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Article

Inclusive financial development and banking sector stability in Africa: Is there a bi-causal relationship?

Benjamin Agyeman [1,*], Joshua Yidenaba Abor [2], and Peter Quartey [3]

1 University of Ghana Business School; benjaminagyeman38@yahoo.com, bagyeman002@st.ug.edu.gh
2 University of Ghana Business School; joshabor@ug.edu.gh
3 University of Ghana – ISSER, pquartey@ug.edu.gh
* Correspondence: University of Ghana Business School; benjaminagyeman38@yahoo.com , bagyeman002@st.ug.edu.gh.

Abstract: This study examines the bi-causal relationship between inclusive finance and banking sector stability in Africa. The study employs the two-step system GMM and the Dumitrescu and Hurlin (2012) Granger Non-Causality Test on annual data of 41 African countries over the period, 2004-2022. The results show that banking stability Granger-causes inclusive finance and vice versa. Thus, past values of stability influences inclusive finance and vice versa, thereby suggesting a bidirectional relationship between them. This offers basis for novel contribution to theory development on the bi-causal relationship between inclusion and stability. Policy makers should design policies that promote inclusion and safeguard stability.

Keywords: Banking Sector Stability, Inclusive Finance, GMM Regression, Dumitrescu and Hurlin (2012) Granger Non-Causality Test, Bi-causal Relationship, PCA Approach, Financial Intermediation, Financial Inclusion Theory, Africa.

JEL Codes: G21, C23, C33

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1. Introduction

Over the past decades, inclusive finance has gained popularity in academia and by policymakers due to the targeted broader objective of inclusivity and sustainable growth (Park & Mercado, 2018). Therefore, it was considered as one of the nine key pillars of the global development agenda and it serves as a catalysts for the AU Agenda 2063 (United Nation Report, 2016). Through inclusive finance, the poor, women, and the unbanked are able to access finance and are brought into the formal economy (Ozili, 2018; United Nation Report, 2016). The benefits of inclusive finance transient through both the macro and micro levels. It is able to salvage the global economy from economic crises thereby fostering economic resilience and financial stability (Ozili, 2018; Wang & Luo, 2022). Therefore, what kind of link exists between inclusive finance and banking sector stability or are these links both mutually reinforcing with the implementation of these two policies? Empirical studies demonstrate that higher level of inclusive finance connotes greater bank stability especially those in countries with stronger institutions (see Ahamed & Mallick, 2019; Vo et al., 2019a: 2020; Ghosh, 2022; Wang & Luo, 2022; Ozili, 2018; Morgan & Pontines, 2018). Moreover, having previously unbanked individuals and small firms in the financial system will help banks have steady customer deposits that enhance the provision of safe loans which promotes banking stability (Morgan & Pontines, 2018; Nguyen & Du, 2022) and are better able to assess default risks through the application of digital technologies which leads to improvement in banks' performance and soundness (Wang & Huazhi, 2018; Banna & Alam, 2021). Conversely, other studies suggested that too much inclusion could harm the stability of the banking sector due to high risks of loan

defaults by non-credit worthy borrowers or individuals (Bhattarai, 2015; Barik & Pradhan, 2021; Cull, Demirgüç-Kunt & Morduch, 2018; Khan, 2011).

Though, considerable amount of studies have been done regarding the relationship between these two variables, further works are needed as existing studies mostly ignored the possible bi-causality relationship between them. Furthermore, existing studies on the relationships between these variables produced conflicting outcomes. Again, as indicated by Anarfo et al. (2019), it is hard to come by a unified theoretical framework that help elucidate the modes through which banking stability is impacted by inclusive finance. Therefore, drawing of consistent conclusion is challenging. Apparently, the importance of studies on the bi-causal links between these variables is very critical as most countries are implementing policies and programs that will boost their financial systems and improve inclusion. To our best of knowledge, Anarfo et al. (2019) is the only study that explicitly examined the bi-causal relationship between financial sector development and financial inclusion in Africa. However, we deviate from their methodology (PVAR) by using the 2 step system GMM and Dumitrescu and Hurlin (2012) non-Granger-causality Test. Moreover, instead of proxying financial sector development by GDP per capita growth rate (annual %) as it was done in their case, we constructed an index for banking sector stability using four indicators of stability including bank Z-score. In this study, we concentrate on establishing the bi-causal relationship between banking stability and inclusive finance in Africa.

We contribute to literature in different ways. First, theoretically, this research advances financial intermediation and inclusion paradigms by filling in the gaps concerning studies of bi-causality models for developing countries since studies regarding this area are still embryonic. Thus, it gives the foundation for theory development on the bi-causal relationship between inclusion and stability. Second, empirically and methodologically, it provides novel Africa-wide evidence using the Dumitrescu and Hurlin (2012) non-Granger-causality Test and the system GMM estimation strategies. These robust econometric approaches ensure more reliable causal inferences and alleviates possible bias from reverse causality and omitted variable issues. Third, the study focuses on Africa, a region where the banking system is evolving and there is a wide range of disparities in inclusion levels within the region: from advanced inclusive financial systems in countries such as the Mauritius and South Africa to underdeveloped systems in countries like Sudan (World Bank, 2020). The regional scope provides relevant, context-specific insights that add empirical depth to the broader literature on specifically the bi-causal relationship between inclusion and stability.

The main result from the empirical analysis (the GMM and Dumitrescu & Hurlin (2012) non-Granger-causality Test estimations) is that there is a reverse causality between inclusive finance and banking sector stability in Africa. It is evident that inclusive finance is a driver of banking sector stability and vice versa. This suggests that both inclusion and stability Granger-cause each other. The result implies that when more people are financially included, it promotes banking sector stability while a well-developed and stable banking sector improves inclusion. This calls for policy makers to treat these two key variables as complements or as outcome variables of each other. The findings also indicate that both inclusion and stability show persistence in the various models with their lags recording statistically significant in explaining the respective dependent variables. This results suggest that previous levels of inclusion and stability were found to be positive and significant drivers of the current levels of both variables. Again, this indicates that the benefits of these variables move beyond their current year and having achieved inclusion and stability this year, subsequent years' attainment of levels of these variables will be easy.

The remaining part of the study is structured as follows: we focus on literature review in section 2, section 3 focuses on our methodology, section 4 contains the results and discussions and in section 5, we provide the conclusion, policy recommendations and future research directions.

2. Literature Review

In 2012, the European Central Bank (ECB) outlined three conditions that are associated with banking stability: (1) the banking system's ability to efficiently move resources from deficit lenders to spenders; (2) able to assess, reasonably price accurately and manage financial risks, and (3) positioned well to absorb financial and real economic surprises and shocks (ECB, 2012). Moreover, the ECB (2023) opined that the stability of banking system "encompasses a state where intermediaries, markets, and market infrastructures possess the resilience to endure shocks without significant disruptions in financial intermediation and the efficient allocation of savings towards productive investments" (ECB, 2023). In simple terms, the banking sector is in a stable state if it is able to absorb all forms of economic shocks to prevent total disruption of the intermediation process in the economy.

2.1. Theoretical Review

The inclusive finance development-banking stability nexus is deeply rooted in the economic and finance theory. Apparently, the theory of financial liberalization, financial intermediation, and Minsk's (1977) theory of financial instability are the three key theoretical frameworks that form the basis for this relationship. McKinnon (1973) and Shaw (1973) postulated the theory of financial liberalization. According to this theory, reduction in financial restrictions enhances access to financial access and for that matter inclusive finance, yet if this expansion is not properly supervised or regulated it could weaken the financial system. The Minsk's theory of financial instability supports this assertion as it focuses on the risks of excessive credit growth due to credit risks or default risks under weak risks management system. Besides, the Gurley and Shaw (1960) theory of financial intermediation identifies the important role of financial institutions in the connection between surplus spenders and surplus lenders in promoting access to financial services. Interestingly, this theory ignores the effects of institutional weaknesses in the intermediation process and assumes markets to be perfect. Other authors like Demirgüç-Kunt and Klapper (2013) suggested that barriers such as distance and documentation hinder participation (access) for the unbanked. This financial inclusion theory has its strength which aims at equity promotion while an "overseeing over-indebtedness" risk is its weakness. Similarly, Banna et al. (2021) opined that the relationship between inclusive finance and banking stability could be examined theoretically by three distinct hypotheses: (i) diversification, cost reduction and market power, (ii) reduction of procyclicality, and (iii) absorption of inclusion-induced monetary shock.

2.2. Empirical Studies

Empirical studies linking inclusive finance development and banking stability have documented mixed findings. This could possibly be due to certain factors such as research methodologies, variables or the selected sample of countries the studies concentrated on. We classify these reviewed papers into three categories: those showing positive effect or negative effect, and no significant effects between these policies.

Majority of works support the positive effects of inclusive finance development on banking stability (see Ahamed et al., 2017; Olusegun et al., 2021; Wang et al., 2022; Morgan & Pontines, 2018). For instance, Chinoda and Kapingura (2023) examine the link among digital financial inclusion (DFI), financial competition, and bank stability in the SSA. The GMM regression results indicate a positive link between DFI and bank stability over the study period, 2014–2020. The impact of financial inclusion on financial development in Nigeria was examined by Anthony-Orji et al. (2022) spanning the period, 1982-2019. The OLS results indicate that deposits have direct impact on financial development while investment is a critical factor that affects financial development and stability in Nigeria. Similarly, Joudar et al. (2025) examine the relationship between financial inclusion and banking stability in 26 countries across Africa and MENA for the years 2011, 2014, 2017,

and 2021 by employing the hierarchical multiple regressions (HMR) approach. The findings indicate that financial inclusion impact financial stability positively through channels such as digital payments and the number of bank branches. However, other channels like ATMs, money supply, and savings have negative impact on financial stability. In examining the impact of financial inclusion on financial stability in the West African Economic and Monetary Union (WAEMU), Coulibaly (2023) document evidence of positive impact of financial inclusion on long term financial stability. In tandem with such result is the study of Ozili (2018) who found that high financial service promotes more stable financial system in African countries.

Conversely, other studies documented negative effects of financial inclusion on financial system citing rapid extension of credit to individuals and the private sector without proper regulation or supervision, lowered lending standards (quality of loans), and weak credit rating breeds more default risks which harms the financial system (e.g., Antwi et al., 2024; De la Torre et al., 2013; Sahay et al., 2015). This financial instability can lead to elevated inflation. Khan (2011), indicates that outsourcing some functions by banks in trying to meet the needs of smaller investors has the potential to increase their reputational risks. Amatus and Alireza (2015) examine the impact of financial inclusion on financial stability in 35 African countries spanning 2004 to 2011. The finding indicates that deposits have negative impact on financial stability as a result of panic withdrawals especially in times of crisis. Khan (2011) argues three ways that inclusive finance negatively impacts the stability of the banking sector: higher inclusion agenda leading to lowering of lending standards by financial institutions, increase in banks' reputational risks, and improper regulation of Micro Financial Institutions (MFIs) that can lead to the dilution of the overall effectiveness of regulation in the economy thereby increasing financial system risks.

Interestingly, few studies recorded no significant link between financial inclusion and banking stability (e.g., Demirguc-Kunt et al., 2022 and the IFC). According to Ardic et al. (2013) study, no link exists between inclusive finance and financial stability probably due to indirect relationship and this is supported by Abbad and Touati (2022). Importantly, CGAP (2023) opined that empirically, inconclusive relationship exist between financial access (account penetration) and financial stability.

Examination of the existing literature indicate mixed findings which can be explained by context specific dynamics, threshold effects, and methodological differences. We are convinced that there is scarce literature on the bi-causal relationship between inclusive finance and banking stability in Africa based on the reviewed literature. Therefore, the yawning gap is addressed in this particular study. This study moves beyond unidirectional assumptions and captures the dynamic interplay between inclusive finance and banking stability by explicitly modeling bi-causality between these two key variables. This approach is both theoretically coherent and empirically validated. Given the dynamic and heterogeneous nature of African economies, system GMM is employed as the baseline estimator to address endogeneity and dynamic bias, while the Dumitrescu–Hurlin (2012) panel causality test serves as a robustness check to validate the existence and direction of bi-causality across countries. The theoretical expectation behind examining causality between inclusive finance and banking stability is entrenched in how wider access to financial services reforms the soundness of the banking system in general. This is supported by theories such as financial intermediation theory. By inference, inclusive finance promotes stability by diversifying risks and increasing participation while stability on the other hand promotes inclusion by building trust and facilitating access. Therefore, the bi-causality expectation is hinged on their underpinning in a virtuous cycle, creating a more resilient and equitable financial system. Thus, inclusion stabilizes banks and stable banks boost deeper inclusion. This study is underpinned by a number of theories including financial inclusion theory (Ozili, 2024), Financial Stability Theory, and Theory of Financial Intermediation (Gurley and Shaw, 1960). We set the hypothesis as:

H1. Inclusive financial development and banking sector stability Granger cause each other.

3. Methodology

3.1. Data Source, Sample, and Description of variables

We employ annual secondary panel data of 41 African countries covering the period, 2004-2022. Appendix A.1 presents the data sources and descriptions of all the variables for this study. The inclusion of countries was solely based on the availability of necessary data for the study. These countries had substantial data observations for at least five consecutive years of data reporting. We relied on World Development Indicators (WDI), the International Monetary Fund (IMF), the Global Financial Development Database, and the World Governance Indicator (WGI) for all the datasets. Let's note that both banking sector stability and inclusive finance serve as dependent and independent variables.

3.2. Dependent Variables

Banking Sector Stability: instead of using single indicator such as bank Z-Score (see Ahamed & Mallick, 2017) we employed an index constructed from 4 indicators inclusive of bank Z-score by using the Principal Component Analysis (PCA hereafter). We expect this variable to have a positive link with inclusive finance as a stable financial system breeds trust thereby promoting inclusion. As a robustness check or alternative measure, we employed the ratio of non-performing loans (NPLs to total loans. We used this because NPLs is primarily the driver of instability in African banking system (see Haile et al., 2024). Again, according to the IMF (2022), NPLs is one of the core financial soundness indicators used by many regulators and researches and it is particularly relevant in low and middle income countries where credit risk is the most immediate threat to banking sector stability. Again, IMF categorically stated that NPLs remain the most practical and policy- relevant stability measure for emerging economies.

Inclusive Finance: We employed seven variables or indicators in constructing the inclusive finance index through the PCA approach. This approach is in tandem with some previous studies (see Iddrisu et al. 2022). We expect inclusive finance to have positive impact on stability since high financial service promotes more stable financial system and the influence of financial inclusion enables banks to attract low-risk retail deposits. As a robustness check, we employed active bank account per thousand adults as an alternative measure of inclusive finance. We are of the view that having bank transaction accounts serves as the foundation for the inclusiveness.

3.3. Independent or control variables

Literature suggests that macroeconomic and institutional factors influence inclusion-stability nexus (see Aluko et al., 2018), hence we included some of these factors in our model. Inflation: We proxy this variable by the annual consumer price index (CPI %). Higher inflation in an economy negatively impacts inclusion due to higher borrowing costs and erosion of purchasing power leading to higher interest rates thereby making it less affordable for SMEs and the low-income individuals. We expect negative connection between the higher levels of this variable and inclusive finance (see Ozili, 2024). Additionally, higher level of inflation creates liquidity risks, increase loan defaults and weakens investor confidence. This has a negative impact on banking stability (See Ozili, 2024). Interest rate spread: We measured it as the difference between commercial banks' average lending and deposit rates. A wider value increases the profitability of banks but too much of it affects bank liquidity and stability due to withdrawal of funds and low levels of deposits. In terms of inclusive finance, access to credit for SMEs and individuals are weakened and individuals are discouraged to save due to low deposit rates thereby reducing financial participation. A wide bank interest rate spread generally hinders

banking sector development by discouraging borrowing, limiting financial intermediation, and reducing competitiveness, while narrower spreads promote efficiency, credit expansion, and deeper financial markets. We expect wide bank interest rate spread to be negatively related with banking sector development and inclusion policy.

Institutional quality reflects the quality of governance which normally serves as proxy for economic institutions. Following previous works (see Kaufmann, 2009; Rojas-Suárez, 2016) we constructed simple institutional quality index by using the average of six governance indicators: control of corruption, voice and accountability, political stability and absence of violence/terrorism, rule of law, regulatory quality, and government effectiveness. We expect institutional quality to have positive impact on both inclusion and stability since strong institutions ensure clear financial regulations, consumer protection and trust in the financial system. Population growth has both positive and negative impact on inclusion and stability (see Joudar et al., 2025; Pal & Bandyopadhyay, 2022). Higher population growth impedes inclusive finance since banks lags behind population growth in provision of financial services. Banks enjoy higher levels of banking services but face potential of increase default risks. We proxy it by the annual population growth rates (%). The annual GDP growth (%) is a proxy for the level of economic activity in the country. It is highly assumed that the banking sector expands in countries that experience higher growth rates since there will be demand for more finance. This will have a positive impact on both inclusive finance and stability of the banking sector.

3.4. Model Specification

In modelling the connection between inclusive finance and banking sector stability, we built our models on: financial liberation theory (McKinnon, 1973; Shaw, 1973), theory of financial innovation (Silber, 1983), Minsk's theory of financial instability, and the Gurley and Shaw (1960) theory of financial intermediation highlighting the role of banks in promoting access to financial services. Subsequently, we included some macroeconomic indicators that account for potential difference within countries in the levels of inclusive finance and banking sector developments as prescribed in literature. In establishing the links between inclusive finance and banking sector stability, we specify models 1-4 which are in line with the previous works (e.g., Anarfo et al., 2019; Morgan & Pontines, 2014).

$$BSTAB_{it} = \beta_1 BSTAB_{it-1} + \beta_2 IFI_{it-1} + \beta_3 INFL_{it-1} + \beta_4 GDP_{it-1} + \beta_5 BSPRD_{it-1} + \beta_6 POP_{it-1} + \beta_7 INSQUAL_{it-1} + v_t + f_i + e_{it} \quad (1)$$

$$IFI_{it} = \alpha_1 IFI_{it-1} + \alpha_2 BSTAB_{it-1} + \alpha_3 INFL_{it-1} + \alpha_4 GDP_{it-1} + \alpha_5 BSPRD_{it-1} + \alpha_6 POP_{it-1} + \alpha_7 INSQUAL_{it-1} + \varphi_t + \psi_i + e_{it} \quad (2)$$

Introducing the dummies for the 2008-2009 Global Finance Crisis and the COVID-19 Pandemic give equations 3 & 4 as follows:

$$BSTAB_{it} = \beta_1 BSTAB_{it-1} + \beta_2 IFI_{it-1} + \beta_3 INFL_{it-1} + \beta_4 GDPG_{it-1} + \beta_5 BSPRD_{it-1} + \beta_6 POPG_{it-1} + \beta_7 INSQUAL_{it-1} + \beta_8 COVID\_DUMMY + \beta_9 GFC\_DUMMY + v_t + f_i + e_{it} \quad (3)$$

$$IFI_{it} = \alpha_1 IFI_{it-1} + \alpha_2 BSTAB_{it-1} + \alpha_3 INFL_{it-1} + \alpha_4 GDP_{it-1} + \alpha_5 BSPRD_{it-1} + \alpha_6 POP_{it-1} + \alpha_7 INSQUAL_{it-1} + \alpha_8 COVID\_DUMMY + \alpha_9 GFC\_DUMMY + \varphi_t + \psi_i + e_{it} \quad (4)$$

Where,

- $IFDI_{it}$ = inclusive financial development index in country i at time t,
- $BSTAB_{it}$ = bank stability index in country i at time t,
- $INFL_{it}$ = Inflation in country i at time t,
- $GDPG_{it}$ = GDP growth in country i at time t
- $BSPRD_{it}$ = Bank interest rate spread in country i at time t
- $POPG_{it}$ = Population growth in country i at time t

- $INSQUAL_{it}$ = Institutional quality in country i at time t
- $COVID\_DUMMY$ = Crisis dummy for 2019-2021 covid-19 pandemic
- GFC_DUMMY = Crisis dummy for 2008-2009 global financial crisis
- ψ_i = Time effect in country i
- φ_t = Country time effect at time t
- Ɛi,t = Error term in the country i at time t.

According to Dumitrescu and Hurlin (2012), x and y denote two stationary variables observed for N individuals on T periods. For each individual $i = 1, \ldots, N$ at time $t = 1, \ldots, T$, then the non-causality test in heterogeneous panel data model is given by a linear model as follows:

$$y_{i,t} = a_i + \sum_{k=1}^{k} \gamma_{i,k} y_{i,t-k} + \sum_{k=1}^{k} \beta_{i,k} x_{i,t-k} + \varepsilon_{i,t} \quad (5)$$

with $K \in N$ and $\beta_i = (\beta_{1,\ldots.}\beta_k)$. Moreover, due to simplicity sake, a_i the individual effect is fixed in time dimension and the initial conditions $(y_{i-k,\ldots.}y_{i,0})$ and $(x_{i-k,\ldots.}x_{i,0})$ of both individual processes of $y_{i,t}$ and $x_{i,t}$ are given and observable.

Note: $y_{i,t}$: Dependent variable for unit i at time t, $x_{i,t}$: Independent variable for unit i at time t, $\beta_{it:}$ Granger causality coefficient, a_i: Individual fixed effects, and K is the number of lags.

The test is based on the following hypotheses:

Ho: No Granger causality for any cross-sectional unit (i. e, $\beta_{it:} = 0$ for all i)

Ha: Granger causality exists for at least one unit ($\beta_{it:} \neq 0$ for some i)

Therefore, we run two models:

Model A: Does inclusive financial development Granger-cause banking sector development? Model B: Does banking sector stability Granger-cause inclusive financial development?

In addition, from equation 5, we specify the Granger-causality models based on Dumitrescu and Hurlin (2012) as follows:

$$BSTAB_{i,t} = a_i + \sum_{k=1}^{k} \gamma_{i,k} BSTAB_{i,t-k} + \sum_{k=1}^{k} \beta_{i,k} IFI_{i,t-k} + \varepsilon_{i,t} \quad (6)$$

$$IFI_{i,t} = a_i + \sum_{k=1}^{k} \gamma_{i,k} IFI_{i,t-k} + \sum_{k=1}^{k} \beta_{i,k} BSTAB_{i,t-k} + \varepsilon_{i,t} \quad (7)$$

Where, BSTAB and IFI are banking sector stability and inclusive finance development indices respectively while the other variables or symbols retain their meanings as indicated under equation 5.

3.5. Estimation techniques

With reference to our panel dataset, objective, and literature we implement the systems generalized method of moments (GMM) estimation for our dynamic models. The GMM estimators and their extensions were engineered by Arellano and Bond (1991), Arellano and Bover (1995), Blundell and Bond (1998) and Holtz-Eakin, Newey, and Rosen (1988). Literature considers mostly two main types of estimators within the GMM: the system GMM and difference GMM. However, the former is preferred over the latter due to its superiority (see Agbloyor et al., 2016; Gyamfi et al., 2022). Two step System GMM is theoretically and empirically superior because it solves the dynamic panel bias problem, strengthens instrument validity, and ensures robust inference in small T, large N financial datasets. It is superior and critical in this study which is centered on Africa because it directly tackles heterogeneity across countries, corrects dynamic bias in short panels as well as controlling endogeneity with strong internal instruments. This makes it the most reliable estimator for study on inclusive finance and banking sector stability. Therefore, we made use of the two-step system GMM in our estimations.

The difference GMM is considered to have two key inefficiencies: using "lagged levels of the explanatory variables as instruments for the regression equation in differences and the nullification of the country-specific effect in the estimation" (see Gyamfi et al., 2022). Conversely, the two –step system GMM has the ability to "produce

more asymptotic efficient estimates than one-step system GMM estimator, particularly in the presence of heteroskedasticity" (see Aluko et al., 2018) and has the capacity to handle endogeneity issues allied with the explanatory variables, and serial correlation tests by the Arellano and Bond (1991) for both first and second order correlations. Hansen test (over-identification restrictions) and the Sargan test (1958) are employed to test the validity of the instruments used in the estimations. The Hansen test is the safeguard that makes system GMM credible in Africa's heterogeneous context by confirming that the instruments used to handle endogeneity are valid and not driving spurious results. If the p value > 0.05 then we fail to reject null hypothesis suggesting that the instruments are valid and if p value < 0.05 we reject null hypothesis indicating that instruments may be invalid (over fitting or correlation with errors. Let's notice here that other estimators were initially considered but were dropped along the line due to their shortcomings. For instance, Panel Quantile Regression has the power of capturing heterogeneity across quantiles but does not solve dynamic panel bias (Nickell bias) and struggles with endogenous regressors. Similarly, Panel Threshold Models are also limited as they are useful for non-linear regime shifts but require large samples and strong assumptions about threshold variables and they are unable to handle endogeneity well.

Besides the GMM estimations approach, the study implemented the Dumitrescu and Hurlin (2012) Granger Non-Causality Test as the alternative approach (robustness check) This test is designed for detecting causal relationship across heterogeneous cross-sectional units. This approach is preferred to the traditional Granger causality because it allows for individual-specific dynamics and heterogeneity. Thus, it is largely used in panel data estimations to test whether one variable Granger-cause another across multiple cross-sectional units. Outcomes of this approach give more reliable and credible findings for policy consideration especially regarding the study of bi-causal linkage between inclusive finance and banking sector stability.

3.6. Principal Component Analysis (PCA)

We employed PCA technique to construct the indices. According to Aluko et al. (2018), PCA is able to transform a number of correlated variables into a smaller number of uncorrelated variables thereby reducing a set of observed variables into principal components which retain information from the original set of variables as much as possible. Construction of indices also avoid proxy bias, enable comparability, policy relevance and captures dynamics. The theoretical justification comes from capability theory (Sen, 1979), measurement theory (Spearman, 1994), institutional economics (North, 1990), systems theory, and development economics. Existing studies that have employed indices include Iddrisu et al., 2022, Anarfo et al., 2019, Gyamfi et al., 2022, etc. This estimation technique stipulates that the jth factor can be written as:

$$BSTABX_j = W_{j1}X_1 + W_{j2}X_2 + W_{j3}X_3 + \ldots + W_{jp}X_p \quad (8)$$

$$IFDIX_j = W_{j1}X_1 + W_{j2}X_2 + W_{j3}X_3 + \ldots + W_{jp}X_p \quad (9)$$

Where, $BSTABX_j$ and $IFDIX_j$ are banking sector stability index and inclusive finance development index respectively, the factor score weights are represented by Wj; the respective components are indicated by X and P denotes the number of variables in the equation. Our indices are therefore specified as follows:

$$BSTABX = f(S1, S2, S3, S4) \quad (10)$$

$$IFDIX = f(BCBPTA, DCBPTA, ATMPHTA, BBPHTA, BBPTK, ATMPTK, BAPTA) \quad (11)$$

Figures 2 shows the scree plots from the PCA with one eigenvalue each being greater than one. Additionally, the results of the principal component in Appendics A.3 and A.4 and Kaiser-Meyer-Olkin (KMO-1974) values indicate the adequacy of our variables for the

construction of the respective indices. We employed the orthogonal vari-max rotation coefficients scoring method in constructing the indices.

Figure 1. Caption please

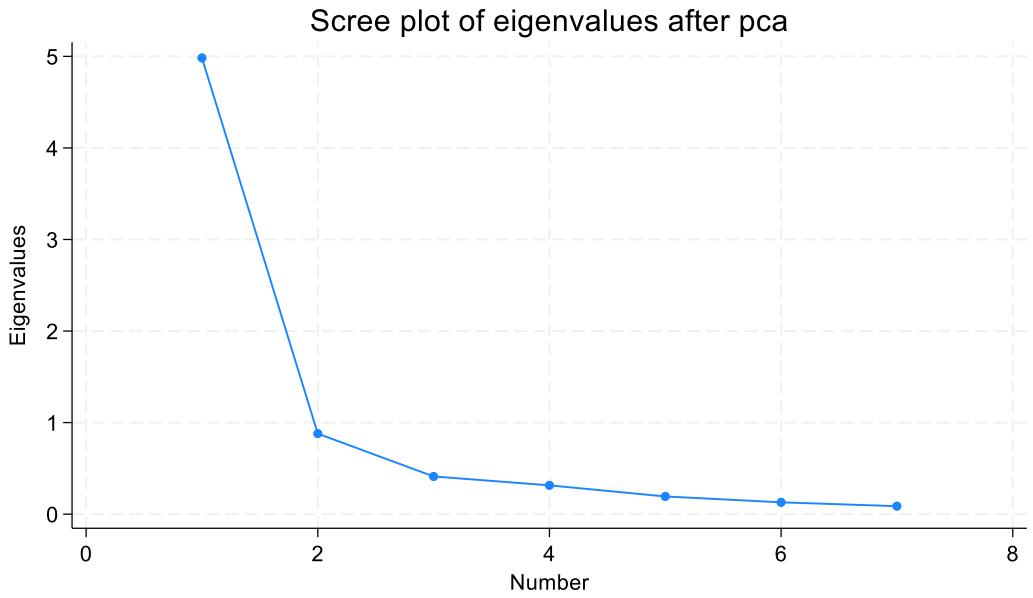
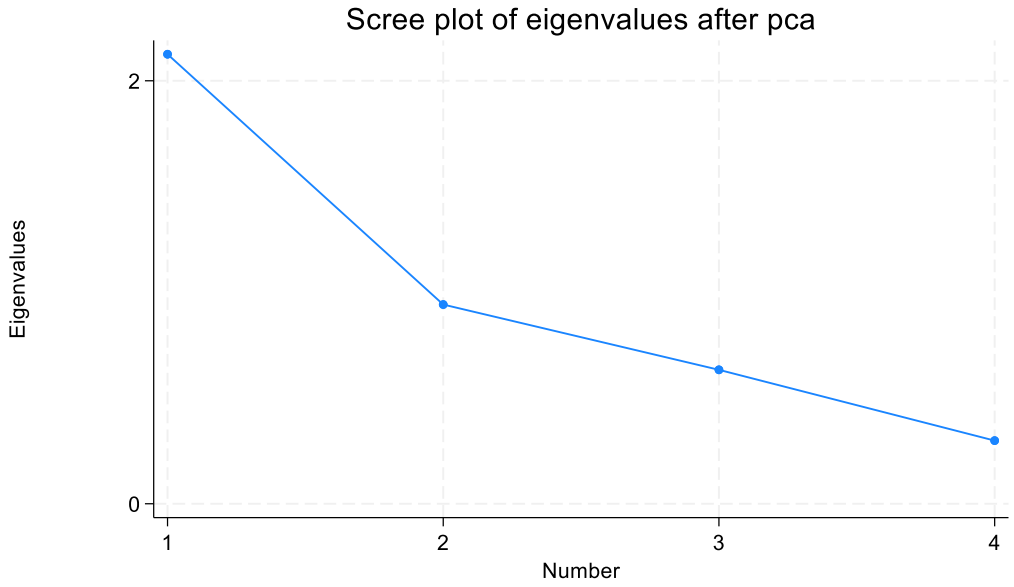


Figure 2. Scree Plot of Eigenvalues after PCA for Inclusive Finance Index



Source. Authors'

4. Results

The descriptive statistics, correlation matrix, unit root tests, regression results and discussions, and robustness analyse are contained in this section. Let's notice that we carried out outliers' checks and the outliers were winsorized before other relevant tests and analyses were done. Similarly, Appendix A.2 under appendices gives the results of the cross-sectional dependence (CD) tests that were carried out. The tests results indicate no level of CD in the dataset. It is therefore imperative to indicate here that our summary statistics, correlation matrix and regression results are devoid of the problems of outliers.

4.1. Descriptive Statistics

The dynamism of the dataset is depicted in Table 1. We first checked for outliers and rectified the data points with issues of outliers appropriately before the main analysis. Therefore, there is no need for any special treatment again since the final dataset shows no abnormal pattern or whatsoever. However, the descriptive statistics indicates a number of the variables are not normally distributed since their respective skewness and kurtosis values lie outside the range 0 and 3. Indeed, this does not have any significant negative impact on our regression results and conclusion of the study. Interestingly, system GMM estimator is able to handle issues of non-normality giving us breathing space to operate. In addition, it is clearly observed from Table 2 that multicollinearity is not a problem in this study.

Banking stability (BSI1 & S4) and inclusive finance (DIFI & BAPTA) serve as both dependent and independent variable in the models at some point in time. IFI has a mean value of 0.0336, minimum and maximum values of -1.5944 and 1.2365 respectively suggesting an average inclusive finance in the selected countries in Africa for the study period is low. BSI1 has a mean value of 3.52e-09 with minimum and maximum values -1.4125 and 2.3 respectively. This suggests that on average, the banking stability index for the study countries is low. The alternative measure, the S4 has the mean value of 72.8920 with 14.72 00 and 143.250 representing the minimum and maximum values respectively.

Table 1. Descriptive Statistics

Variables.	Obs.	Mean	Std. Dev.	Min.	Max.	Skewness	Kurtosis
DIFI	697	0.0336	0.1825	-1.5944	1.2365	-1.2030	26.7943
IFI	738	9.25e-09	1.0000	-0.8802	3.0320	1.728902	5.3896
BAPTA	738	324.3433	367.9549	0.4700	1440	1.7289	5.3896
BSI1	738	3.52e-09	1.0000	-2.1377	2.2938	0.6770	2.7630
S4	738	21.2679	13.9088	2.0881	54.8516	0.8698	3.0246
GDPPC	738	2179.9810	2176.137	133.170	7808.21	1.4057	3.7949
BSPRD	738	7.7060	9.1074	-3.6017	66.8948	2.3087	11.2546
DBSPD	697	-0.0551	2.0501	-19.846	14.7542	-0.8826	24.8341
INFL	738	6.8943	5.8806	-8.9747	21.7111	0.9255	3.3662
GDPG	738	4.2679	3.4813	-3.5506	10.7602	-0.3919	2.9832
POPG	738	2.4618	0.7704	0.7730	3.5988	-0.6888	2.70170
DPOPG	697	-0.0058	0.1752	-1.3559	2.3979	3.1282	70.7086
INSQ	738	-0.6245	0.5499	-1.8978	0.8757	0.4118	3.2958

Note. DIFI is the first difference of inclusive finance Index, IFI is inclusive finance index, BAPTA is bank accounts per 1000 adults, BSI1 is banking sector stability index, S4 is alternative measure of banking stability, BSPRD is bank interest rate spread, INFL is inflation, GDPG is growth domestic product growth rate, POPG is population growth, INSQ is institutional quality. Please, note that D in front of the symbols of the variable(s) indicates the first difference of that variable(s) was/were used

Table 2. Correlation Matrix

	DIFI	1FI	BAPTA	BSI1	S4	BSPD	INFL	GDP	POP	INSQ
DIFI	1.00									
IFI	0.23	1.00								
BAPTA	0.23	1.00	1.00							
BSI1	-0.18	-0.10	-0.10	1.00						
S4	-0.06	-0.19	-0.19	0.35	1.00					
BSPD	-0.07	-0.08	-0.08	0.35	0.25	1.00				
INFL	-0.02	-0.07	-0.07	0.18	0.31	0.38	1.00			
GDPG	-0.01	-0.17	-0.17	0.00	-0.07	0.04	0.01	1.00		
POPG	-0.09	-0.65	-0.65	0.08	0.25	0.100	0.09	0.22	1.00	
INSQ	0.16	0.51	0.51	-0.34	-0.31	-0.12	-0.19	0.07	-0.37	1.00

Note. This table presents pairwise correlation coefficients based on aggregate samples, the sizes of which may vary due to missing values.

4.2. Unit Roots Test Results

In panel data analysis, it is very important for the variables to be stationary. We conducted four different panel unit root tests for all our variables. These different tests were the Levine–Lin Chu (LLC) test, Harris-Tzavalis (HT) test, Im Pesaran & Shin (IPS) test, and Philips–Perron (PP) test. Using different tests give more predictive results as compared to the univariate ones and there is greater level of flexibility in computing the coefficients compare to ADF. The results of the panel roots tests are indicated in Table 3. IFI and BSPRD are integrated of order one I (1) with the remaining variables being integrated of order zero I (0). As an accepted approach, we took first difference of all the variables of order one I (1) making them stationary before employing them in our analysis.

Table 3. Panel Unit Root Tests Results

VAR.	LLC Test		Im–Pesaran–Shin		Fisher Test		Harris-Tzavalis Test	
	Test statistic	p-value	Test statistic	p-value	Test statistic	p-value	Test statistic	p-value
IFI	-5.4354	0.1650	-6.2389	0.0000	84.3556	0.4074	0.9266	0.9996
D.IFI	-13.021	0.0095			410.176	0.0000	0.1999	0.0000
BAPTA	-5.4354	0.1650	-6.2389	0.0000	84.3556	0.4074	52.5628	0.0000
D.BAPTA	-13.021	0.0095			410.176	0.0000		
BSI	-9.3476	0.0009	-1.9278	0.0269	127.431	0.0010	0.7548	0.0003
POPG	-6.2485	0.0453			136.682	0.0001	0.7776	0.0056
GDPG	-13.744	0.0000	-8.7023	0.0000	-12.503	0.0000	0.2585	0.0000
INSQUAL	-11.827	0.0000	-1.6243	0.0522	134.096	0.0003	0.8593	0.7501
BSPRD	-0.0163	0.4942	0.7063	0.7600	201.160	0.0000	0.7471	0.0001
D.BSPRD	-28.224	0.0000	-8.8550	0.0000				
INFL	-17.230	0.0000	-7.7456	0.0000	338.395	0.0000	0.3984	0.0000
S1	-9.954	0.0074	-3.2824	0.0005	139.751	0.0001	0.7324	0.0000
S4	-7.9730	0.0231	-1.0870	0.1385	113.691	0.0118	0.7496	0.0009
D.S4			-11.7502	0.0000				

In addition to the four panel unit roots tests conducted above, we employed the cross-sectional augmented IPS test (CIPS) which is a second-generation panel unit root test that account for cross sectional dependence in the panel dataset. The results indicate that inclusive finance index (IFI), population growth (POPG), bank interest rate spread (BSPD), and active bank accounts per 1000 adults (BAPTA) are integrated of order one I (1) hence these were differenced before the regression analyses were done. Their critical values are greater than their respective CIPS statistics or values. The remaining variables

are integrated of order zero I (0). Let's notice here that three cross sectional dependence test were conducted as well.

Table 4. Results of the CIPS Test

VARIABLE	CIPS	CRITICAL VALUES		
		10%	5%	1%
IFI	-1.447	-2.03	-2.11	-2.25
DIFFERENCED IFI	-2.806	-2.03	-2.11	-2.25
BSI1	-2.461	-2.03	-2.11	-2.25
INFLATION (INFL)	-2.647	-2.03	-2.11	-2.25
GDPG	-2.945	-2.03	-2.11	-2.25
POPG	-1.523	-2.03	-2.11	-2.25
DIFFERENCED POPG	-2.352	-2.03	-2.11	-2.25
BSPD	-1.647	-2.03	-2.11	-2.25
DIFFERENCED BSPD	-3.309	-2.03	-2.11	-2.25
INSQ	-2.488	-2.03	-2.11	-2.25
S4	-2.036	-2.03	-2.11	-2.25
DS4	-3.966	-2.03	-2.11	-2.25
BAPTA	-1.447	-2.03	-2.11	-2.25
DBAPTA	-2,585	-2.03	-2.11	-2.25

4.3. Selection and computation of lag order

The technique for selecting the appropriate number of lags for carrying out the baseline and robustness analyses is reported in Table 5. The selection criteria of the three models by Andrews and Lu (2001) and the overall co-efficient of determination, AIC and HQIC call for order four while SBIC calls for order one. These are based on their least values. However, for a short panel (T = 18) using lag four will lead to loosing too many degree of freedom and risk overfitting as well as instrument proliferation (weakens validity) in GMM estimation. Similarly, DH (2012) emphasized the need for parsimony in lag selection in short panels. In view of this we restricted our lags to a maximum of two.

Table 5. Lag Order Selection and Estimation

LAG	LL	LR	DF	P	FPE	AIC	HQIC	SBIC
0	-32.3392				0.6756*	5.2830	5.2651	5.3699*
1	-29.4448	5.7888	4	0.215	0.8140	5.4531	5.3995	5.7138
2	-25.6162	7.6574	4	0.105	0.8932	5.4794	5.3901	5.9140
3	-22.0071	7.2181	4	0.125	1.1251	5.5396	5.4145	6.1480
4	-14.1879	15.638*	4	0.004	0.9199	4.9520*	4.7912*	5.7342

Notes. AIC, Akaike information criteria, HQIC, Hannan-Quinn information criterion, SBIC, Schwarz Bayesian information criteria.

4.4. Regression Results of Bi-Causal relationship between Banking Sector Stability and Inclusive Finance Development using GMM.

The GMM estimation results show a confirmation of bi-causal relationship between banking sector stability (BSI) and inclusive financial development (DIFI) as indicated in Table 6. There is positive and statistical significance effects of the lags of IFI on BSI. This tends to suggest that past improvements in inclusive finance enhances the stability of the banking sector. Specifically, the result indicates that one-unit increase in financial inclusion is associated with a 0.6580 unit improvement in stability. This suggests that broader access to financial services enhances diversification of deposit base, reduction in the reliance of volatile funding sources, and increasing formal savings as more people get financially included thereby enhancing the resilience and soundness of the banking

system. Thus, inclusive finance reduces reliance on informal and risky financial channels. This finding supports the financial intermediation theory. On the other hand, we document evidence that banking stability shows persistence and positively impact inclusive finance over the study period. In terms of magnitude, the result shows that one-unit increase in stability leads to an average 0.3207unit increase in inclusion, holding other factors constant. This means that greater banking sector stability is associated with higher financial inclusion. This finding supports the finance-growth nexus theory. Moreover, as stable banks expand, they create the needed infrastructure and trust that promotes inclusive finance.

Our results are in tandem with some theoretical and empirical papers that documented evidence of financial inclusion exhibiting positive impact on financial sector development (see Anarfo et al, 2019; Koudalo & Toure, 2023; Ofoeda, Mawutor & Ohenebeng, 2024; Damane & Ho, 2024). However, other studies obtained contrasting outcomes (see Khan, 2011; Čihák, Mare & Melecky, 2021). Let's notice here that most of the previous studies examined one-way relationship, while we examine bi-causal relationship between stability and inclusion. We do not discount the findings of these studies but our finding of bidirectional relationship is more comprehensive since these two variables could depend on each other thereby exhibiting complementation rather than competition. This is in sharp contrast to the assertion that too much inclusion leads to lower asset quality thereby causing banking instability (Khan, 2011). This result is an indication that policies directed at achieving financial inclusion will not swallow the financial sector development but can improve it.

The macroeconomic and institutional variables exhibit mixed results. However, we limit our discussions to only inflation and institutional quality. The finding suggests that inflation shows asymmetric effects on inclusion and stability. The lag of inflation posits strong impact on IFI as it recorded positive coefficient and statistical significance in model 2. The coefficient of inflation on financial inclusion is 0.0318, significant at the 1% level ($p = 0.008$). This implies that a one-percentage point increase in inflation is associated with a 0.0318 unit rise in inclusion. The finding supports the financial adaptation theory. Previous studies found similar findings (see Madouri, 2025; Ozili, 2024) and higher inflation can lead to high default risks thereby having negative effect on bank stability. Madouri's (2025) study who finds that inflation can drive short-term financial deepening. This is more serious in areas where digital finance platforms can easily provide safe and accessible alternatives to depreciating cash. Conversely, the lag of inflation negatively and statistically impacts BSI. This is indicates that past inflation values undermine current banking sector stability. In situation like this, banks are subjected to higher non-performing loans and distortion in interest rate structures cumulating into difficulty in managing liquidity and risks. The coefficient of inflation on banking sector stability is –0.0124, significant at the 5% level ($p = 0.015$). This indicates that one-percentage point increase in inflation reduces stability by 0.0124 units. This shows that past inflation values undermine current banking sector stability. This reflects a behavioural response that more people and SMEs are pushed to demand more financial services probably to access credit or protect savings due to rising inflation. This finding concurs the financial fragility theory which opined that inflation erodes the real value of deposits, discourages savings, and destabilizes banks. Studies by Ozili (2024) and Sarbeng-Adjebeng Akrofi (2022) lend credence to our findings where they indicate that in economies with weak inflation-targeting frameworks the real value of bank assets deteriorate and there are high levels of defaults risks. Additionally, banks' profits are reduced due to increased non-performing loans (NPLs) occasioned by inflation pressures.

On the other hand, the lag of institutional quality positively and significantly influences both IFI and BSI but with a stronger effect on inclusion compared to stability. This indicates that the previous institutional regulation positively impact current BSI and IFI in Africa. Specifically, the findings show that a one-unit increase in institutional quality raises inclusion by 2.3742 units while a one-unit increase in institutional quality raises

inclusion by 0.1462 units. By implication, strong institutions are needed for a sustained inclusion and stability due to the creation of trust and access to financial services by individuals and businesses alike. The impact of effective institutions (quality institutions) on IFI may signal how transparent and effective institutions reduce or lower barriers to inclusion and promotes banking resilience (Ofoeda et al., 2024). Similarly, rule of law and regulatory qualities, political stability, and absence of violence were found to be critical drivers of financial inclusion, particularly in sub-Saharan Africa (Iwugo et al., 2023; Muriu, 2020)

Table 6. Main Regression Results: Two-Step System GMM Estimation

	BSTAB (1)		INCL. FIN (2)	
VARIABLES	Coeff.	P > |Z|	Coeff.	P > |Z|
LBSI	1.2767	0.000***	0.3207	0.088*
LDIFI	0.6580	0.050**	0.7997	0.027**
LINFL	-0.0124	0.015**	0.0318	0.008***
LGDPG	-0.0016	0.782	-0.0113	0.213
LDPOPG	0.0812	0.079*	-0.0620	0.496
LDBSPRD	0.0095	0.603	0.0008	0.944
INSQ	0.1462	0.021**	2.3742	0.003***
Model Diagnostics				
AR(1)	-3.35(0.001)		-0.43(0.668)	
AR(2)	-0.40(0.692)		-1.72(0.085)	
Instruments	39		37	
Groups	41		41	
Obs.	656		656	
Wald Chi2	883.24		17.98	
Prob.	0.000		0.012	
Hansen Test	28.54 (0.593)		26.62 (0.592)	

Note. BSTAB is banking stability model and model 2 is financial inclusion model (INCL. FIN). ***, ** and * are significant at 1%, 5% and 10% level, respectively. Again, LDFI is lagged digital finance Index, LIFI is lagged inclusive finance index, LBSI1 is lagged banking sector stability index, LGDP is lag of GDP growth rate, LBSPRD is the lag of bank interest rate spread, INFL is inflation, LGDPG is growth domestic product growth rate, POPG is population growth, LINSQ is the lag of institutional quality. Please, note that D in front of the symbols of the variable(s) indicates the first difference of that variable(s) was/were used.

In trying to ascertain whether the 2008/2009 Global Financial Crisis and the COVID-19 Pandemic could have any serious impact on the outcome of our initial results, we introduced time dummies to account for the potential effects of these crisis on inclusion and stability. Table 7 presents the results of that estimation. It is clearly seen that these crisis did not have great impact on Africa's banking sector stability and inclusive finance. For instance, the analysis on the inclusion of the dummies confirms our earlier findings of bi-causal relationship between stability and inclusion. The finding suggests positive effect (0.1417 & 0.0113) of COVID-19 on both inclusion and stability. Thus, during that crisis period both variables may have improved slightly possibly due to a surge in mobile money use, digital banking adoption, and policy supports across Africa. However, the coefficients are not statistically significant indicating that the evidence is too weak to draw conclusion that the pandemic had systematic impact on these outcomes in Africa. On the other hand, GFC_DUMMY enters negatively in the banking stability model (-0.1661).This is consistent with the global stress that various economies experienced during the crisis period. Conversely, it is positive in the inclusion regression (0.0341) which suggests the impact of efforts implemented to cushion inclusion during the crisis time. Apparently, neither coefficients is statistically significant suggesting the impact of GFC was not

uniform enough to warrant robust statistical significance in our sample. This indicates that the effects were heterogeneous across the various countries or possibly absorbed by some macroeconomic variables to some extent. The findings are consistent with existing literature (see Anwar, 2024; Giese & Haldane, 2020; Laeven & Valencia, 2010).

Table7. Results of the Inclusion of the Crisis Dummies: Two step System GMM Estimation

	STABILITY (1)			INCLUSION (2)		
Variables	Coeff.	STD. ERROR	P > |Z|	Coeff.	STD. ERROR	P > |Z|
LBSI1	0.9153	0.0634	0.000***	0.0482	0.0236	0.041**
LDIFI	0.5852	0.2736	0.032**	0.4297	0.1377	0.000***
LINFL	0.0027	0.0066	0.683	0.0048	0.0052	0.361
LGDPG	-0.0007	0.0058	0.901	-0.0326	0.0104	0.002***
LDPOPG	0.2139	0.4499	0.634	-0.3045	0.3054	0.319
LDBSPD	-0.0534	0.0285	0.061*	0.0095	0.0131	0.470
LINSQ	-0.0233	0.0583	0.690	-0.1001	0.0511	0.050**
COVID_DUMMY	0.1417	0.0964	0.142	0.0113	0.0206	0.583
GFC_DUMMY	-0.1661	0.2152	0.440	0.0341	0.0294	0.246
Model Diagnostics						
AR (1)	-3.20			-2.80		
P VALUE	0.001			0.005		
AR(2)	-0.61			0.66		
P VALUE	0.544			0.508		
INSTRUMENTS	38			39		
GROUPS	41			41		
OBSERVATIONS	656			656		
WALD CHI2	839.01			79.20		
PROB.	0.000			0.000		
HANSEN	25.75			22.16		
PROB.	0.587			0.814		

Note. This table reports empirical results from estimating the study's models using the baseline system GMM where the crisis dummies were included in the models. Model 1 (column 1) is the banking stability index and model 2 is the inclusive finance index. Asterisks indicate significance at 10% (*), 5% (**), and 1% (***) levels.

4.5. Robustness checks

There are various ways in which previous studies have shown results robustness. Some studies simply replace the dependent variable with another variable especially exchanging an index for a single indicator (see Gyamfi et al., 2022) while others change the methodology (estimator). We have employed both approaches in this study where the Dumitrescu and Hurlin (2012) Granger Non-Causality Test is used as a second estimator to estimate our parameters while we substituted the indices of stability and inclusion with their respective single indicators.

Table 8 presents the Dumitrescu and Hurlin (2012) Granger Non-Causality Test results. This serves as a robustness check to our baseline model (GMM). From the test results under model 1 (BSTAB), the Z-bar statistic = 9.1414 and p-value = 0.0000. Since 0.0000 < 0.05, we reject the null hypothesis of no Granger-causality. This gives an indication that at least one country shows Granger causality from IFI to BSTAB. Similarly, in the inclusive finance model, the Z-bar statistic = 5.4022 and p-value = 0.0000. Again, since 0.0000 < 0.05, we reject the null hypothesis of no Granger-causality. This gives an indication that at least one country exhibits Granger causality from BSTAB to IFI. Since the null hypotheses in both cases are rejected, there is strong statistical evidence that:

banking sector stability Granger-causes inclusive finance and inclusive finance Granger-causes banking sector stability. Therefore, there is bi-causal relationship (bidirectional granger causality) between banking sector stability and inclusive financial development in Africa.

These results indicate practically that past values or lags of banking sector stability help determine inclusive finance and vice versa. Put differently, the results suggest that changes in banking sector stability help determine or predict changes in inclusive finance and vice versa. Consequently, the policy implication is that these two variables must be treated as complements. Thus, improving one of them could reinforce the other.

Table 8. Dumitrescu and Hurlin (2012) Granger non-causality Test Results

	Banking Stability Index (BSTAB)	Inclusive Finance Index (DIFI)
Lag Order	1	1
W-bar	3.0190	2.1931
Z-bar	9.1414 (p-value = 0.0000)	5.4022 (p-value = 0.0000)
Z-bar tilde	6.3049 (p-value = 0.0000)	3.4939 (p-value = 0.0005)
Hypotheses	Ho: IFI does not Granger-cause BSI1 Ha: IFI does Granger-cause BSI1 for at least one panel (country)	Ho: BSI1 does not Granger-cause IFI Ha: BSI1 does Granger-cause IFI for at least one panel (country)

Note. Regression Results of Bi-Causal Relationship between Banking Sector Stability and Inclusive Finance Development using Dumitrescu and Hurlin (2012) Granger Non-Causality Test. Given the short transmission channel in financial system, a single lag captures the most relevant dynamics and prior studies usually use lag 1.

Table 9 and 10 present the results of the relationship between the single indicator (S4) of stability and inclusion index; and between stability index and single indicator (BAPTA) of inclusion. The findings confirmed our earlier findings of bi-causal relationship between stability and inclusion under section 4.4. Table 9 provides evidence of the lags of S4 having positive and statistically significant impact on inclusion (0.001 & p-value = 0.011) while inclusion index has positive and statistically significant impact on S4 (4.1283 & p-value = 0.016). Similar outcomes were recorded when BAPTA and banking stability index were paired (see Table 10). On the other hand, Table 11 presents the results of the introduction of the dummies in the model involving S4 and inclusion index. The findings also concur our earlier outcomes.

Subsequently, sensitivity analysis was used to test whether our conclusion are stable under plausible alternatives specifications. Here, we varied the lag structure, the instrument setting and estimation setting where we ran one-step system GMM instead of the earlier two-step system GMM. Table 12 presents the results to that effect. Once again, the findings concur our earlier evidence of bi-causal relationship between stability and inclusion as well as the impact of inflation and institutional quality on the stability-inclusion nexus.

5. Conclusion, Implications and Further Directions

Governments over the years have been implementing policies to address the issues of financial inclusion and banking sector stability. The present study examined the bi-causal relationship between inclusive finance and banking stability in 41 African countries over the period, 2004-2022. The results show strong statistical evidence that: banking sector stability Granger-causes inclusive finance and inclusive finance Granger-causes banking sector stability. Therefore, there is bi-causal relationship (bidirectional granger causality) between these two variables. This suggests that stability can serve as a policy tool for African economies in their efforts to promoting inclusive finance. Additionally, the study documented evidence of inflation and institutional quality playing significant roles in the stability-inclusion nexus in Africa.

Table 9. Main Regression Results using alternative measure of banking sector stability: Two-Step System GMM Estimation

	STABILITY (S4) (1)			INCLUSION (IFI) (2)		
VARIABLES	Coeff.	STD. ERROR	P > |Z|	Coeff.	STD. ERROR	P > |Z|
LDS4	0.6728	0.0573	0.000***	0.0026	0.0010	0.011**
LDIFI	4.1283	1.7071	0.016**	0.2883	0.0971	0.003***
LINFL	0.2413	0.0485	0.000***	-0.0021	0.0013	0.064*
LGDPG	-0.1934	0.0952	0.042**	-0.0024	0 .0096	0.8010
LDPOPG	12.8088	9.0965	0.159	-0.0872	0.2425	0.719
LDBSPD	-0.6606	0.2933	0.024**	0 .0051	0.0084	0.543
LINSQ	-4.1471	2.0800	0.046**	0.0376	0.0200	0.060*
AR (1)	-3.36			-2.62		
P VALUE	0.001			0.009		
AR(2)	-0.07			0.58		
P VALUE	0.943			0.565		
INSTRUMENTS	39			37		
GROUPS	41			41		
OBSERVATIONS	656			656		
WALD CHI2	2764.28			25.49		
PROB.	0.000			0.001		
HANSEN	26.41			24.57		
PROB.	0,702			0.700		

Note. This table reports empirical results from estimating the study's models using the baseline system GMM. Model 1 (column 1) is the alternative measure of banking stability – S4 which is non-performing loans and model 2 is inclusive finance index. Asterisks indicate significance at 10% (*), 5% (**), and 1% (***) levels.

Table 10. Main Regression Results using alternative measure of digital finance: Two-Step System GMM Estimation

	STABILITY (1)			INCLUSION (2)		
Variables	Coeff.	STD. ERROR	P > |Z|	Coeff.	STD. ERROR	P > |Z|
LDBAPTA	0.0016	0. 0006	0.003***	0.8020	0.0866	0.000***
BSI1	0.9862	0.0930	0.000***	43.8422	21. 7863	0.044**
LINFL	-0.0191	0.0088	0.030**	2..0946	1.9489	0.282
LGDPG	0.0474	0.0191	0.013**	-3.1876	1.526	0.037**
LDPOPG	0.0121	0.0868	0.889	-12.4421	20.8297	0.550
LDBSPD	-0.0257	0.3330	0.440	-14.4696	7.0216	0.039**
LINSQ	-1.5030	0.7708	0.051*	37.0151	15.7058	0.013**
AR (1)	-3.19			-2.89		
P VALUE	0.001			0.004		
AR(2)	0.56			-0.09		
P VALUE	0.578			0.843		
INSTRU.	38			40		
GROUPS	41			41		
OBSER.	656			656		
WALDCH2	273.33			319.73		
PROB.	0.000			0.000		
HANSEN	30.16			33.71		
PROB.	0.458			0.385		

Note. This table reports empirical results from estimating the study's models using the baseline system GMM. Model 1 (column 1) is banking stability index and model 2 is an alternative measure of inclusive finance index-BAPTA which is active bank accounts per thousand adults. Asterisks indicate significance at 10% (*), 5% (**), and 1% (***) levels.

Table 11. Main Regression Results using alternative measure of banking sector stability with the introduction of the Dummies: Two-Step System GMM Estimation

	STABILITY (1)			INCLUSION (2)		
Variables	Coeff.	STD. ERROR	P > |Z|	Coeff.	STD. ERROR	P > |Z|
LDS4	0.6396	0.0633	0.000***	0.0047	0.0019	0.012**
DIFI	3.8141	1.7686	0.031**	0.5538	0.1915	0.004***
LINFL	0.5346	0.2801	0.056*	-0.0033	0.0040	0.406
LGDPG	-0.1944	0.1118	0.082*	-0.0109	0.0045	0.015**
LDPOPG	19.4741	9.7451	0.046**	0.1492	0.1845	0.419
LDBSPD	-0.7266	0.3514	0.039**	0.0083	0.0094	0.374
LINSQ	-2.8235	1.1770	0.016**	0.0483	0.0215	0.024**
COVID_DUMMY	0.7663	0.8121	0.345	-0.0065	0.0252	0.796
GFC_DUMMY	0.0328	1.7173	0.985	-0.0162	0.0443	0.714
AR (1)	-3.61			-2.47		
P VALUE	0.000			0.014		
AR(2)	-0.74			0.72		
P VALUE	0.458			0.471		
INSTRUMENTS	38			38		
GROUPS	41			41		
OBSERVATIONS	656			656		
WALD CHI2	3114.49			34.48		
PROB.	0.000			0.000		
HANSEN	26.52			21.30		
PROB.	0.544			0.812		

Note. This table reports empirical results from estimating the study's models using the baseline system GMM where the crisis dummies were included in the models. Model1 (column 1) is the alternative measure of banking stability index and model2 is the inclusive finance index Asterisks indicate significance at 10% (*), 5% (**), and 1% (***) levels.

Table 12. Dynamic panel-data estimation, one-step system GMM

	STABILITY (1)			INCLUSION (2)		
Variables	Coeff.	STD. ERROR	P > |Z|	Coeff.	STD. ERROR	P > |Z|
LBSI1	0.8955	0.0773	0.000***	33.0838	20.1389	0.038**
LDBAPTA	0.0006	0.0003	0.002***	0.7884	0.0388	0.000***
LINFL	-0.0076	0.0046	0.034**	7.9996	0.9251	0.048**
LGDPG	0.0087	0.0183	0.009***	-11.2971	4.7202	0.017**
LDPOPG	-0.0216	0.0807	0.789	-17.6860	17.4538	0.311
LDBSPD	-0.0123	0.0321	0.701	-13.7565	6.8759	0.045**
LINSQ	-1.4579	0.6341	0.022**	245.8787	84.4511	0.004***
AR (1)	-3.33			-3.06		
P VALUE	0.001			0.002		
AR(2)	0.63			-0.99		
P VALUE	0.530			0.322		
INSTRUMENTS	41			41		
GROUPS	38			38		
OBSERVATIONS	656			656		
WALD CHI2	262.20			806.62		
PROB.	0.000			0.000		
HANSEN	30.16			36.27		
PROB.	0.458			0.199		

Asterisks indicate significance at 10% (*), 5% (**), and 1% (***) levels.

This study advances theory by clarifying the kind of relationship between inclusion and stability. Understanding the theoretical underpinnings of this reverse causality serves

as a guide for policy makers in Africa to obtain the optimum results of inclusive finance and banking sector stability. Furthermore, this study extends the extant literature on inclusion–stability nexus by using system GMM and the Dumitrescu and Hurlin (2012) Granger Non-Causality Test to establish the relationship between these variables. It addresses the gap relating to studies on reverse causality between these variables. These findings have a couple of policy implications for governments or policy makers in Africa.

First, policy makers must consider treating both inclusion and stability as outcome variable of each other rather than treating them separately or contradictory as opined by Khan (2011). The finding suggests that policies that aimed at enhancing inclusive finance will not hamper stability. For instance, policy that targets the expansion in banking sector infrastructure (including digital infrastructure) has the potential to increase inclusive finance (access) while increasing access to financial services (inclusion) could strengthen the banking sector stability. The right theoretical underpinnings of such relationships will serve as a guide to assist policy makers in Africa to design and implement the right policies that will help them achieve optimal benefits from these policy variables. Secondly, there should be continuous policy towards promoting inclusive finance programs where the unbanked, underprivileged communities or rural communities have access to affordable credit, investment opportunities, and other banking services. This issue could be addressed through mobile banking, other digital platforms, and policies that are deliberately curved to support businesses and entrepreneurship in the underserved communities. Additionally, there is the need to integrate digital and traditional finance in trying to improve inclusion. This will ensures that inclusion translates into stronger banking sector stability thereby preventing the current situation where most digital transactions bypass the banks. On the other hand, while it is necessary for expansion of credit, providers of such facilities must be cautious in ensuring strong oversight mechanisms to maintain systemic stability. Put differently, regulatory frameworks must be strengthened through robust consumer protection and supervision that will help prevent the negative impact of expansion on stability. Furthermore, there is the need for a balanced financial framework where inclusion policies are not only government driven but must be market driven too and ensures long-term sustainability while stability policies do not inadvertently frustrate inclusion. At the macroeconomic front, the controls: inflation and institutional quality play significant role in the stability-inclusion nexus, hence governments must implement reforms that ensure that institutions are stronger, accountable, transparent, and efficient while central banks should aim at balancing price stability and the goals of financial access.

As it is normal for studies to have limitations so it is with this study. A sample of 41 countries out of a total of 54 is deemed adequate but a larger sample would have enhanced the relevance of the results. We encourage further studies to increase the sample size. Furthermore, we could not determine the total number of countries in our sample that showed significant causality and those that did not regarding the DH (2012) test results. However, the panel level tests confirmed overall causality relationship between stability and inclusion. Therefore, we suggest that future study run the DH (2012) test at country levels to unpack country-specific dynamics for policy specifications. Let us notice that these limitations did not have any negative impact on the study's outcomes and therefore do not invalidate the outcomes of this study.

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AI Use Statement: The authors confirm that no AI tools were used in the writing, editing, data analysis, or figure generation of this manuscript.

Appendices

Appendix A.1. Data Source and Description of Variables

Variable	Notation	Description/measurement	Source
Banking Sector Stability Index	BSSI	PCA output from 4 BSS variables	
BSS1	S1	Bank Z-score	GFDD
BSS2	S2	Bank credit to bank deposits (%)	GFDD
BSS3	S3	Liquid assets to deposits and short term funding (%)	GFDD
BSS4	S4	Bank non-performing loans to gross loans	
Inclusive Finance Index	IFI	PCA output from seven inclusive finance variables	
Inclusive Finance1	BCBPTA	Borrowers from commercial banks per 1000 adults.	IMF
Inclusive Finance2	DCBPTA	Depositors with commercial banks per 1000 adults.	IMF
Inclusive Finance3	BBPHTA	Commercial bank branches per 100,000 adult	IMF
Inclusive Finance4	BBPTK	Bank branches per 1000 km square,	IMF
Inclusive Finance5	BAPTA	Bank account per 1000 adults	IMF
Inclusive Finance6	ATMPHA	ATMs per 100,000 adults	IMF
Inclusive Finance7	ATMPTK	ATMs per 1000 km square,	IMF
Institutional quality	INSQUL	An average of the six institutional quality variables	WGI
Population Growth	POP	Population growth rate (% annual)	WDI
Bank Spread	BSPRD	Average bank lending- deposit rates	GFDD
Economic growth	GDP	GDP growth (annual %)	WDI
Inflation	INFL	Consumer prices (annual %)	WDI

Appendix A.2. Cross-sectional Dependence Tests Results

No.	Test	Test Statistic	P-Value	Decision
1	Pesaran	1.513	0.1303	Failed to reject Ho
2	Friedman	28.483	0.8688	Failed to reject Ho
3	Frees	0.118 Critical values from Frees' Q distribution alpha = 0.10: 0.1521 alpha = 0.05: 0.1996 alpha = 0.01: 0.2928		Failed to reject Ho at all alpha levels

Appendix A.3. Principal Components Results for Digital Finance Index

Component	Eigenvalues	Difference	Proportion	Cumulative
Comp 1	4.9835	4.1039	0.7119	0.7119
Comp 2	0.8795	0.4678	0.1256	0.8376
Comp 3	0.4117	0.0968	0.0588	0.8964

Comp 4	0.3150	0.1214	0.0450	0.9414
Comp 5	0.1935	0.0641	0.0276	0.9690
Comp 6	0.1294	0.0420	0.0185	0.9875
Comp 7	0 .0873486		0.0125	1.0000

Source. The Authors. Note: The index is robust since the eigenvalue of 4.9835 is greater than 1.

Appendix A.4. Principal Components Results for Banking Sector Stability Index

Component	Eigenvalues	Difference	Proportion	Cumulative
Comp 1	2.1257	1.1836	0.5314	0.5314
Comp 2	0.9421	0.3086	0.2355	0.7670
Comp 3	0.6335	0.3349	0.1584	0.9253
Comp 4	0.2987		0.0747	1.0000

Source. The Authors. NOTE: KMO value = 62.10.

Appendix A.5. Countries for the study

GHANA	NAMIBIA	UGANDA	GUINEA
NIGERIA	MAURITIUS	MALAWI	LIBERIA
KENYA	BOTSWANA	MADAGASTER	ETHIOPIA
MAURITANIA	SOUTH AFRICA	MOZAMBIQUE	CHAD
MOROCCO	GABON	MALI	CONGO, DEM. REP.
ANGOLA	LIBYA	RWANDA	SUDAN
ALGERIA	ZIMBABWE	ZAMBIA	BURKINA FASO
SENEGAL	CONGO REP	NIGER	SIERRA LEONE
TANZANIA	BENIN	TOGO	COTE DIVOIRE
TUNISIA	CAMEROON	EGYPT	

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