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Effects of financial inclusion of small and medium-sized enterprises on financial stability: evidence from selected sub-Saharan African countries

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Abstract

This study investigates the impact of SME financial inclusion on financial stability in 11 sub-Saharan African countries from 2005 to 2019. Using fixed effects estimation with Driscoll and Kraay standard errors and a fixed effect panel quantile regression model, the findings align with the excessive financial inclusion theory, showing that SME financial inclusion, measured by SME depositors with commercial banks, negatively impacts financial stability, with the effect intensifying at higher stability levels. To mitigate these risks, it is recommended that banks diversify their deposit base, financial regulators incorporate bank-run vulnerability into stability assessments, and ensure financial institutions maintain adequate capital levels.

Keywords: Sub-Saharan Africa, Financial inclusion, Financial stability, Small and medium-sized enterprises, Fixed effect model, Quantile regression

JEL Classification: G0, G2, G21, G28

Introduction

Since the early 2000 s, the idea of financial inclusion has attracted a lot of attention due to empirical research suggesting that higher levels of financial inclusion—that is, more financial services available to low-income households and small and medium-sized businesses (SMEs)—have a positive impact on the objective of reducing poverty in a nation (Shiimi, 2010). As a result, as part of their broader plans for economic and financial growth, developing economies—including those in sub-Saharan Africa (SSA)—have actively worked to advance financial inclusion. Higher levels of financial inclusion are typically the result of low-income households and SMEs having simpler and more inexpensive access to and use of financial services and products. This helps to reduce poverty, create jobs, and increase an economy's general resilience to shocks and economic cycles. In this sense, greater financial inclusion supports SMEs' significant contributions as catalysts for both social and economic stability (Shinozaki 2012; Demirgüç-Kunt et al., 2013; Nega & Hussein, 2016). Nevertheless, a crucial lesson from the 2007–2009 global financial crisis (GFC) was that heightened levels of financial inclusion could also hamper financial stability (Creel et al., 2015). Therefore, it has become increasingly important for macroeconomic stability for policymakers to limit systemic financial risk and preserve financial stability. In this sense, the idea of financial stability has also become a focus of policymakers and scholars around the world.

While there is evidence that links financial stability to a country's ability to develop sustainably, there is also evidence that suggests financial instability can seriously impede the process of developing countries' ability to grow—indeed, it can even have an impact on the growth of developed economies (Creel et al., 2015). Considering these nuances, governments, central banks, and regulators worldwide have adopted policies and taken the initiative in recent years to encourage financial inclusion in their nations while carefully weighing the impact on financial stability (Caruana, 2012). The question of whether the trend toward increased financial inclusion tends to promote or worsen financial stability has drawn more attention. Despite this, there is a dearth of empirical studies addressing and demonstrating the connection between the two ideas, particularly in the SSA region's less developed economies and in relation to how SMEs' financial inclusion influences financial stability. This gap in the literature is what this study seeks to fill. This is partially because country-specific information on general financial inclusion and on the financial inclusion of SMEs is scarce (Morgan & Pontines, 2018). Motivated by this challenge, the primary objective of this study is to investigate the impact of the financial inclusion of SMEs on financial stability in the SSA region. For the purposes of our study, financial stability is used interchangeably with bank-level stability. This is because banks are relatively the most important supplier of financial products and services in the SSA region (Abor & Adjasi, 2022; Anarfo et al., 2022; Beck & Cull, 2014). To support our study, we use country-specific data collected from the World Bank Global Financial Development Database (GFDD), International Monetary Fund (IMF) Financial Access Survey (FAS) and World Bank Development Indicators (WDI), for the years 2005–2019 on which we applied a fixed effects model with Driscoll and Kraay (1998) standard errors to control for cross-sectional dependence in our panels. We further investigate the financial inclusion–stability nexus using a fixed effect panel quantile regression model to investigate whether the financial inclusion of SMEs affects financial stability differently when levels of financial stability fluctuate in the SSA countries in our study.

The focus on the interconnectedness between financial stability and financial inclusion of SMEs in SSA is important because although SMEs have the potential to foster macroeconomic growth, development, and stability, compared to other regions, the SSA region has lagged in offering SMEs the financial services and products they require (Oshora et al., 2021). This is true even though governments in the region have widely undertaken steps to increase financial inclusion, such as the introduction and execution of National Financial Inclusion Strategies (NFISs) that target the unbanked (i.e., low-income households and SMEs) (Alliance for Financial Inclusion—AFI, 2023). Due to financial exclusion, many SMEs in the SSA region are unable to reach their full potential. For example, there are 44 million micro, small, and medium-sized businesses in SSA alone. These companies require access to funding to expand, add jobs, and boost the economy. However, 51 percent of them need more money than they currently have access to. For instance, just a third to a fifth of SMEs have a bank loan or line of credit in the SSA region (Runde et al., 2021; World Bank, 2014). In the SSA region, SMEs face significant challenges due to credit constraints—28.3% of businesses are thought to be completely credit constrained (Runde et al., 2021). This makes the SSA region an interesting financial inclusion case study. The choice of the 11 countries in this study is based on their diverse economic structures, levels of financial development, and availability of data, which provide a comprehensive overview of the region.

There is a shortage of empirical studies investigating the link between SMEs'access to and use of finance and financial stability, especially in the context of SSA. The few studies that analyze this relationship are either single-country cases focused on developed economies or multiple-country cases focusing on advanced and emerging economies (see Morgan & Pontines, 2018; Brei et al., 2020). Notwithstanding how scant the research conducted in this area is, previous studies generally offer two conflicting views. On one hand, there is evidence to support a unidirectional positive correlation between financial stability and financial inclusion (Okpara, 2011; Prasad, 2010; Cull et al., 2012). Authors contend that in line with the institutional theory (DiMaggio & Powell, 1983; Meyer & Rowan, 1977), financial inclusion initiatives foster resource efficiency and financial intermediation, which in turn enhances financial stability provided that a nation establishes enhanced financial infrastructure and competent supervision. These efforts also give a large portion of the population, including the underprivileged, better access to and use of banking services (Okpara, 2011; Prasad, 2010; Cull et al., 2012).

On the other hand, some researchers found that more financial inclusion undermines financial stability, particularly when economic agents are given access to the formal financial sector and all its products and services regardless of their level of income or risk tolerance—a concept referred to as *extreme or excessive financial inclusion* or financial over-inclusion (Amatus & Alireza, 2015; Morawetz, 1908; Naceur et al., 2019; Ozili, 2021). The disagreement in the empirical research about the impact of increased financial inclusion on financial stability—that is, whether it has a positive or negative effect makes it difficult for policymakers to decide how to effectively advance financial inclusion while preserving financial stability. In this regard, it is necessary to conduct research to determine the relationship between financial stability and inclusion, particularly in the SSA region where studies under this theme are scarce. The main hypotheses of this study are: (1) financial inclusion of SMEs positively impacts financial stability in SSA countries, and (2) the impact of financial inclusion on financial stability varies with the level of financial stability in these countries.

This study contributes to the literature in three ways. First, despite the well-documented benefits of SMEs on economic growth and poverty reduction (Annemalla & Kasturi, 2023; Shinozaki, 2012; Demirgüç-Kunt et al., 2013; Nega & Hussein, 2016), research on the impact of financial inclusion of SMEs on financial stability, especially in the SSA region is still limited. We fill this gap by empirically assessing the impact of the financial inclusion of SMEs on financial inclusion in SSA. In this regard, we offer evidence-based conclusions to support existing studies focused on the SSA region (see, Jungo et al., 2022; Amatus & Alireza, 2015).

Second, we add to recent studies on the financial inclusion and stability nexus (see Matsebula & Sheefeni, 2022; Anthony-Orji et al., 2019; Al-Smadi, 2018; Neaime & Gaysset, 2018; Jungo et al., 2022; Jima and Makoni, 2023) by looking into whether, when financial stability levels in the SSA countries change, financial inclusion of SMEs has a varied impact on financial stability in the region. This allows us to provide a nuanced account of the implications of the financial inclusion of SMEs on financial stability in each case and gives policymakers a prism through which to craft focused policy initiatives more effectively to safely promote SMEs'financial inclusion in the SSA region.

Third, in contrast to preceding empirical studies (see Amatus & Alireza, 2015; Naceur et al., 2019), we cater for the possibility of cross-sectional dependence between the study's countries. In the increasingly globalized financial and economic environment, policy actions in one country can have a substantial effect on several other countries. This is especially true in the SSA region. Cross-sectional dependence between SSA countries is suggested by political agreements that support regional financial integration and market development, as they may have spillover effects such as capital account opening and cross-border financial institution liberalization (De Hoyos & Sarafidis, 2006; Dogan et al., 2017; Latif et al., 2018; Lovegrove et al., 2007; Bhatia et al., 2009; Frey & Volz, 2013). To control for possible cross-sectional dependence among the panels in our study, we use a fixed effect panel regression model with Driscoll and Kraay (1998) standard errors as our baseline model. The model is robust to very general forms of cross-sectional ("spatial") and temporal dependence as well as heteroskedasticity and autocorrelation (Hoechle, 2007; Mehmood & Mustafa, 2014). Consequently, policymakers will be able to avoid the less-than-ideal policy designs that would otherwise result from empirical research and subsequent studies that neglected to account for cross-sectional dependence.

Our findings reveal a negative relationship between the financial inclusion of SMEs and financial stability in the context of SSA countries, and the negative link is even stronger as levels of financial stability increase across countries. Our findings are in line with the extreme financial inclusion or financial over-inclusion theory (Morawetz, 1908). The research findings indicate that further efforts are required to advance the financial inclusion of SMEs safely and securely in the SSA region. The financial system can be made more stable, especially if efforts are made to enhance risk mitigation in the banking sector, enhance financial sector supervision, and improve cooperation amongst regional financial sector authorities.

The remainder of this paper is organized as follows. Sect. "Literature review" gives a brief review of the theoretical and empirical literature. Sect. "Methodology and data" presents the methodology and offers the data sources. Sect. "Empirical results and analysis" discusses the empirical results. The last section deals with concluding remarks and offers policy recommendations.

Literature review

Financial inclusion and financial stability have gained significant interest among policymakers, but there is no standard definition for either term. Financial inclusion broadly ensures equal access to basic financial products and services for individuals and businesses, including transactions, payments, savings, credit, and insurance, in a safe, responsible, and sustainable manner (World Bank, 2018). A stable financial system does not hinder an economy's performance and can eliminate financial imbalances caused by large adverse events (Schinasi, 2004).

Scholars have suggested both positive and negative impacts of increasing SME financial inclusion on financial stability. According to institutional theory (DiMaggio & Powell, 1983; Meyer & Rowan, 1977), financial inclusion of SMEs can enhance financial stability by encouraging efficient resource mobilization and financial intermediation. This is contingent on improvements in financial infrastructure and stronger financial sector supervision and regulatory frameworks. Increasing lending to smaller firms can diversify bank assets, reducing the riskiness of a bank's loan portfolio and the interconnectedness risks of the financial system (Khan, 2011). Adasme et al. (2006) found that small firms' non-performing loans have quasi-normal loss distributions, reducing the risk of large and infrequent losses, thus positively affecting financial stability. Hannig and Jansen (2010) suggest that low-income groups are resilient to economic cycles, making their inclusion in the financial sector beneficial for financial stability. They note that financial institutions serving low-income economic agents can weather macro-crises and sustain local economic activity. Prasad (2010) highlights that inadequate credit access for SMEs negatively impacts employment growth, potentially affecting macroeconomic and financial stability. Financially excluded SMEs usually use cash for most transactions and make decisions regardless of central bank monetary policies. Financial inclusion improves the efficiency of the monetary policy transmission mechanism (Prasad, 2010; Adasme et al., 2006).

Conversely, the theory of extreme credit extension (Morawetz, 1908) suggests that increased financial inclusion of SMEs can negatively impact banking sector stability when access to financial services is granted irrespective of income level and riskiness (Cull et al., 2012; Ahamed & Mallick, 2019; Frączek, 2019; Ozili, 2021). If expanding the pool of borrowers reduces lending standards, it could lead to a crisis similar to the 2007–2010 sub-prime crisis in the United States. Additionally, outsourcing functions like credit assessment to reach smaller borrowers can increase reputational risk and adversely impact financial stability (Khan, 2011; Cull et al., 2012; Ahamed & Mallick, 2019; Frączek, 2019; Danisman & Tarazi, 2020; Feghali et al., 2021).

Our study's conceptual framework incorporates insights from theoretical literature and empirical research on the relationship between financial stability and financial inclusion (Čihák et al., 2016, 2021; Hakimi et al., 2022; Koudalo & Toure, 2023; Le et al., 2019; Wang & Luo, 2022). The excessive financial inclusion theory (Morawetz, 1908) identifies channels through which the negative effects of financial inclusion on financial stability are communicated. Promoting financial services to economic agents irrespective of income or risk tolerance may jeopardize financial stability (Čihák et al., 2016; Hakimi et al., 2022; Koudalo & Toure, 2023; Le et al., 2019; Morawetz, 1908). Risks associated with growing financial inclusion, especially for low-income economic agents, include heightened transaction and information costs due to information asymmetry and incomplete credit and collateral histories. This can jeopardize financial system stability. Therefore, maintaining financial stability requires strong governance and adequate financial regulation and supervision (Hakimi et al., 2022; Le et al., 2019; Wang & Luo, 2022).

We use institutional theory to identify channels through which financial inclusion's positive effects on financial stability are disseminated (DiMaggio & Powell, 1983; Meyer & Rowan, 1977). Greater financial stability can result from enhanced financial system regulation and oversight, achieved through increased access to and use of financial products and services (Čihák et al., 2016; DiMaggio & Powell, 1983; Koudalo & Toure, 2023; Meyer & Rowan, 1977; Wang & Luo, 2022). Financial inclusion allows banks to increase savings, retail deposits, and the transmission of monetary policy, diversify loan portfolios, and lower non-performing loan levels. This effect is particularly noticeable in economies with high levels of institutional quality (Hakimi et al., 2022; Le et al., 2019; Wang & Luo, 2022). For a comprehensive literature review on this topic, refer to Damane and Ho (2024), which systematically reviews theoretical literature on financial inclusion and financial stability, along with empirical research examining their relationship.

To understand the role of SMEs in financial inclusion and stability, it is crucial to delve into their structural characteristics. SMEs in SSA are not a homogeneous group; they vary significantly in terms of size, sector, financial literacy, access to formal credit, and risk profiles. Distinguishing between micro, small, and medium enterprises in terms of financial needs, risk exposure, and contribution to financial stability provides a more nuanced understanding of the observed effects. Incorporating these structural characteristics and recognizing the heterogeneity of SMEs in SSA strengthens the analysis by offering a detailed and accurate picture of the challenges and opportunities these enterprises face. This approach aligns with recent studies by Hakimi et al. (2022) and Le et al. (2019), which emphasize the importance of considering SME heterogeneity in financial inclusion research.

Micro-enterprises often face the highest barriers to financial inclusion due to informality, lack of collateral, and limited financial literacy. Small enterprises, while slightly better positioned, still encounter significant challenges in accessing formal credit and navigating regulatory environments. Medium enterprises, although more established, may still struggle with risk exposure and financial stability due to market volatility and economic cycles (Lu et al., 2021). These challenges are like those faced by small businesses in Greece, where structural impediments such as limited financial support and regulatory barriers hinder their growth and stability (Meramveliotakis & Manioudis, 2021).

Factors such as informality, lack of collateral, and regulatory barriers are particularly relevant in the context of SSA. Informal SMEs often operate outside the formal financial system, making it difficult for them to access credit and other financial services. Lack of collateral further exacerbates this issue, as financial institutions are reluctant to lend to businesses without sufficient guarantees. Regulatory barriers, including complex and burdensome procedures, can also hinder SMEs' access to financial services (Lu et al., 2021). This is echoed in the Greek context, where small businesses face similar regulatory challenges that impede their access to necessary financial resources (Meramveliotakis & Manioudis, 2021).

Empirical studies on the relationship between financial inclusion and financial stability have mostly focused on the banking sector's stability and its influence by increased access to and use of financial services. Studies specifically examining the impact of SME financial inclusion on financial stability are limited. An overview of these studies is provided in Appendix 1, covering developed and developing countries, including SSA. Most studies use single proxies for financial inclusion and financial stability, such as the bank's distance to default (bank z-score) for stability and indicators of usage or access for inclusion. Macroeconomic indicators like GDP, inflation (CPI), domestic private sector credit, and exchange rates are typically used as control variables. The studies show conflicting evidence of both positive and negative impacts of financial inclusion on financial stability.

Methodology and data

General functional form

To empirically test the theoretical connection between the financial inclusion of SMEs and financial stability in SSA, the general form of our model, presented in Eq. 1 is informed by the review of literature and the study's conceptual framework that is enshrined in theory. Equation 1 is also consistent with the benchmark models used by Greene (2001), Brei et al., (2020), Morgan and Pontines (2018), Siddik et al., (2018) as well as Amatus and Alireza (2015):

$$\text{FINSTAB}_{i,t} = \beta \text{SME\_INCL}_{i,t}, + \gamma X_{i,t} + \Omega_{i,t} + \vartheta_{i,t} + \varepsilon_{i,t}, \tag{1}$$

where the panel of countries and the study's time dimension are represented by $i = 1, \ldots, N \text{ and } t = 1, \ldots, T,$ respectively. FINSTAB is financial stability, the study dependent variable which is proxied by bank credit to bank deposits (%), bank z-scores, liquid assets to deposits and short-term funding (%), and a composite indicator of financial stability (the method of principal component analysis—PCA), respectively. The bank Z-scores measure banks' distance from insolvency. They are calculated as the sum of the return on assets and the capital asset ratio divided by the standard deviation of the return on assets (Demirgüç-Kunt and Huizinga, 2010; Laeven and Levine, 2009; Brei et al., 2020; Morgan & Pontines, 2018).

SME_INCL is our main independent variable of interest. It represents the financial inclusion of SMEs. It is proxied using two measures. First, deposit accounts with commercial banks: of which SME deposit accounts. Second, depositors with commercial banks: of which SME depositors.

The proxies of financial inclusion of SMEs used in this study are like those used by Brei et al., (2020) and Morgan and Pontines (2018), and they are in line with the theoretical underpinnings of previous studies that investigated the relationship between bank performance, credit growth, and bank riskiness (see Borio and Lowe, 2002; Fahlenbrach, et al., 2018; Köhler, 2012). X is a vector of parsimonious control variables that have a potential effect on financial stability (Amatus et al., 2015; Brei et al., 2020; Morgan & Pontines, 2018; Siddik et al., 2018). They include the logarithm of GDP per capita (which is used as a proxy for economic development), the ratio of private sector credit by deposit money banks and other financial institutions to GDP (which is used to proxy financial sector development), and inflation, as used in the study by Phan et al., (2021). In the model, β and γ are coefficients of the model. The time and country fixed effects are captured with $\Omega_{i,t}$and $\vartheta_{i,t}$, respectively. They control for unobserved time-invariant variation in banking system stability across countries. ε is the error term.

The fixed effect model with Driscoll and Kraay standard errors

Equation 1 can be estimated using methods like GMM, fixed effects, and random effects, but these techniques overlook heterogeneity and cross-sectional dependency between groups. Policy decisions in one country can significantly influence multiple nations in globalized financial and economic sectors, especially in the SSA region (De Hoyos & Sarafidis, 2006; Dogan et al., 2017; Latif et al., 2018). For example, political agreements in the SSA region promoting regional financial integration and financial market development may result in spillover effects like capital account opening and cross-border financial institution liberalization (Lovegrove et al., 2007; Bhatia et al., 2009; Frey & Volz, 2013). This suggests that there may be cross-sectional dependence between the SSA countries in our study. To control for possible cross-sectional dependence among the panels in our study, we estimate Eq. 1 using a fixed effects model with Driscoll and Kraay (1998) standard errors as our baseline model. Driscoll–Kraay standard errors are robust to cross-sectional and temporal dependence. The technique is nonparametric and does not plan restrictions on the limiting behavior of the number of panels. In this regard, the cross-sectional dimension in finite samples does not affect feasibility, even if the number of panels is significantly larger than T (Driscoll & Kraay, 1998; Mehmood & Mustafa, 2014).

Compared to alternative models, such as the Generalized Method of Moments (GMM), the fixed effects with clustered standard errors, random effects models, and Prais–Winsten regression, the fixed effects model with Driscoll–Kraay standard errors stands out. While GMM handles endogeneity and dynamic panel data, it may not adequately address cross-sectional dependence (Arellano & Bond, 1991). System-GMM extends GMM by using additional moment conditions, potentially improving efficiency (Blundell & Bond, 1998). However, both methods may still fall short in handling cross-sectional dependence effectively. Fixed effects with clustered standard errors account for within-group correlation but may fall short in handling cross-sectional dependence (Cameron & Trivedi, 2005). Random effects models, though efficient under certain assumptions, often rely on unrealistic assumptions about the correlation between individual effects and regressors (Baltagi, 2008). Prais–Winsten regression addresses serial correlation but is less effective for cross-sectional dependence (Prais & Winsten, 1954). Driscoll–Kraay standard errors, on the other hand, are robust to both cross-sectional and temporal dependence, nonparametric, and feasible even with a large number of panels, making them a superior choice for our study (Driscoll & Kraay, 1998; Mehmood & Mustafa, 2014).

To estimate the fixed effects model with Driscoll–Kraay standard errors, a two-step method is used (Hoechle, 2007; Mehmood & Mustafa, 2014). First, all model variables are within the transformed $z_{i,t} \in \{y_{i,t}, x_{i,t}\}$ as follows:

$$\widetilde{z}_{it} = z_{it} - \overline{z_i} + \overline{\overline{z}}, \tag{2}$$

where $\sum_{t=t_i}^{T_i} z_{it}$ and $\overline{\overline{z}} = \left(\sum T_i\right)^{-1} \sum_i \sum_t z_{it}$.

Equation 2 recognizes that the within-estimator corresponds to the OLS estimator of

$$\widetilde{y}_{it} = \widetilde{x}\prime_{it}\theta + \widetilde{\varepsilon}_{it}. \tag{3}$$

The second step estimates Eq. 3 using pooled OLS estimation with Driscoll–Kraay standard errors. Another key advantage of the two-step method implementation of the approach is that it works for both, balanced and unbalanced panels, respectively. And is capable of handling missing values (Hoechle, 2007).

As an extension of our baseline model, our study employs a fixed effect panel quantile regression model, developed by Koenker and Bassett (1978), to examine how financial inclusion of SMEs affects financial stability at different levels of financial stability in the 11 SSA nations. This approach allows us to analyze the impact across the entire conditional distribution, accounting for unobserved individual country variability. The general model for panel quantile regression is:

$$Q_i(\tau_k|x_{it}) = \alpha_{i0}(\tau_k) + X_{it}\prime\beta_0(\tau_k), i = 1, \ldots, N, t = 1, \ldots, T, \quad (4)$$

where $Q_i(\tau_k|x_{it})$ is the conditional τ_k quantile of the dependent variable given covariate vector $X_{it}\prime$. The model includes individual fixed effects $\alpha_{i0}(\tau_k)$, depending on both the individual i and quantile level τ_k, and a common slope coefficient $\beta_0(\tau_k)$ shared by all cross-sections. The fixed effects account for unobserved individual heterogeneity in panel data.

To implement the panel quantile regression, we used the following steps: (1) specified the quantile levels of interest (e.g., 25 th, 50 th, 75 th percentiles); (2) applied the fixed effects transformation to control for unobserved heterogeneity; and (3) estimated the model using quantile regression techniques. The results were interpreted by examining the coefficients at different quantiles, providing insights into how the impact of SME financial inclusion on financial stability varies across the distribution.

Data sources and variables

This study utilizes panel data from 11 SSA countries spanning the period from 2005 to 2019. The timeframe was selected based on the availability of comprehensive data for these years. The countries included in the sample are presented in Appendix 2. These countries were chosen based on the comprehensiveness of their available data, ensuring a robust and reliable dataset for analysis. The final sample consists of countries with the most complete and consistent data across the selected period, allowing for a thorough examination of the research questions.

We collected country-specific data from the World Bank Global Financial Development Database (GFDD), the International Monetary Fund (IMF) Financial Access Survey (FAS), and the World Bank Development Indicators (WDI). The choice of study variables was informed by existing literature and the availability of data. Detailed descriptions of the variables and their respective sources are provided in Appendix 3. The data from these sources were meticulously merged to create a cohesive dataset, ensuring that each variable was consistently represented across all countries and years in the study. This careful integration of data sources enhances the reliability and validity of our findings.

Four proxies of financial stability are included in the study, namely the ratio of bank credit to bank deposits (in percent), bank *Z*-scores, the ratio of liquid assets to deposits and short-term funding (in percent), as well as a composite indicator of financial stability calculated using the method of principal component analysis (PCA). Similar proxies of financial stability have been used in previous studies (see Pal & Bandyopadhyay, 2022; Jungo et al., 2022; Hakimi et al., 2022; Abdulkarim & Ali, 2019; Saha & Dutta, 2021; Matsebula & Sheefeni, 2022; Siddik et al., 2018; Operana, 2016). Two proxies of the financial inclusion of SMEs are included in the study, namely, SME deposit accounts with commercial banks and SME depositors with commercial banks, respectively. The same proxies of financial inclusion of SMEs were used in previous studies (see Amatus & Alireza, 2015).

The descriptive statistics of the variables are presented in Appendix 4. Each series' average values are represented by its mean, and its degree of variability, or how far it deviates from the mean, is captured by its standard deviation. For every series, the minimum and maximum denote the lowest and highest values, respectively (Livingston, 2004). The composite measure of financial stability has a mean value of zero and a standard deviation that is approximately equal to one. In this regard, the composite indicator follows a Gaussian or standard normal distribution, according to these data properties (Livingston, 2004). Further, we note that on average, the bank credit to bank deposits ratio is 64.9% in SSA and the ratio of liquid assets to deposits and short-term funding is around 41.9%, respectively. As can be observed from the comparatively large standard divisions of private sector credit by deposit money banks as a ratio of GDP and levels of inflation, respectively, the descriptive statistics also demonstrate the presence of heterogeneity in the panels. The standard deviations of the bank credit-to-deposit ratio, the liquid asset-to-deposit ratio, and the short-term financing ratio all support the same conclusion. This supports the application of panel data approaches that account for the heterogeneity of each country.

Three macroeconomic variables, namely, gross domestic product (GDP) per capita, the ratio of private credit by deposit money banks to GDP (in percent), and consumer prices (annual percentage change), respectively, are included in the baseline model as part of the control variables. Similar control variables are commonly used in studies related to financial stability (see Pal & Bandyopadhyay, 2022; Jungo et al., 2022; Hakimi et al., 2022; Abdulkarim & Ali, 2019; Saha & Dutta, 2021; Matsebula & Sheefeni, 2022; Siddik et al., 2018; Operana, 2016). In this regard, per capita GDP is a measure of economic progress and is expected to have a positive impact on financial stability. The private credit to GDP ratio gauges the state of the financial system generally and is expected to have a mixed effect on financial stability since high levels may point to a higher susceptibility to instability of the financial system. We anticipate that inflation will have a negative effect on stability as price fluctuations might lead investors to restrict borrowing since they are estimating possible future returns to be adversely affected by high debt service costs (Amatus & Alireza, 2015; Fouejieu, 2017; Koudalo & Toure, 2023; Morgan & Pontines, 2018).

Empirical results and analysis

Testing for cross-sectional dependence

We first test for the presence of cross-sectional dependence (or weak cross-sectional dependence) using two tests, namely, tests by Pesaran (2015, 2021), and the power enhancement CD test by Fan et al. (2015). These tests were chosen for their robustness and ability to detect both strong and weak dependencies. Pesaran's tests are reliable for various panel data structures, while Fan et al.'s test enhances power, making it effective in identifying subtle dependencies. Their complementary strengths provide a comprehensive assessment of cross-sectional dependence. From Table 1, the cross-sectional dependence exponent is significantly higher than 0.5, and the CD tests reject the null

Table 1 Results of cross-sectional dependence tests

Variables	CD	CDw+
FINSTAB_1	7.200	127.570
	(0.000)	(0.000)
FINSTAB_2	0.000	0.000
	(1.000)	(1.000)
FINSTAB_3	0.000	0.000
	(1.000)	(1.000)
FINSTAB_PCA	0.000	0.000
	(1.000)	(1.000)
SME_INCL_1	9.880	109.230
	(0.000)	(0.000)
SME_INCL_2	5.150	162.880
	(0.000)	(0.000)
GDPPC	2.520	136.850
	(0.012)	(0.000)
PSC	10.760	140.880
	(0.000)	(0.000)
INF	2.550	58.150
	(0.011)	(0.000)

Source Authors' composition

Note p-values in parenthesis. CD is the cross-sectional dependence test by Pesaran (2015, 2021). CDw+ is the cross-sectional dependence test with power enhancement by Fan et al. (2015)

hypothesis of weak cross-sectional dependence for all variables. The evidence suggests that an estimation method that considers cross-sectional dependence is necessary.

Choice between random effects and fixed effects model

The primary objective of this study is to investigate the impact of the financial inclusion of SMEs on financial stability in the SSA region. To facilitate this, we support the choice between a random effects and fixed effects model. Appendix 5 presents results from the random effects and fixed effects model variants across four panels, respectively. From Appendix 5, the *p*-value of the LM test statistic across most of the panels is less than 0.05 (except for panel 4). This indicates the presence of panel (fixed or random) effects in the model variants. Therefore, in most of the cases, the random effects model is preferred over the simple OLS model. The null hypothesis of the Hausman test is that the difference in coefficients is not systematic. From Appendix 5, the *p*-value of the test statistic is less than 0.05 in panel 1 and less than 0.1 in panel 4. This indicates that the fixed effects model is more preferred relative to the random effects model. In this regard, subsequent sections will focus on fixed effects models with *FINSTAB*_1 and *FINSTAB_PCA* as dependent variables.

Tests for serial correlation and heteroskedasticity in fixed effects regression

Appendix 6 presents results of the serial correlation and heteroskedasticity tests performed on the estimated fixed effects model variants, across two panels. The study horizon, spanning 15 years, used the Wooldridge test to test for serial correlation, rejecting the null hypothesis of no first-order correlation. The modified Wald test was used to test for heteroskedasticity, rejecting the null hypothesis of homogeneous residuals. The results suggest that future econometric techniques should account for the presence of serial correlation and heteroskedasticity in financial inclusion of SMEs in SSA.

Results of the baseline model

This study's main objective is to investigate the impact of the financial inclusion of SMEs on financial stability in the SSA region. The statistical tests performed call for the use of a fixed effects model that controls for the presence of cross-sectional dependence, serial correlation and heteroskedasticity (see Appendices A5 and A6 for the detailed results). In this regard, our study uses the fixed effects model with Driscoll and Kraay standard errors. Table 2 presents the results of the OLS fixed effects model alongside those of the fixed effects model with Driscoll and Kraay standard errors across two panels. Comparing the two versions of fixed effects models, the results show no significant differences between them. This implies that the findings are robust and reliable, validating the use of the Driscoll and Kraay model. The consistency across models enhances confidence in the results, suggesting that the observed relationships are genuine and not artifacts of model specification. This robustness supports the formulation of dependable policy recommendations base.

That is, the values of the coefficients in both models as well as their signs and levels of significance are broadly similar. For instance, in panel 1—where the dependent variable is *FINSTAB*_1 [i.e., bank credit to bank deposits (%)], financial inclusion of SMEs in the case of both proxies used (i.e., *SME_INCL*_1 and *SME_INCL*_2) does not have a statistically significant impact on financial stability (i.e., *FINSTAB*_1). A possible reason could be that the financial activities of SMEs might not be substantial enough to influence overall stability measured by bank credit to bank deposits. Conversely, in panel 2—where the dependent variable is *FINSTAB_PCA* (i.e., the composite indicator of financial stability), financial inclusion of SMEs as proxied by *SME_INCL*_2 has a negative and statistically significant impact on financial stability (i.e., *FINSTAB_PCA*) in the SSA region, at the 5% level. When bank Z-scores, the ratio of liquid assets to deposits, and short-term funding (in percent) are added to the financial stability measure, the result becomes negative.

Higher financial inclusion of SMEs can lead to increased risk-taking by banks, as they extend credit to a broader range of borrowers, some of whom may have higher risk profiles. This increased risk-taking can result in liquidity issues and potential instability within the financial system. For instance, a one percent increase in financial inclusion of SMEs, as proxied by SME depositors with commercial banks, decreases the composite indicator of financial stability by 0.258%, ceteris paribus. This finding aligns with the excessive financial inclusion theory (Morawetz, 1908), which posits that promoting financial services to SMEs without considering their income or risk tolerance can jeopardize financial stability (Čihák et al., 2016; Hakimi et al., 2022; Koudalo & Toure, 2023; Le et al., 2019).

Additionally, Amatus and Alireza (2015) and Naceur et al. (2019) found similar results, indicating that outstanding deposits in commercial banks can signal a high probability of bank default due to increased risks during periods of financial stress. That is, demand-deposit contracts offer banks liquidity but also expose them to panic-based bank runs

Table 2 Results of fixed effects model and fixed effects model with Driscoll and Kraay standard errors

	Fixed effects model (*ordinary least square, OLS*)				Fixed effects model *with Driscoll and Kraay standard errors*			
	Model 1		Model 2		Model 1		Model 2	
Regressors	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
Panel 1: FINSTAB_1 (dependent variable)								
SME_INCL_1	0.391 (1.756)	0.925			0.391 (3.233)	0.905		
SME_INCL_2			− 1.444 (1.891)	0.447			− 1.443 (3.045)	0.643
GDPPC	− 70.047 (10.967)	0.000	− 54.54 (12.917)	0.000	− 70.04 (20.477)	0.004	− 54.54 (18.732)	0.011
PSC	2.221 (0.359)	0.000	1.851 (0.405)	0.000	2.221 (0.497)	0.001	1.852 (0.469)	0.001
INF	− 0.269 (0.191)	0.161	− 0.333 (0.186)	0.077	− 0.269 (0.223)	0.248	− 0.333 (0.229)	0.168
Observation	139		121		139		121	
R-squared	0.021		0.013		0.453		0.296	
Overall model significance	F(4.124) = 25.67 Prob > F = 0.0000		F(4.106) = 11.17 Prob > F = 0.0000		F(4.14) = 73.81 Prob > F = 0.0000		F(4.14) = 39.05 Prob > F = 0.0000	
Panel 2: FINSTAB_PCA (dependent variable)								
SME_INCL_1	− 0.094 (0.834)		0.263		− 0.094 (0.138)		0.506	
SME_INCL_2	− 0.258 (0.832)		0.003		− 0.258 (0.098)		0.02	
GDPPC	0.256 (1.252)	0.839	0.135 (1.134)	0.905	0.256 (1.629)	0.877	0.135 (1.148)	0.928
PSC	0.418 (0.172)	0.018	0.057 (0.016)	0.001	0.042 (0.025)	0.114	0.057 (0.019)	0.011
INF	− 0.006 (0.113)	0.579	− 0.010 (0.010)	0.347	− 0.006 (0.008)	0.433	− 0.01 (0.007)	0.172

Table 2 (continued)

	Fixed effects model (*ordinary least square, OLS)*				**Fixed effects model *with Driscoll and Kraay standard errors***			
	Model 1		**Model 2**		**Model 1**		**Model 2**	
Regressors	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**
Observation	87		78		87		78	
R-squared	0.589		0.706		0.107		0.208	
Overall model significance	F(4.75) = 2.24 Prob > F = 0.0722		F(4.124) = 4.34 Prob > F = 0.0036		F(4.14) = 1.38 Prob > F = 0.2907		F(4.14) = 4.81 Prob > F = 0.0118	

Note Regression results are authors' estimation. Values in parenthesis are standard errors

(Goldstein and Pauzner, 2005). This is reflective of a low and less diversified depositor base in the SSA region, where financial systems are often underdeveloped and heavily reliant on a narrow base of depositors. This lack of diversification means that during periods of financial stress, the risk of bank runs is higher, as there are fewer sources of stable funding. Additionally, the financial inclusion of SMEs might lead to increased risk-taking by banks, as they extend credit to a broader range of borrowers, some of whom may have higher risk profiles. This can exacerbate financial instability, particularly in regions like SSA where economic volatility is more pronounced. A similar point is made by Kulu et al. (2022), who argues that theoretically, higher saving deposits should allow banks to generate more credits, which will strengthen their balance sheet and increase their assets and efficiency. The SAA case exhibits a less diversified deposit mix, which implies that the number of outstanding deposits with commercial banks has an inverse relationship with financial stability.

Panel quantile regression model

As an extension of our main results, our study proposes a fixed effect panel quantile regression model[1] to investigate whether the financial inclusion of SMEs affects financial stability differently when levels of financial stability fluctuate in the 11 SSA nations. This allows for the examination of the impact of the financial inclusion of SMEs on financial stability in SSA across the conditional distribution, accounting for unobserved individual country variability. Quantile regression is particularly suitable here as it captures the varying effects of financial inclusion at different points in the financial stability distribution, providing a more comprehensive analysis than mean regression models (Koenker & Hallock, 2001). Financial stability varies significantly across our sample due to differing economic policies, market conditions, and institutional frameworks (Beck et al., 2007). Literature suggests that the relationship between financial inclusion and financial stability can vary depending on the level of financial stability, with both positive and negative effects observed in different contexts (Han & Melecky, 2013).

The results of the quantile regression model are presented in four panels in Table 3. The results are broadly in line with those of the fixed effects models presented in Sect. 4.4. In panel 1 and panel 3, respectively, financial inclusion of SMEs as proxied by *SME_INCL*_1 has a negative albeit statistically insignificant impact on the proxies of financial stability (i.e., *FINSTAB*_1 and *FINSTAB_PCA*) across all quantiles. Conversely, in panel 2, the impact of financial inclusion of SMEs as proxied by *SME_INCL*_2 has a negative and statistically significant impact on *FINSTAB*_1 only from the 40 th to 90 th quantile at an average of −9.019 percent. Similarly, in panel 4, the impact of financial inclusion of SMEs as proxied by *SME_INCL*_2 has a negative and statistically significant impact on *FINSTAB_PCA* only from the 40 th to 70 th quantile at an average of −0.254 percent. These results indicate that financial inclusion of SMEs as proxied by SME depositors with commercial banks has a negative impact on financial stability in the SSA region. The impact is more pronounced as the level of financial stability as proxied by

[1] The quantile regression method being proposed was developed by Koenker and Bassett (1978). It is a semi-parametric approach which in contrast to linear regression, does not assume the distribution of the errors or call for normally distributed data. This enhances its resistance to anomalies and non-normal errors (Porter, 2014; Petscher & Logan, 2014). The method is also unaffected by monotonic transformations like logarithmic transformations, a feature that linear regression models lack (Koenker, 2005).

Table 3 Quantile regression results

FINSTAB_1 (dependent variable)									
***Panel 1* Regressors**	**10 th quantile**	**20 th quantile**	**30 th quantile**	**40 th quantile**	**50 th quantile**	**60 th quantile**	**70 th quantile**	**80 th quantile**	**90 th quantile**
SME_INCL_1	− 1.773	− 2.320	− 2.672	− 3.092	− 4.150	− 5.117	− 5.817	− 6.262	− 6.957
GDPPC	70.941	62.544	57.141	50.691	34.432	19.587	8.831	1.994	− 8.678
PSC	0.656	0.751	0 0.812	0.884	1.068*	1.236**	1.357**	1.434*	1.555*
INF	− 0.062	− 0.066	− 0.069	− 0.073	− 0.082	− 0.090	− 0.095	− 0.099	− 0.105
Observation	87	87	87	87	87	87	87	87	87
Panel 2 Regressors	10 th quantile	20 th quantile	30 th quantile	40 th quantile	50 th quantile	60 th quantile	70 th quantile	80 th quantile	90 th quantile
SME_INCL_2	− 2.290	− 3.472	− 5.261	− 6.231*	− 7.298**	− 8.747**	− 9.959**	− 10.820**	− 11.596**
GDPPC	50.284	43.844	34.097	28.816	23.001	15.109	8.509	3.818	− 0.406
PSC	0.988	1.091	1.248**	1.332***	1.426***	1.553***	1.659***	1.734**	1.802**
INF	− 0.226	− 0.214	− 0.197	− 0.187	− 0.177	− 0.163	− 0.151	− 0.143	− 0.135
Observation	78	78	78	78	78	78	78	78	78
FINSTAB_PCA (dependent variable)									
Panel 3 Regressors	10 th quantile	20 th quantile	30 th quantile	40 th quantile	50 th quantile	60 th quantile	70 th quantile	80 th quantile	90 th quantile
SME_INCL_1	− 0.074	− 0.078	− 0.083	− 0.087	− 0.095	− 0.100	− 0.107	− 0.111	− 0.116
GDPPC	4.112	3.301	2.322	1.626	0.141	− 0.922	− 2.207	− 3.028	− 3.972
PSC	0.015	0.021	0.027	0.032	0.043	0.050	0.059	0.065	0.071
INF	0.003	0.001	− 0.002	− 0.003	− 0.007	− 0.009	− 0.012	− 0.014	− 0.016
Observation	87	87	87	87	87	87	87	87	87
Panel 4 Regressors	10 th quantile	20 th quantile	30 th quantile	40 th quantile	50 th quantile	60 th quantile	70 th quantile	80 th quantile	90 th quantile
SME_INCL_2	− 0.304	− 0.291	− 0.280	− 0.273*	− 0.260**	− 0.246**	− 0.236*	− 0.222	− 0.217
GDPPC	4.105	3.016	2.020	1.458	0.341	− 0.909	− 1.801	− 2.965	− 3.433
PSC	0.051	0.053	0.054*	0.055**	0.057*	0.059*	0.060***	0.062**	0.063**
INF	− 0.003	− 0.005	− 0.007	− 0.008	− 0.010	− 0.012	− 0.014	− 0.016	− 0.017
Observation	78	78	78	78	78	78	78	78	78

Source Authors' composition

Note Coefficients (standard errors) are outside (inside) the parentheses. ***, **, and *denote the statistical significance at 1%, 5% and 10%, respectively

the ratio of bank credit to bank deposits in the region increases, with some moderation when the financial stability proxy is bank z-scores. Similar results were obtained by Isayev (2024) who concludes that in line with the excessive financial inclusion theory (Morawetz, 1908), if the promotion of financial services and products to SMEs is done irrespective of their income or risk tolerance, it may raise the risk of extreme events, unanticipated losses to the financial system, and eventually more frequent banking crises (Morgan & Pontines, 2018).

The quantile regression results offer deeper insights into how SME financial inclusion impacts financial stability across different levels of stability in SSA countries. For example, *SME_INCL*_2 has a significant negative impact on *FINSTAB*_1 from the 40 th to 90 th quantile and on *FINSTAB_PCA* from the 40 th to 70 th quantile. These findings suggest that as financial stability improves, the negative effects of SME financial inclusion become more pronounced due to increased risk-taking and liquidity issues. Policymakers should consider these varying impacts when designing regulations to manage associated risks effectively.

In the fixed effects model, the average impact of SME financial inclusion on financial stability was not significant, suggesting that SME activities might not be substantial enough to influence overall stability. However, the quantile regression results indicate that the negative impact of *SME_INCL*_2 becomes significant in the middle quantiles (40 th to 70 th) for both *FINSTAB*_1 and *FINSTAB_PCA*. This suggests that as financial stability improves, the influence of SME financial inclusion becomes more pronounced, potentially due to increased risk-taking and liquidity issues.

The stable coefficient value across these quantiles implies a consistent relationship, possibly moderated by effective risk management practices and a more diversified financial system. This aligns with the excessive financial inclusion theory, which posits that promoting financial services to SMEs without considering their risk profiles can increase financial instability (Hakimi et al., 2022; Le et al., 2019; Morawetz, 1908).

These findings underscore the importance of considering the level of financial stability when assessing the impact of SME financial inclusion and support the formulation of targeted policy recommendations to manage associated risks.

General method of moments model

Endogeneity is a critical concern in our analysis of the impact of SME financial inclusion on financial stability, as both could be influenced by unobserved factors or exhibit reverse causation. To address this, we employ the Generalized Method of Moments (GMM) estimation technique, which effectively handles endogeneity in panel data by using internal instruments derived from lagged values of the explanatory variables. Specifically, we apply the system GMM estimator, as proposed by Arellano and Bover (1995) and Blundell and Bond (1998). The results of the GMM model (see Appendix 7) are broadly in line with those of the baseline model.

Conclusion and policy recommendations

This study investigated the impact of financial inclusion of SMEs on financial stability across 11 countries in the SSA region using country level data from 2005 to 2019. Results from the baseline model, that is, the fixed effects estimation with Driscoll and Kraay standard errors and the fixed effect panel quantile regression model conform with the excessive financial inclusion theory (Morawetz, 1908) and confirm that financial inclusion of SMEs (proxied by SME depositors with commercial banks) negatively impacts financial stability (proxied by bank credit to bank deposits and a composite indicator, respectively) in SSA countries. Specifically, the fixed effect panel quantile regression model shows that financial inclusion of SMEs jeopardizes financial stability as SSA countries attain higher levels of financial stability.

Based on the study's findings, three crucial policy recommendations can be made. First, banks in the SSA region should enhance and diversify their deposit base. This will reduce their idiosyncratic risk, stabilize earnings streams, and improve lending resilience. For example, Kenya's mobile money services like M-Pesa have significantly increased financial inclusion while maintaining stability through regulatory oversight and integration with traditional banking systems (World Bank, 2020). Second, financial stability assessments that form part of macroprudential policies of financial sector regulators such as central banks should include frameworks for assessing the degree of a bank's vulnerability to panic-based bank runs. This would allow for a better assessment of the financial sector's vulnerabilities especially as financial services and products are extended to the previously underserved households and businesses. South Africa's inclusive banking policies and promotion of digital banking have increased account ownership and usage, particularly among low-income households, while strengthening financial stability (World Bank, 2020). Third, financial sector regulators should encourage higher efficiencies in the financial institutions and keep close monitoring of capital adequacy levels to ensure they meet regulatory requirements. Cameroon's expansion of mobile money services has improved financial resilience and inclusion, managed through targeted regulatory frameworks and support for digital financial services (Mfossa, 2019).

This study focuses on 11 SSA countries due to the limited availability of relevant data across the region. This constraint has inevitably narrowed the scope and impact of our findings. To address the limitation of the small sample size, we acknowledge that it affects the generalizability and robustness of our results. The small sample size is primarily due to data availability and the specificity of the study population. We have employed robust statistical techniques to mitigate its impact, including different model specifications and subsample analyses, to ensure our findings are not overly sensitive to the small sample size.

To enhance the policy implications, we suggest future research should include a comparison between the SSA region and other economies from previous related empirical studies. This comparison could provide valuable insights into the varying impacts of financial inclusion policies across different regions, thereby extending the research direction. Supplementing our analysis with additional data or alternative methods, such as qualitative data or meta-analyses, could support the quantitative findings. By addressing these limitations and suggesting ways to overcome them, we hope to guide future research in building upon our work and achieving more robust and generalizable results.

Appendix 1: Empirical studies on the impact of financial inclusion of SMEs on financial stability

Author	Region/country	Study period	Method	Impact of financial inclusion on financial stability
Jungo et al. (2022)	46 SSA and 31 LAC countries	2005–2018	FGLS model	(+)
Hakimi et al. (2022)	112 banks from 10 MENA countries	2004–2017	System GMM	(+)
Neaime and Gaysset (2018)	8 MENA countries	2002–2015	GMM and GLS	(+)
Amatus and Alireza (2015)	35 SSA countries	2004–2011	Dynamic GMM model	(−)
Naceur et al. (2019)	98 countries	1980–2016	Dynamic panel logit model	(−/+)
Operana (2016)	Philippines	2002:4–2015:4	Reduced form VAR	(+)

Note (+); (−) and (+/−) represent positive, negative, and mixed impacts of financial inclusion on financial stability, respectively

Appendix 2: List of 11 sub-Saharan African countries used in this study

No.	Country
1	Angola
2	Burundi
3	Cameroon
4	Chad
5	Comoros
6	Equatorial Guinea
7	Guinea
8	Madagascar
9	Namibia
10	Republic of Congo
11	South Sudan

Appendix 3: Description of variables

Variables	Symbol	Transformation	Data sources
Bank credit to bank deposits (%)	*FINSTAB*_1	Percentage	World Bank Global Financial Development Database (GFDD)
Bank *Z*-scores/distance to default	*FINSTAB*_2	Natural log	GFDD
Liquid assets to deposits and short-term funding (%)	*FINSTAB*_3	Percentage	GFDD
Financial stability indicator	*FINSTAB_PCA*	Natural log	GFDD
SME deposit accounts with commercial banks	*SME_INCL*_1	Natural log	International Monetary Fund (IMF) Financial Access Survey (FAS)

Variables	Symbol	Transformation	Data sources
SME depositors with commercial banks	*SME_INCL_2*	Natural log	FAS
GDP per capita	*GDPPC*	Natural log	World Bank World Development Indicators (WDI)
Private credit by deposit money banks to GDP (%)	*PSC*	Percentage	GFDD
Inflation, consumer prices (annual %)	*INF*	Percentage	WDI

Appendix 4: Descriptive statistics

Variable	Obs.	Mean	Std. dev.	Min	Max
FINSTAB_1	157	64.98605	28.30067	6.708983	154.8505
FINSTAB_2	96	2.605222	0.473431	1.258219	3.423253
FINSTAB_3	98	41.96838	20.3081	9.238362	108.2813
FINSTAB_PCA	94	6.55E − 09	1.424411	− 4.53459	3.581041
SME_INCL_1	145	9.856198	1.405531	4.60517	13.11011
SME_INCL_2	127	9.763813	1.422074	4.521789	12.35715
GDPPC	158	7.210216	1.038674	5.59893	9.562584
PSC	157	14.25434	14.85393	0.4294444	70.894
INF	161	11.91807	34.71074	− 8.97474	379.9996

Source Authors' compilation

Appendix 5: Random effects and fixed effects model post estimation results

	Random effects model Model 1		**Fixed effects model Model 1**		**Random effects model Model 2**		**Fixed effects model Model 2**	
Regressors	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**
Panel 1: FINSTAB_1 (dependent variable)								
SME_INCL_1	− 0.485 (3.639)	0.894	0.391 (1.756)	0.925				
SME_INC					− 1.873 (3.622)	0.605	− 1.444 (1.891)	0.447
GDPPC	− 12.719 (3.293)	0.000	− 70.047 (10.967)	0.000	− 9.498 (4.694)	0.043	− 54.54 (12.917)	0.000
PSC	1.650 (0.574)	0.004	2.221 (0.359)	0.000	1.421 (0.386)	0.000	1.851 (0.405)	0.000
INF	− 0.500 (0.193)	0.001	− 0.269 (0.191)	0.161	− 0.447 (0.184)	0.015	− 0.333 (0.186)	0.077
Observation	139		139		121		121	
R-squared—overall	0.269		0.021		0.291		0.013	
Overall significance	Wald chi2(4) = 54.53 Prob > chi2 = 0.0000		*F*(4.124) = 25.67 Prob > *F* = 0.0000		Wald chi2(4) = 106.84 Prob > chi2 = 0.0000		*F*(4.106) = 11.17 Prob > *F* = 0.0000	
Breusch–Pagan Lagrange multiplier (LM)	chibar2(01) = 43.82 Prob > chibar2 = 0.0000				chibar2(01) = 60.76 Prob > chibar2 = 0.0000			
Hausman test: choice between fixed or random effects	chi2(4) = 37.03 Prob > chi2 = 0.0000				chi2(4) = 20.40 Prob > chi2 = 0.0004			
Panel 2: FINSTAB_2 (dependent variable)								

	Random effects model		Fixed effects model		Random effects model		Fixed effects model	
	Model 1		Model 1		Model 2		Model 2	
Regressors	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
SME_INCL_1	− 0.019 (0.033)	0.555	− 0.012 (0.200)	0.548				
SME_INCL_2					− 0.037 (0.363)	0.304	− 0.030 (0.023)	0.197
GDPPC	− 0.124 (0.360)	0.731	− 0.199 (0.301)	0.511	− 0.105 (0365)	0.774	− 0.128 (0.317)	0.688
PSC	0.003 (0.002)	0.133	0.002 (0.004)	0.587	0.006 (0.003)	0.087	0.004 (0.004)	0.349
INF	− 0.002 (0.002)	0.384	− 0.002 (0.002)	0.533	− 0.002 (0.002)	0.284	− 0.002 (0.002)	0.517
Observation	87		87		78		78	
R-squared—overall	0.127		0.015		0.367		0.226	
Overall significance	Wald chi2(4) = 7.30 Prob > chi2 = 0.121		*F*(4.75) = 0.44 Prob > *F* = 0.7828		Wald chi2(4) = 100.15 Prob > chi2 = 0.0000		*F*(4.66) = 0.80 Prob > *F* = 0.5321	
Breusch–Pagan Lagrange multiplier (LM)	chibar2(01) = 133.76 Prob > chibar2 = 0.0000				chibar2(01) = 43.82 Prob > chibar2 = 0.0000			
Hausman test: choice between fixed or random effects	chi2(4) = 3.66 Prob > chi2 = 0.4539				chi2(4) = 2.35 Prob > chi2 = 0.6712			
Panel 3: FINSTAB_3 (dependent variable)								
SME_INCL_1	− 0.272 (1.717)	0.874	− 1.041 (1.074)	0.336				
SME_INCL_2					1.574 (1.199)	0.190	1.152 (1.138)	0.315
GDPPC	− 1.344 (5.062)	0.791	15.975 (16.105)	0.324	− 1.159 (4.112)	0.778	13.412 (15.506)	0.390

	Random effects model		Fixed effects model		Random effects model		Fixed effects model	
	Model 1		Model 1		Model 2		Model 2	
Regressors	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**
PSC	− 0.350 (0.276)	0.205	− 0.341 (0.222)	0.129	− 0.447 (0.256)	0.080	− 0.476 (0.228)	0.041
INF	0.019 (0.108)	0.857	0.726 (0.146)	0.620	0.052 (0.123)	0.675	0.098 (0.145)	0.499
Observation	89		89		80		80	
R-squared—overall	0.537		0.178		0.537		0.019	
Overall significance	Wald chi2(4) = 13.62 Prob > chi2 = 0.0086		*F*(4.76) = 1.35 Prob > *F* = 0.2593		Wald chi2(4) = 16.90 Prob > chi2 = 0.0020		*F*(4.67) = 1.28 Prob > *F* = 0.2883	
Breusch–Pagan Lagrange multiplier (LM)	chibar2(01) = 42.21 Prob > chibar2 = 0.0000				chibar2(01) = 41.40 Prob > chibar2 = 0.0000			
Hausman test: choice between fixed or random effects	chi2(4) = 2.10 Prob > chi2 = 0.7174				chi2(4) = 2.42 Prob > chi2 = 0.6590			
Panel 4: FINSTAB_PCA (dependent variable)								
SME_INCL_1	− 0.133 (0.185)	0.471	− 0.094 (0.834)	0.263				
SME_INCL_2					− 0.247 (0.099)	0.013	− 0.258 (0.832)	0.003
GDPPC	− 0.209 (0.296)	0.478	0.256 (1.252)	0.839	− 0.223 (0.176)	0.203	0.135 (1.134)	0.905
PSC	0.056 (0.016)	0.001	0.418 (0.172)	0.018	0.057 (0.134)	0.000	0.057 (0.016)	0.001
INF	− 0.014 (0.009)	0.125	− 0.006 (0.113)	0.579	− 0.019 (0.119)	0.108	− 0.010 (0.010)	0.347
Observation	87		87		78		78	
R-squared—overall	0.692		0.589		0.744		0.706	

Regressors	Random effects model Model 1 Coefficient	*p*-value	Fixed effects model Model 1 Coefficient	*p*-value	Random effects model Model 2 Coefficient	*p*-value	Fixed effects model Model 2 Coefficient	*p*-value
Overall significance	Wald chi2(4) = 73.33 Prob > chi2 = 0.0000		F(4.75) = 2.24 Prob > F = 0.0722		Wald chi2(4) = 50.71 Prob > chi2 = 0.0000		F(4.124) = 4.34 Prob > F = 0.0036	
Breusch–Pagan Lagrange multiplier (LM)	chibar2(01) = 0.76 Prob > chibar2 = 0.192				chibar2(01) = 0.00 Prob > chibar2 = 0.499			
Hausman test: choice between fixed or random effects	chi2(4) = 8.06 Prob > chi2 = 0.0894				chi2(4) = 9.19 Prob > chi2 = 0.0565			

Note Values in parenthesis under coefficients contain robust standard errors. Breusch–Pagan Lagrange multiplier (LM). Hausman test for choice between fixed or random effects models

Appendix 6: Results of serial correlation and heteroskedasticity tests

	Fixed effects model			
	Model 1		**Model 2**	
Regressors	**Coefficient**	***p*-value**	**Coefficient**	***p*-value**
Panel 1: FINSTAB_1 (dependent variable)				
SME_INCL_1	0.391 (1.756)	0.925		
SME_INCL_2			− 1.444 (1.891)	0.447
GDPPC	− 70.047 (10.967)	0.000	− 54.54 (12.917)	0.000
PSC	2.221 (0.359)	0.000	1.851 (0.405)	0.000
INF	− 0.269 (0.191)	0.161	− 0.333 (0.186)	0.077
Observation	139		121	
R-squared—overall	0.021		0.013	
Wooldridge test for serial correlation	$F(1, 10) = 79.537$ Prob > F = 0.0000		$F(1, 10) = 29.545$ Prob > F = 0.0003	
Modified Wald test for group wise heteroskedasticity	chi2 (11) = 5223.32 Prob > chi2 = 0.0000		chi2 (11) = 8391.34 Prob > chi2 = 0.0000	
Panel 2: FINSTAB_PCA (dependent variable)				
SME_INCL_1	− 0.094 (0.834)	0.263		
SME_INCL_2			− 0.258 (0.832)	0.003
GDPPC	0.256 (1.252)	0.839	0.135 (1.134)	0.905
PSC	0.418 (0.172)	0.018	0.057 (0.016)	0.001
INF	− 0.006 (0.113)	0.579	− 0.010 (0.010)	0.347
Observation	87		78	
R-squared—overall	0.589		0.706	
Wooldridge test for serial correlation	$F(1, 6) = 20.713$ Prob > F = 0.0039		$F(1, 6) = 20.797$ Prob > F = 0.0038	
Modified Wald test for group wise heteroskedasticity	chi2 (8) = 1.1e + 32 Prob > chi2 = 0.0000		chi2 (8) = 6.1e + 31 Prob > chi2 = 0.0000	

Note Wooldridge test for serial correlation results are authors' estimation. Modified Wald test for group wise heteroskedasticity results are authors' estimation

Appendix 7: Results of general method of moments

	Model 1		Model 2	
Regressors	Coefficient	*p*-value	Coefficient	*p*-value
Panel 1: FINSTAB_1 (dependent variable)				
SME_INCL_1	− 1.219 (1.934)	0.529		
SME_INCL_2			− 1.853 (2.334)	0.427
GDPPC	− 1.495 (3.686)	0.685	− 0.108 (6.118)	0.986
PSC	0.775 (0.191)	0.000	0.662 (0.302)	0.028
INF	− 1.225 (0.255)	0.000	− 1.303 (0.298)	0.000
Observation	139		121	
Wald chi2(4)	154.23		107.57	
Prob > chi2	0.000		0.000	
Panel 2: FINSTAB_PCA (dependent variable)				
SME_INCL_1	− 0.161 (1.137)	0.243		
SME_INCL_2			− 0.231 (0.785)	0.003
GDPPC	− 0.114 (0.156)	0.463	− 0.029 (0.101)	0.769
PSC	0.052 (0.009)	0.000	− 0.431 (0.014)	0.000
INF	− 0.032 (0.009)	0.001	− 0.04 (0.013)	0.001
Observation	87		78	
Wald chi2(4)	342.73		877.58	
Prob > chi2	0.000		0.000	

Note Regression results are authors' estimation. Values in parenthesis are standard errors

Author Contribution

S.Y.H. conceptualized the research idea and overall study design. M.D. proposed the methodological framework, conducted the research, and performed the data analysis. Both authors contributed to the writing and revision of the manuscript.

Availability of data and materials

The data that support the findings of this study are openly available in [World Bank Global Financial Development Database (GFDD), International Monetary Fund (IMF) Financial Access Survey (FAS) and World Bank Development Indicators (WDI).] at [Global Financial Development Database (worldbank.org), Financial Access Survey—IMF Data, World Development Indicators|DataBank (worldbank.org), respectively].

Declarations

Competing interests

The authors report there are no competing interests to declare.

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