Moreover, this result is particularly noteworthy because, in the case of Tunisia, post-revolutionary political and security instability, social conflicts, and the costs associated with fighting terrorism have deteriorated the business and investment climate and have greatly contributed to deterring both foreign and local investors. Similarly, Pasara and Garidzirai (2020) found a positive long-term relationship between gross capital formation and economic growth in South Africa. In addition, Boamah, Adongo, Essieku, and Lewis Jr (2018) emphasize that gross fixed capital formation positively influences economic growth in Asian countries. Reddy and Ramaiah (2020) show that gross capital formation has contributed significantly to economic growth in India.

Several empirical studies underline the central role of information and communication technologies (ICT) in promoting economic growth. Beck, Demirgüç-Kunt, and Levine (2007) show that the rapid spread of information and communication technologies (ICT) in SSA countries is associated with a faster increase than elsewhere in the world

in the number of telephone subscribers, personal computer users, and Internet accounts. Online banking is now an opportunity to reach mass markets efficiently and effectively. Chabossou (2018) argues that improving access to information and communication technologies creates employment opportunities, facilitates knowledge transfer, and enhances economic efficiency and transparency. ICT development presents an opportunity for developing countries to positively influence their economic growth. Quah (2002) and Aghaei and Rezagholizadeh (2017) argue that ICTs create added value at the enterprise and sectoral levels and, as a result, improve productivity and economic growth at the country level.

Other empirical studies confirm the central role of ICT in economic growth. The study by Asongu and Le Roux (2017) examined a sample of 49 countries in sub-Saharan Africa during the period from 2002 to 2012. The results demonstrate the role of the spread of information and communication technologies, particularly in sustainable and inclusive development in sub-Saharan Africa. Haftu (2019) examines the relationship between ICT and economic growth for a sample of 40 countries in sub-Saharan Africa from 2005 to 2015. The empirical results show a significant and positive impact of ICT (such as the penetration of cell phones and internet access) on economic growth. Moreover, recent empirical studies have explored the nexus between ICT and economic growth (Kumari & Singh, 2024; Musakwa & Odhiambo, 2024; Verma et al., 2023) using many ICT proxies. The empirical results indicate a positive and significant impact of ICT on economic growth for most of the ICT proxies used.

To summarize, previous studies have mainly investigated the relationship between financial innovation and economic growth. However, there is no consensus on the indicators of financial innovation: some studies used domestic credit to the private sector to measure financial innovation, while other studies focused on trade openness, gross capital formation, and information and communication technologies as indicators of financial innovation. This study aims to clarify this ambiguity by selecting an appropriate indicator of financial innovation.

We put our following hypothesis H1.

H_1: Financial innovation has a positive impact on the economic growth of sub-Saharan African countries.

H_{1a}: Internal credit to the private sector has a positive impact on the economic growth of sub-Saharan African countries.

H_{1b}: Openness to international trade has a positive impact on the economic growth of sub-Saharan African countries.

H_{1c}: Gross capital formation has a positive impact on the economic growth of sub-Saharan African countries.

H_{1d}: Information and Communication Technologies have a positive impact on the economic growth of sub-Saharan African countries.

4.2. The Role of Financial Development in Economic Growth

Schumpeter (1911) emphasizes that the effective operation of banks promotes technological innovation by selecting and funding entrepreneurs most likely to succeed in their innovative endeavors. Similarly, Gurley and Shaw (1960) argue that financial innovation, as a component of financial development, helps to reduce investment risk and lower the costs of financial intermediation. Through the services they provide, financial innovations stimulate growth by fostering capital accumulation and enhancing factor productivity. These services include the acquisition of project information and the allocation of resources to the most profitable projects, the improvement of risk management, the facilitation of financial and commercial transactions, the monitoring of investment projects, and control over the management of financed enterprises, the mobilization of savings, and the facilitation of trade in goods and services.

Pinshi and Kabeya (2021) argue that a well-developed financial system is a crucial driver of healthy and sustainable economic growth. In contrast, an underdeveloped financial sector and restricted access to finance represent significant obstacles to economic development.. (Gelbard et al., 2014). Goldsmith (1969); McKinnon (1973); King and Levine (1993a) and King and Levine (1993b) adopted a financial development valuation approach based on the ratio of liquid liabilities in the financial system, including currency in circulation and liabilities of banks and financial intermediaries bearing interest and gross domestic product (GDP). This ratio aims to provide an overall indication of the proportion of financial assets relative to the size of the economy. However, this commonly used

indicator for measuring financial development has significant limitations. It probably reflects more the degree of monetization of economic transactions than the basic functions of the financial system. These functions include aspects such as the mobilization of savings and the efficiency of investment allocation, which are highlighted in the theoretical models (Ghirmay, 2004). Guru and Yadav (2019) and Konstantakopoulou (2023) confirm that the size of financial intermediaries contributes positively and significantly to economic growth.

Other empirical studies have also explored the link between financial development and economic growth. Zakaria and Basah (2021) analyzed the relationship between Malaysia's financial development and economic growth from 1990 to 2019. The empirical results showed a significant long- and short-term relationship between financial development and economic growth. Abbas et al. (2022) found that financial development has a significant positive effect on economic growth in middle-income countries using an Autoregressive Distributed Lag (ARDL) model. Similarly, the empirical results of the study conducted by Nguyen et al. (2022) show that financial development has a positive and significant influence on economic growth. Moreover, this positive relationship is linear. Kim and Park (2023) investigated the relationship between financial development and economic growth in South Korea using a time series analysis. The results showed that financial development contributes positively and significantly to economic growth. In addition, Gizaw et al. (2024) found a positive but negligible impact of financial development on economic growth in African and Asian emerging countries using the Dynamic Common Correlation Effect (DCCE) model.

El Aouam (2022) assesses the financial development by the Market Capitalization/GDP ratio. He finds a positive association between this indicator and economic growth. Moreover, Levine and Zervos (1996) demonstrate a positive correlation between the size of the stock market and its ability to raise capital and facilitate risk diversification. Evan (2023) found that stock market capitalization has a negative and significant impact on economic growth in Kenya. In a more recent study, Bhattarai et al. (2024) examined the relationship between stock market development and economic growth in Nepal from 1994 to 2019 using the ARDL model. The results emphasized that there is a long-term unidirectional causality relationship running from the stock market development index to economic growth.

Previous studies show a general consensus on the existence of a positive relationship between financial development and economic growth. Some studies have used the size of financial intermediaries as an indicator of financial development, while others have used stock market capitalization as a proxy for financial development. This study aims to investigate the impact of financial development on economic growth in sub-Saharan Africa from a broad perspective that controls for several proxies of financial development. This holistic analysis allows for a deeper and more integrated understanding of the impact of financial development on economic growth. Additionally, the present study aims to provide practical recommendations to support financial and economic policies in Sub-Saharan Africa, addressing aspects that have been overlooked in previous studies.

We advance the following hypotheses.

H_2: Financial development has a positive impact on the economic growth of sub-Saharan African countries.

H_{2a}: The size of financial banking intermediaries has a positive impact on the economic growth of sub-Saharan African countries.

H_{2b}: The development of stock markets has a positive impact on the economic growth of sub-Saharan African countries.

5. RESEARCH DESIGN

5.1. Sample and Data

Our empirical study includes a sample of eight Sub-Saharan African countries: Mozambique, Ghana, Nigeria, South Africa, Mauritius, Ivory Coast, Botswana, and Kenya, covering the period from 2011 to 2021. We obtained our data from various sources. First, data on GDP growth, private sector credit, and gross capital formation were collected from the World Bank website. Second, data on exports and imports of goods and services were obtained from the International Monetary Fund website. Third, we used The Global Economy website to gather information on trade openness and liquid liabilities. Finally, market capitalization data were collected from the CEIC website.

5.2. Variables Measures

This paper aims to examine the impact of financial innovation and financial development on economic growth. Financial innovation is measured using four variables: domestic credit to the private sector, openness to international trade, gross capital formation, and information and communication technology. Financial development is assessed using two variables: liquid liabilities and stock market capitalization. Table 3 summarizes all variables measures.

Table 3. Variables measures.

Variable	Notation	Measure
Economic growth	GDP	Gross domestic product is the sum of consumer and government spending, public and private investment, and the difference between exports and imports.
Internal credit to private sector	CR	The credit/GDP ratio is calculated by comparing the total amount of credit granted by a country's banks over a given period, usually one year, to the gross domestic product.
Openness to international trade	OPEN	The degree of openness is calculated by dividing the average of imports and exports by the country's GDP.
Gross capital formation	GCF	It is a measure of investment and includes fixed assets (tangible or intangible) from production processes.
Information and communication technology	ICT	It provides a comprehensive set of technical resources necessary for implementing information and communication services to produce, manipulate, convert, store, manage, transmit, and retrieve information and communicate.
Financial intermediaries size	FIS	It is calculated as the ratio of the liquid liabilities of the financial system, including the currency in circulation as well as the liabilities of banks and non-bank financial intermediaries bearing interest, to GDP.
Development of the stock market	CAP	Market capitalization is assessed by the value of shares of listed companies relative to GDP.

5.3. Model Specification

To examine the effect of financial innovation and financial development on the economic growth of sub-Saharan African countries, we use the following model.

$$DLGDP_{it} = \alpha + \beta_1 DCR_{it} + \beta_2 DGCF_{it} + \beta_3 DFIS_{it} + \beta_{it} DICT_{it} + \beta_5 CAP_{it} + \beta_6 OPEN_{it} + \varepsilon_{it} \quad (1)$$

With

i: 1-8 Number of countries in the sample (Individual dimension).

t: 2011-2021 (Temporal dimension).

DLGDP: Differentiated Logarithm GDP at the date t for the country i.

DCR: Differentiated Internal Credit to order 1 at the date t for the country i.

DGCF: Differentiated Gross Capital Formation to order 1 at the date t for the country i.

DFIS: Differentiated Financial Intermediaries Size to order 1 at the date t for the country i.

DICT: Differentiated Information and Communication Technology to order 1 at the date t for the country i.

CAP: Market capitalization.

OPEN: Openness to international trade.

5.4. Descriptive Statistics

Table 4 presents the descriptive statistics of the variables.

Table 4. Descriptive statistics.

Variables	LGDP	CAP	CR	GCF	FIS	OPEN	ICT
Mean	10.756	57.548	43.531	24.553	47.050	33.709	33.388
Median	10.729	25.123	28.092	21.447	39.550	31.580	34.500
Maximum	11.759	331.043	128.838	60.058	164.650	62.890	73.500
Minimum	10.056	4.000	10.246	12.400	22.020	10.555	2.900
Standard deviation	0.578	86.030	37.975	10.516	29.392	13.685	20.562
Skewness	0.425	2.225	1.182	1.794	2.275	0.243	0.276
Kurtosis	1.791	6.393	2.813	5.610	7.961	1.952	1.904
Jarque-Bera	8.005	114.895	20.627	72.205	166.190	4.892	5.520
Probability	0.018	0.000	0.000	0.000	0.000	0.086	0.063
Sum	946.594	5064.300	3830.744	2160.715	4140.450	2966.415	2938.200
Sum sq. dev.	29.084	643912.1	125469.2	9622.565	75163.24	16295.42	36784.37
Observations	88	88	88	88	88	88	88

5.5. Methodology

This study employed a panel data methodology to analyze the relationship between financial innovation, financial development, and economic growth. Analyzing panel data offers several advantages over analyzing cross-sectional data or time series, such as reducing the phenomenon of multicollinearity among variables, increasing the number of degrees of freedom, and enhancing the power of the tests.

The Pearson correlation matrix was used to assess multicollinearity among the explanatory variables. Additionally, a panel unit root test was applied to evaluate the stationarity of the time series data. Conducting unit root tests for panel data analysis is crucial for verifying the stationarity of time-series data across multiple cross-sectional units. We employed the Levin-Lin-Chu test, Im-Pesaran-Shin test, and Fisher-type tests.

To identify the model that adequately reflects the underlying process of data generation, we perform the Hausman test to compare the fixed effects model and the random effects model. The Hausman test determines the most appropriate model for panel data analysis.

5.6. Correlation Matrix

Table 5 presents the Pearson correlation matrix to establish multi-collinearity between the explanatory variables. The results of this table show that almost all the coefficients are less than 0.6, so there are no problems of multicollinearity among the explanatory variables (Coakes, Steed, & Ong, 2010; Hair, Anderson, Babin, Black, & Tatham, 2006).

Table 5. Correlation matrix of Pearson.

Variables	CAP	CR	GCF	FIS	OPEN	ICT
CAP	1.000	0.808	-0.348	0.059	-0.113	0.449
CR	0.808	1.000	-0.283	0.533	0.177	0.531
GCF	-0.348	-0.283	1.000	-0.025	0.523	-0.388
FIS	0.059	0.533	-0.025	1.000	0.467	0.392
OPEN	-0.113	0.177	0.523	0.467	1.000	-0.026
ICT	0.449	0.531	-0.388	0.392	-0.026	1.000

5.7. Stationarity Study

We study the stationarity of the variables using the tests of Levin, Lin, and Chu (2002); Im, Pesaran, and Shin (2003), and ADF-Fisher, Maddala and Wu (1999). These tests are based on the null hypothesis of a unit root. The results in Table 6 show that the majority of the unit root tests provided probabilities greater than 5% for the variables: log of gross domestic product, internal credit to the private sector, gross capital formation, information and communication technology, and liquid liabilities. These variables are not stationary and become stationary after

differentiation; they are then integrated at order 1, I(1). While the unit root tests provided probabilities less than 5% for the variables: openness to international trade and stock market capitalization. These variables are stationary at level I(0). Table 6 presents the stationarity tests.

Table 6. Stationarity test of variables.

Variables	Levin, Lin, and Chu		Im, Pesaran, and Shin		ADF–Fisher chi2	
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend
LGDP	-2.691 (0.003)	-7.237 (0.000)	-1.061 (0.144)	-2.216 (0.013)	21.63 (0.155)	37.972 (0.001)
DLGDP	-9.655 (0.000)	-9.904 (0.000)	-4.702 (0.000)	-1.484 (0.068)	53.470 (0.000)	34.398 (0.004)
CR	-2.414 (0.007)	-4.527 (0.000)	-0.655 (0.256)	-0.436 (0.331)	26.004 (0.054)	23.405 (0.103)
DCR	-5.688 (0.000)	-5.426 (0.000)	-2.493 (0.006)	-0.932 (0.175)	37.124 (0.002)	26.370 (0.049)
GCF	-0.570 (0.284)	-3.195 (0.000)	0.152 (0.560)	0.366 (0.643)	25.660 (0.059)	15.438 (0.492)
DGCF	-4.875 (0.000)	-6.209 (0.000)	-2.621 (0.004)	-1.490 (0.068)	34.340 (0.004)	31.455 (0.011)
OPEN	-9.956 (0.000)	-29.014 (0.000)	-5.702 (0.000)	-4.495 (0.000)	61.328 (0.000)	47.554 (0.000)
ICT	2.887 (0.998)	-2.688 (0.003)	4.642 (1.000)	0.191 (0.575)	2.990 (0.999)	13.671 (0.623)
DICT	-4.552 (0.000)	-6.007 (0.000)	-1.984 (0.023)	-1.142 (0.126)	28.773 (0.025)	30.801 (0.014)
FIS	0.512 (0.695)	-2.078 (0.018)	1.167 (0.878)	1.384 (0.916)	23.716 (0.095)	21.759 (0.151)
DFIS	-2.278 (0.011)	-2.337 (0.009)	-0.992 (0.160)	-0.036 (0.485)	34.570 (0.004)	24.739 (0.074)
CAP	-18.614 (0.000)	-8.134 (0.000)	-7.645 (0.000)	-1.841 (0.032)	59.189 (0.000)	40.043 (0.000)

Note: LGDP: Logarithm GDP.
DLGDP: Differentiated logarithm GDP.
CR: Internal credit.
DCR: Differentiated internal credit.
GCF: Gross capital formation.
DGCF: Differentiated gross capital formation.
FIS: Financial intermediaries size.
DFIS: Differentiated financial intermediaries size.
ICT: Information and Communication Technology.
DICT: Differentiated information and communication technology.
CAP: Market capitalization.
OPEN: Openness to international trade.

6. EMPIRICAL RESULTS

6.1. Homogeneity Test

Homogeneity tests include a large number of tests in which the null hypothesis states that a time series is homogeneous between two given times. Table 7 presents the homogeneity test.

Table 7. Homogeneity test.

Effects test	Statistics	d.f.	Prob.
Cross-section F	0.366	(7.72)	0.918
Cross-section chi-square	3.045	7	0.880

The p-value obtained is greater than 0.05, so the null hypothesis is accepted. Therefore, we can adopt a homogeneous panel model.

6.2. Hausman Specification Test

The Hausman test follows a Chi-square distribution with k-1 degrees of freedom and allows a choice to be made between the fixed effects model and the random effects model, which accounts for data heterogeneity.

The hypotheses are as follows.

H_0: Presence of random effect H_1: Presence of fixed effect.

When the probability of this test is lower than the retained threshold, the fixed effects model is preferred. The Hausman test provides the following results, which are presented in Table 8.

Table 8. Hausman test.

Test summary	Chi-sq. statistic	Chi-sq. d.f.	Prob.
Cross-section random	2.564	7	0.922

The probability of the Hausman test is greater than the 5% threshold (the p-value is 0.922, which is less than 0.05), so we accept the null hypothesis H0. Therefore, we should adopt a random effects model.

6.3. Estimation of the Random Effect Model

Table 9 provides the results of our estimated model.

Table 9. Results of the impact of financial development, financial innovation on economic growth.

Variable	Coefficient	Standard Error	t-statistic	Prob.
C	-5.579	3.293	-1.693	0.094
DGCF	-0.035	0.071	-0.497	0.620
DICT	0.073	0.036	2.013	0.047**
DFIS	-0.124	0.044	-2.800	0.006***
CAP	0.045	0.031	1.436	0.155
DCR	0.066	0.042	1.545	0.126
OPEN	0.198	0.090	2.198	0.031**

Note: *** and ** imply the significance at 1% and 5% level, respectively.

Our main results can be interpreted as follows.

For financial innovation, Table 9 shows that DCR had a positive but not statistically significant effect on economic growth. Our hypothesis H1a is rejected. This result corroborates the empirical evidence by Soltani, Ochi, and Saidi (2014), which shows that internal credit to the private sector has no effect on economic growth. However, this result contradicts the findings of Qamruzzaman and Jianguo (2018) and Nazir et al. (2021), which establish a significant correlation between credit to the private sector and economic growth. Internal credit to the private sector does not contribute to enhancing economic growth in sub-Saharan African countries. Despite reforms such as financial liberalization and banking sector integration, the financial sector in these countries remains notably weak. The lack of a link between internal credit to the private sector and economic growth can also be attributed to the scarcity of banks in rural areas, low banking awareness, and difficulties in obtaining credit information.

Furthermore, we find that the coefficient on DGCF is negative and not significant. These results align with those Kuawo-Assan (2015). The Gross Capital Formation has no effect on economic growth in sub-Saharan African countries. Our hypothesis H1b is rejected. Nevertheless, this result does not confirm the findings of Pasara and Garidzirai (2020), Boamah et al. (2018), and Reddy and Ramaiah (2020), which show a significant positive impact of gross capital formation on economic growth.

Many sub-Saharan African countries face the problem of acquiring access to the necessary funding to expand investment in fixed capital. Additionally, some sub-Saharan African countries suffer from political instability and economic risks such as inflation and high levels of debt, creating an unfavorable environment for investment in fixed capital.

Table 9 also shows that the coefficient on OPEN is 0.1980, indicating a higher economic growth of 19.80% for each 1% increase in trade openness. Openness to international trade has a positive impact on the economic growth of sub-Saharan African countries. These results confirm the empirical evidence by Ikpesu, Vincent, and Dakare (2019), which shows that the export-oriented growth strategy is valid in sub-Saharan African countries. Exports could have positive effects on employment in an economy due to their impact on growth via the derived demand theory. The effects of trade opening on growth may differ depending on the trade opening variable. Zahonogo (2016) finds that countries in sub-Saharan Africa need to control trade openness productively, especially imports of consumer goods, by stimulating their economic growth through international trade. Furthermore, these results are in line with the empirical findings of Banday et al. (2021) and Hao (2023), which show that trade openness has a positive impact on economic growth. Our hypothesis H1c is then confirmed. Furthermore, we find that the ICT variable has a positive and significant effect on economic growth. The coefficient for ICT is 0.0737, indicating a higher economic growth of 7.37% for each 1% increase in Information and Communication Technology. This coefficient is significant at the 5% level. This variable has played an important role in enhancing economic growth. These results are confirmed by several previous studies, such as Nwamen (2006), Musakwa and Odhiambo (2024), Haftu (2019), and Asongu and Le Roux (2017). By using effective information and communication technologies, companies can achieve productivity gains that enhance their competitiveness, thereby contributing to sustainable economic growth, which is essential for poverty reduction. ICTs expand opportunities for developing countries to participate in international markets. The Internet is transforming the way goods and services are produced, delivered, sold, and purchased. We confirm our hypothesis H1d.

In summary, these findings underscore the important role of financial innovation in promoting economic growth in sub-Saharan Africa. Moreover, indicators of financial innovation, such as domestic credit to the private sector and gross capital formation, have no impact on economic growth in sub-Saharan Africa. Weaknesses in the financial sector are a significant constraint to economic growth. Conversely, trade openness and information and communication technologies have a positive and significant impact on economic growth, suggesting that ICT and international trade should be strengthened in sub-Saharan Africa.

For financial development, we find that the coefficient on FIS is -0.1245, indicating a 12.45% decrease in economic growth for each 1% increase in liquid liabilities. This coefficient is significant at the 5% level. Liquid liabilities have a negative effect on economic growth in sub-Saharan African countries. When liquid liabilities increase, debt levels rise, which can serve as a warning signal to investors and regulators, as it may indicate an increased risk of default or financial crisis. Increasing reliance on debt can make banks more vulnerable to financial problems, including defaults or crises that threaten the stability of the financial and economic system. The size of financial intermediaries has a negative impact on the economic growth of sub-Saharan African countries. Our hypothesis H2a is rejected. However, this result is in opposition to the findings of Guru and Yadav (2019), Konstantakopoulou (2023), and Nguyen et al. (2022), who concluded that the size of financial intermediaries has a positive and significant impact on economic growth. Otherwise, the weaknesses of the financial sector in these sub-Saharan African countries primarily contribute to the negative impact of liquid liabilities on economic growth. Sub-Saharan African countries, therefore, need to reform their financial sector by improving liquidity management and access to finance.

The empirical findings also show that the CAP variable does not affect economic growth. This result corroborates Hasan et al. (2013), who find that the development of the stock market has no effect on economic growth in Sub-Saharan African countries. Our hypothesis H2b is then rejected. Nevertheless, this result does not corroborate the findings of El Aouam (2022) and Bhattarai et al. (2024), which confirm the positive and significant impact of market capitalization on economic growth. In fact, financial markets in Africa face many challenges, particularly in terms of resource mobilization, transaction weaknesses, liquidity issues, few listed companies, lower market capitalization, and a lack of technology. Additionally, poor infrastructure in Sub-Saharan African countries constitutes a major challenge to developing these markets and supporting economic growth in the region.

Although previous studies have shown that the size of financial intermediaries and market capitalization, taken as major indicators of financial development, play a crucial role in economic growth, Sub-Saharan Africa faces structural challenges that hinder the proper functioning of these mechanisms. Countries in Sub-Saharan Africa should focus on reforms to their financial systems and enhance their infrastructure to facilitate the development of financial markets, thereby promoting economic growth.

7. CONCLUSION

This study aims to analyze the effect of financial innovation and development on economic growth. Our empirical evidence is based on eight Sub-Saharan African countries, including Mozambique, Ghana, Nigeria, South Africa, Mauritius, Ivory Coast, Botswana, and Kenya, from 2011 to 2021. To achieve our objective, we used the Random Effects Model.

Our paper identified several significant findings. First, we demonstrated that information and communication technology positively impacts economic growth. This result has important policy implications for Sub-Saharan countries, which have increasingly prioritized ICT-related issues in recent years. Therefore, Sub-Saharan African countries should develop local plans for ICT applications and expand their use across various economic sectors due to their importance in fostering economic growth. Second, openness to international trade positively influences the economic growth of Sub-Saharan African countries. An export-oriented growth strategy is valid for these nations. To maximize the benefits of trade openness, it is essential for them to diversify exports, develop strategies to facilitate access to global markets, and reduce trade barriers. Third, the size of financial intermediaries has a negative impact on economic growth in these countries. Liquid liabilities contribute to the slowdown of economic growth. Policymakers must implement necessary reforms to improve the financial system and infrastructure to unlock the positive role of financial intermediaries in promoting growth. Fourth, domestic credit to the private sector and gross capital formation have no significant impact on economic growth. Weaknesses within the financial sector pose substantial constraints to growth. Finally, the development of financial markets has not contributed to economic growth. Countries in Sub-Saharan Africa should prioritize financial system reforms and infrastructure development to facilitate financial market growth and, consequently, economic development.

All these results have interesting implications. In fact, policymakers and stock market authorities in Sub-Saharan countries should implement strategies to attract more domestic and foreign capital, thereby increasing the supply and demand for securities in their capital markets and supporting their economic activity. Furthermore, a strong and stable banking system is a prerequisite not only for a robust private sector but also for an efficient and dynamic stock market. Despite its apparent robustness, the South African banking system is not immune to some weaknesses. Its dependence on sovereign debt and its relationships with sometimes fragile companies are real risks that could negatively impact economic growth. Additionally, to enhance the positive impact of ICT on economic growth in Sub-Saharan African countries, it is necessary to accelerate the level of digitalization to initiate structural economic transformation, develop local plans for ICT applications, and expand its use across various sectors of the economy, as this is important for boosting economic growth. It is true that our paper has two main limitations: a small sample size and difficulty in obtaining data in these countries. However, it offers a fertile ground for investigation, for example, into the influence of the quality of economic institutions, investment in infrastructure (especially in transport and energy), and the analysis of demographic dynamics (population growth, age distribution). Additionally, understanding the impact of external factors such as global economic shocks, fluctuations in commodity prices, and climate change would also be important for a better understanding of development challenges and opportunities in the region.

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