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Threshold effects of financial inclusion on financial stability: Evidence from BRICS nations

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Abstract: This paper investigates the impact of financial inclusion on financial stability in BRICS countries from 2004 to 2020. Using a panel smooth transition regression model, the results reveal a U-shaped relationship between financial inclusion and financial stability. Financial inclusion reduces financial stability up to a threshold of 44.7%. Beyond this point, financial inclusion contributes to greater financial stability, through gradual transitions. Enhanced financial inclusion supports banks in stabilizing their deposit funding by facilitating access to more stable, long-term funds and alleviating the negative impacts of fluctuations in returns. Furthermore, the study examines the role of institutional quality in shaping the financial inclusion-financial stability nexus, indicating a significant positive effect, especially in the upper regime. These findings provide valuable insights for financial regulatory authorities, highlighting the importance of promoting financial inclusion in BRICS economies and adapting regulations to mitigate potential risks to global financial stability.

Keywords: financial inclusion; financial stability; u-shaped relationship; institutional quality; BRICS countries; panel smooth transition regression

1. Introduction

The financial liberalization of the 1980s and 1990s led to significant transformations in modern finance, characterized by the relaxation of financial regulations and the advent of modern financial models in the early 2000s. While instrumental in driving industrialization, the banking sector often neglected certain marginalized groups, particularly those living in poverty. In 2005, the United Nations designated the year of microfinance to address financial disparities across social and business sectors (Wang and Luo, 2022). Nonetheless, significant advancements in innovative technology have given rise to a new concept of financial inclusion, increasingly recognized as a crucial development concern. This concept gained significant attention after the 2007 financial crisis, which caused a marked decline in the average real growth of global bank deposits by over 12 percentage points annually (Financial Access Survey, 2010).

Financial inclusion, conceived to alleviate individual financial constraints, has emerged as a multifaceted strategy aimed at providing a diverse range of services tailored to all segments of the population and various business entities, according to their respective needs. This paradigm revolves around four primary financial instruments, such as savings, insurance, credit, and payment mechanisms. Moreover, it serves to enhance not only capital inflows but also the interconnected framework of corporate capital.

In 2011, within a global population of 2.5 billion individuals, half of those living

in developing countries lacked access to banking services, and only 43% of account holders used these services for savings (Global Financial Index Database, 2011). This scarcity significantly impacted small and medium-sized enterprises (SMEs), with approximately 200 million entities encountering difficulties in accessing affordable credit during the same period (Global Financial Index Database, 2011). However, with the advent of new financial technologies, recent data underscores substantial progress. For instance, the number of unbanked adults decreased from 2 billion in 2014 to 1.7 billion in 2017, representing approximately 40% of the global adult population (Global Financial Index Database, 2018). These advancements in financial inclusion align with global initiatives aimed at enhancing the adaptability and inclusiveness of financial systems (As outlined by the Central Committee of the Communist Party of China (CPC) in 2019).

In 2020, the China Banking and Insurance Regulatory Commission outlined plans for financial institutions to provide inclusive resources and manage credit risks through reforms and technological advancements (Hua et al., 2023). These regulatory efforts focus on improving capital reserves, optimizing liquidity, and maintaining credit risks at manageable levels to prevent the spread of crises and contagion effects (Cecchetti et al., 2011). Such initiatives have significantly advanced financial inclusion, resulting in 71% of the population in developing nations having a bank account by 2021. Within the BRICS nations, Brazil and South Africa demonstrate prominent financial infrastructure with 77% ownership, despite enduring economic constraints. Russia closely follows with 80% adult account penetration, while India achieves 83% through strategic initiatives such as Jan Dhan Yojana. Leading the group, China demonstrates the highest ownership at 86%, indicative of comprehensive financial reforms and strides in economic empowerment (Global Financial Index Database, 2021). These developments underscore the growing emphasis on the relationship between financial inclusion and financial stability within the BRICS nations.

The existing literature underscores the growing importance of financial inclusion and its potential impact on financial stability. Some studies suggest that increased investment in the financial sector may be necessary to enhance services, meet customer needs, and achieve adequate returns to strengthen stability. However, this approach could result in higher capital expenditures and potentially lower profits due to increased costs (Sathye and Sathye, 2017; Shihadeh and Liu, 2019). Additionally, the development of financial inclusion might lead to financial instability through imprudent borrowing practices (Allen et al., 2016; José and Garcia, 2016; Khan, 2011; Soederberg, 2013), illustrating the concept of unsound financial practices. Conversely, other research argues that when financial inclusion reaches an optimal level, it can enhance bank stability, exemplifying the concept of "sound financial practices." By attracting a diverse clientele from various social backgrounds, each with distinct needs and behaviors, banks can diversify their customer portfolios and revenue sources, particularly through deposits. This approach aligns with the fundamental principles of banking philosophy. Consequently, banks aim to strengthen their lending capacity, reduce concentration risks, and enhance overall financial stability (Han and Melecky, 2013; Hannig and Jansen, 2010; Morgan and Pontines, 2014).

Based on the discussion above, the current literature suggests uncertainty

regarding the association between financial inclusion and financial stability. This ambiguity may arise because these studies do not consider the potential nonlinear effect of financial inclusion on financial stability, particularly in BRICS countries. Given the vulnerability of these countries to economic shocks and weaknesses in financial infrastructure, rigorous liquidity and risk management are crucial to ensuring banking stability and preventing financial crises. Thus, the examination of the literature reveals that financial inclusion may initially undermine financial stability due to excessive costs and inadequate practices such as over-lending. However, once financial inclusion is well-developed, it can enhance stability by fostering diversification, increasing access to cheaper deposits, and reducing the volatility of deposit funding. This, in turn, provides banks with more stable long-term funds, thereby reinforcing overall financial stability. By doing so, our study contributes to the existing literature in the following ways:

Firstly, to our knowledge, previous studies within the context of the BRICS, such as Barik and Pradhan (2021), have primarily focused on the negative linear effects of developing financial inclusion, often overlooking its potential positive impacts. We argue that it is crucial to investigate whether the development of financial inclusion may enhance, to some extent, the financial stability of BRICS countries. If so, understanding how to strengthen this positive effect and at what level this reinforcement should be initiated is essential. In light of this, this paper enriches the study by Barik and Pradhan (2021) by exploring a potential nonlinear association between financial inclusion and financial stability within BRICS nations from 2004 to 2020.

Secondly, unlike existing studies that use polynomial expressions to investigate nonlinear effects between financial inclusion and financial stability (Antwi et al., 2024; Hua et al., 2023), which often result in multicollinearity issues (Arcand et al., 2012), this study employs a panel smooth transition regression (PSTR) framework. This approach accommodates regime-switching behavior and identifies the threshold value, providing insights into whether transitions between different regimes occur gradually or abruptly. To the best of our knowledge, there is currently no study employing this approach in this specific context.

Thirdly, this paper contributes to the revised literature on the effects of financial regulatory on bank behavior (Basty et al., 2023; Grosse, 2012; VanHoose, 2007). Previous research has predominantly focused on the impact of such regulations on bank profitability (Ahamed et al., 2021). Our paper extends the literature by empirically assessing how policies, including institutional quality, interact with financial inclusion and influence banking stability within BRICS nations.

The remaining sections of the paper are organized as follows: Section 2 provides brief literature framework. Section 3 presents the data and variables. Section 4 explains the panel smooth transition methodology. Section 5 outlines the main empirical results. Section 6 draws key conclusions and discusses their implications for policymakers.

2. Literature framework

The current literature increasingly examines the relationship between financial

inclusion and financial stability. Despite this growing interest, there remains a lack of consensus regarding the nature of this relationship. Specifically, the theoretical literature presents several perspectives on how financial inclusion can influence financial stability.

The first perspective supports the notion that robust financial inclusion acts as a catalyst for financial stability, aligning with the principle of 'more finance, more stability.' Financial inclusion, characterized by accessibility, affordability, and sustainability, facilitates the provision of financial services to small enterprises and rural communities, thereby improving resource allocation and bolstering financial stability. Moreover, this effort correlates with a notable decrease in non-performing loan rates and bank risk premiums (Han and Melecky, 2013). By broadening the base of potential depositors and borrowers, financial inclusion enhances banks' risk management capacities (Morgan and Pontines, 2014). During periods of economic turbulence, it is observed that small depositors, who represent the majority of participants in financial inclusion initiatives, tend to maintain their deposits, thereby bolstering the resilience of financial systems, particularly in nations with extensive financial inclusion programs (Hannig and Jansen, 2010; Mehrotra and Yetman, 2015).

The second perspective argues that the positive or negative relationship between financial inclusion and financial stability are subjected to regulatory strategies, risk-taking behavior and the level of financial inclusion within a nation (Allen et al., 2016; José and Garcia, 2016; Khan, 2011). Banking institutions strive to establish an optimal financing structure, shaping their risk management approach through increased risk exposure (Smaoui et al., 2020). While the development of financial inclusion often leads to greater credit availability, which can improve financial stability (Morgan and Pontines, 2014), it can also foster imprudent borrowing practices and subsequent financial instability (José and Garcia, 2016). The recurrent extension of credit to a specific borrower by one or multiple financial institutions can result in excessive credit, thereby creating negative externalities and potentially destabilizing the financial system (Jia et al., 2021). Notably, the 2008 financial crisis was partially caused by excessive lending to groups with poor credit histories (Soederberg, 2013).

An alternative perspective posits that the initial phase of the development of financial inclusion may lead to financial instability and inefficiency due to increased operational costs for banks. During this stage, banks allocate resources to develop new services that meet customer needs, aiming to enhance stability and efficiency while achieving adequate returns. This strategic focus results in higher capital expenditures, potentially impacting profits due to these operational expenses. Nonetheless, in the subsequent phase of financial inclusion development, banks can enhance financial efficiency and stability by increasing cheap retail deposits and further diversifying customer portfolios. This approach strengthens lending capacity and fosters stability within the financial system (Sathye and Sathye, 2017; Shihadeh and Liu, 2019).

The empirical literature examining the relationship between financial inclusion and financial stability presents heterogeneous and inconclusive findings. Some studies suggest a positive impact of financial inclusion on financial stability, employing various estimation techniques such as generalized method of moments (GMM), ordinary least squares (OLS) and quantile regression (Ahamed and Mallick, 2019; Atellu and Muriu, 2022; Elgharib, 2024; Hakimi et al., 2022; Vo et al., 2020).

Conversely, other studies establish a negative association between financial inclusion and banking stability using a GMM approach across BRICS nations from 2005 to 2015 (Barik and Pradhan, 2021). Amatus and Alireza (2015) find a negative link between financial inclusion, measured by deposits, and financial stability across 35 Sub-Saharan African countries, employing a GMM method. Furthermore, Feghali et al. (2021) suggest that financial inclusion, in terms of loans, adversely impact financial stability, utilizing panel regression with fixed effects and two-stage least squares methods on an international scale.

Recent empirical research has focused on exploring the transmission channels through which financial inclusion influences financial stability. For instance, Hua et al. (2023) underscore the pivotal role of financial regulation in shaping the relationship between financial inclusion and financial stability, employing Tobit and OLS models across 115 countries from 2004 to 2019. Ofoeda et al. (2024) demonstrate the significant impact of institutional quality on bolstering the nexus between financial inclusion and financial stability, using panel threshold techniques across 48 sub-Saharan African countries from 2002 to 2021. Antwi et al. (2024) identify financial development as a critical determinant of the positive impact of financial inclusion on financial stability within 60 developing nations from 2002 to 2019, employing a GMM approach. Additionally, both Antwi et al. (2024) and Saha and Dutta (2021) find compelling evidence of banking competition's enhancement of the relationship between financial inclusion and financial stability. Importantly, all these studies reveal an inverted U-shaped relationship between financial inclusion and financial stability, often attributed to disorderly lending practices. This suggests that financial inclusion contributes positively to financial stability up to an optimal point, beyond which further increases in financial inclusion may lead to financial instability. Conversely, Saha and Dutta (2021) observe a U-shaped relationship between financial inclusion and financial stability across 92 countries, employing a GMM approach.

In light of this, our study addresses the conflicting empirical evidence in the literature, which has reported both positive and negative relationships between financial inclusion and financial stability. In this context, our research suggests the following hypothesis:

There is a nonlinear relationship between financial inclusion and bank stability within the financial system.

3. Data set and variables measures

3.1. Data

This research examines the impact of financial inclusion on financial stability using data from BRICS countries (Brazil, China, India, Russia, and South Africa) over the period 2004–2020. The dataset is compiled from multiple sources, including the World Bank World Development Indicators (WDI), International Monetary Fund (IMF), and Bankscope financial data.

3.2. Measurement of variables and descriptive statistics

3.2.1. Independent variable: Financial inclusion

Financial inclusion, a multifaceted concept, is commonly analyzed through two principal dimensions: financial outreach and financial usage (Amidžic et al., 2014). Despite significant scholarly contributions, achieving a universal consensus on a financial inclusion index remains challenging (Ahamed and Mallick, 2019). To address this, our study builds upon the framework established by Barik and Pradhan (2020) by employing principal component analysis (PCA) to develop a comprehensive financial inclusion index. This composite indicator comprises six sub-indices, each defined according to specific dimensions. In terms of accessibility, our analysis incorporates the number of commercial bank branches and Automated Teller Machines per 1000 km^2 (BB_km^2 and ATM_km^2, respectively), as well as the number of commercial bank branches and ATMs per 100,000 adults (BB_POP and ATM_POP, respectively), reflecting the demographic and geographic penetration of banking services. Regarding usage, the study includes the volume of current loans (OLC) and current deposits (ODC) as a percentage of GDP, respectively.

In accordance with Ahamed and Mallick (2019), financial inclusion indices for each country have been normalized on a scale ranging from 0 to 1. A value of 0 indicates financial exclusion, whereas a value of 1 signifies full financial inclusion. The results of the principal component analysis for each financial inclusion indicator are presented in **Table 1**.

Table 1. Principal component analysis: Financial inclusion index of BRICS countries.

	PC_1	PC_2	PC_3	PC_4	PC_5	PC_6
Eigen values	3.233	1.513	0.829	0.233	0.109	0.082
Percentage of variance	0.539	0.252	0.138	0.039	0.018	0.014
Cumulative percentage	0.539	0.791	0.929	0.968	0.986	1.000
Variables	**Comp_1**	**Comp_2**	**Comp_3**	**Comp_4**	**Comp_5**	**Comp_6**
OLC	0.457	0.345	−0.278	0.354	0.665	0.165
ODC	0.490	0.311	0.111	0.133	−0.640	0.473
BB_km^2	0.282	−0.520	0.605	−0.167	0.322	0.390
BB_POP	−0.416	0.226	0.554	0.684	0.035	0.007
ATM_km^2	0.480	0.207	0.415	−0.104	−0.026	−0.737
ATM_POP	−0.261	0.648	0.255	−0.592	0.207	0.231

Note: All variables are presented in **Table 2**.

3.2.2. Dependent and control variables

Financial stability, as the dependent variable in this study, is evaluated using the country-specific Banks *Z*-score ratio, as employed by Barik and Pradhan (2021). This indicator is widely acknowledged in empirical research as an unbiased measure of bank risk (Susan et al., 2024; Zanfack et al., 2024). Higher returns and increased capitalization contribute to enhanced bank stability, while greater return volatility can undermine it. The Z-score index offers insights into a bank's financial health and risk profile, reflecting its crisis management capabilities and the current market conditions. For instance, a higher Z-score may indicate more effective financial risk management and greater resilience among banking institutions (Ahamed and Mallick, 2019).

Consistent with existing literature, our analysis incorporates a series of control variables, including trade openness (TO), financial openness (FO), inflation rate (INFL), and banking efficiency (COSTS). Detailed definitions and data sources for all variables are provided in **Table 2**. Descriptive statistics for each variable are presented in **Table 3**.

Table 2. Definitions and sources of variables.

Variables	Definition	Sources
Z_score	The banking system Z-score index by country serves as an inverse proxy for the probability of a bank's failure, with a high indicator implying a low probability of insolvency. $$Z\_score_{it} = \frac{ROA_{it} + EQA_{it}}{\sigma(ROA)_{it}}$$ where ROA_{it}: represents the return on assets, EQA_{it}: signifies the equity-to-assets ratio, $\sigma(ROA)_{it}$: denotes the standard deviation of the return-on-assets.	Bankscope
BB_km^2	Number of commercial bank branches per 1000 km^2.	IMF
BB_POP	Number of commercial bank branches per 100.000 adults.	IMF
ATM_km^2	Number of ATMs per 1000 km^2.	IMF
ATM_POP	Number of ATMs per 100.000 adults.	IMF
OLC	Outstanding Credits to private sector as a % of GDP.	IMF
ODC	Outstanding Deposit in private sector as a % of GDP.	IMF
TO	The trade openness ratio, measured as a sum of exports and imports of goods and services, expressed as a share of GDP.	WDI
INFL	Inflation, consumer price rate.	WDI
KAOPEN	The financial openness index developed by Chinn and Ito.	Chinn and Ito's website
COSTS	Banking efficiency indicator, calculated as the ratio of the bank's overhead costs to total assets.	Bankscope

Note: WDI: World Bank's World Development Indicators database; IMF: International Monetary Fund; Bankscope: Bankscope-Financial Data; WGI: Worldwide Governance Indicators.

Table 3. Summary statistics.

Variables	Mean	ST. D	Min	Max	Q1	Q3
Z_score	0.148	0.047	0.054	0.246	0.132	0.173
Financial Inclusion	0.352	0.265	0	1	0.142	0.479
KAOPEN	0.279	0.175	0.163	0.716	0.163	0.417
INFL	0.045	0.033	−0.007	0.155	0.018	0.062
TO	0.459	0.459	0.125	0.221	0.374	0.556
COSTS	0.050	0.104	0.008	0.843	0.017	0.038

Note: The analysis reveals that the mean financial stability across countries (Z-score) is 0.148, ranging from 0.054 to 0.246. Similarly, the average financial inclusion is 0.352, with a standard deviation of 0.265. Among the control variables, trade openness (TO) averages 0.459, while financial openness (FO) shows a slightly lower mean of 0.279. The inflation rate index (INFL) averages 0.045, whereas the mean banking efficiency (COSTS) is recorded at 0.050. For detailed information on all variables, please refer to **Table 2**.

4. Methodology: Panel smooth transition regression

Expanding beyond the study by Barik and Pradhan (2020), this research aims to examine the potential nonlinear association between financial inclusion and financial stability within BRICS nations. When the relationship between financial inclusion and financial stability is nonlinear, models that do not account for such nonlinearities may

introduce a downward bias in estimating these variables. Additionally, the inclusion of squared terms can induce multicollinearity issues, potentially leading to misleading results influenced by specific parameter effects (Arcand et al., 2012). To address these challenges, the study employs a panel smooth transition regression model (PSTR), introduced by González et al. (2005). This approach provides an alternative to traditional threshold panel models, encompassing an infinite number of regimes bounded by two extreme regimes. The transition function of PSTR operates based on both logistic (referred to as $m = 1$) and exponential (referred to as $m = 2$) principles, facilitating gradual or abrupt changes between regimes, respectively. The PSTR model is executed through a three-step process: specification, estimation, and evaluation (Cheikh et al., 2021). Formally, a panel smooth transition regression model is presented below:

$$Y_{it} = \omega_i + \alpha_0' X_{it} + \alpha_1' X_{it} g(q_{it}; \gamma, c) + \varepsilon_{it} \tag{1}$$

where $i = 1, \ldots, 5$; $t = 2004, \ldots, 2020$. Y_{it}: denotes the financial stability measure (Z-score) observed in country i at time t, serving as the dependent variable. X_{it}: indicates independent variables, which include the variable of interest representing the measure of financial inclusion, along with a set of control variables. Additional details regarding the variables are available in **Table 2**.

The transition function $g(q_{it}; \gamma, c)$: is a normalized and constrained function, limited to the range of 0 to 1. q_{it}: denotes the threshold variable (financial inclusion). γ: represents the velocity of transition between regimes. c: stands for the threshold parameter. ω_i: captures the unobserved individual effect. ε_{it}: indicates the error term of the model. For detailed model specifications, please refer to González et al. (2005).

5. Results of the panel smooth transition

5.1. Panel unit root test results

To validate the appropriateness of our variables of interest for panel smooth transition estimation, an initial assessment of stationarity is performed using the augmented Dickey-Fuller (ADF) Fisher-type unit root test. The results of these analyses indicate that the variables are stationary at the 1% significance level. Detailed results of the panel unit root tests are provided in **Table 4**.

Table 4. Unit root tests.

	ADF	
	Levels	**First Difference**
Z_score	−4.615***	
Financial Inclusion	−1.839**	−3.932***
KAOPEN	−0.827	−2.568***
INFL	−5.240***	
TO	−3.555***	
COSTS	−4.555***	

Note: Statistical significance at the 1% and 5% levels is indicated by (***) and (**), respectively. This table presents the results of unit root tests performed on all variables across BRICS countries from 2004 to 2020. Detailed descriptions of the variables can be found in **Table 2**.

5.2. Panel smooth transition results

Our analysis begins with assessing linearity and identifying the appropriate parameter order. Subsequently, the optimal number of regimes needed to capture the nonlinearities in the slope coefficients is determined. Following this, the parameters of the threshold-based model are estimated to understand the elasticity of the relationship between financial inclusion and stability across BRICS nations.

5.2.1. Linearity tests

Ben Cheikh et al. (2021) assert that before proceeding with the estimation of a panel smooth transition regression (PSTR), it is crucial to validate the statistical significance of the regime-switching effect through linearity tests. If the assumption of non-linearity is confirmed, the subsequent step involves determining the optimal number of transition functions. This task is facilitated by adhering to two fundamental criteria guiding the selection between logistic ($m = 1$) and exponential ($m = 2$) panel smooth transition functions. Firstly, precedence is given to the function exhibiting the lowest *p*-value in the linearity test. Secondly, preference is accorded to the function demonstrating the lowest values of both the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC).

Table 5 illustrates the rejection of the null hypothesis of linearity across all three tests, particularly evident when evaluating two functions ($m = 1$, $m = 2$). This finding suggests that the relationship between financial inclusion and financial stability in BRICS countries is nonlinear, with a significance level of 1%. Furthermore, based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) criteria, the logistic function ($m = 1$) emerges as the most suitable choice. This finding aligns with theoretical expectations, showing a gradual transition between financial inclusion and financial stability (Josè and Garcia, 2016). Consequently, our study is confined to the logistic function ($m = 1$). Detailed results are provided in **Tables 5** and **6**.

Table 5. Comparison of linearity and nonlinearity tests.

Tests		H_0 comapred to H_1
LMW	$m = 1$	26.543*** (0.000)
LMF	$m = 1$	7.121*** (0.000)
LRT	$m = 1$	32.761*** (0.000)
LMW	$m = 2$	30.561*** (0.001)
LMF	$m = 2$	4.126*** (0.000)
LRT	$m = 2$	39.252*** (0.000)

Note: The analysis employs three statistical tests to assess model specifications—LMW (Wald Test), LMF (Fisher Test), and LRT (Likelihood Ratio Test)—with associated *p*-values provided in parentheses. The hypotheses tested are as follows: H_0: proposes a linear model. H_1: suggests a PSTR model with at least one threshold variable ($r \geq 1$). The logistic function corresponds to $m = 1$ and the exponential function to $m = 2$. Significance levels are indicated as follows: *** signifies statistical significance at the 1% level.

Table 6. Model comparison ($m = 1$ and $m = 2$) with BIC, AIC, and RSS.

$m = 1$		
RSS	**AIC**	**BIC**
0.006	−9.081	−8.736
$m = 2$		
RSS	**AIC**	**BIC**
0.006	−9.043	−8.669

Note: RSS: Residual Sum of Squares, AIC: The Akaike Information Criterion, BIC: the Bayesian Information Criterion.

The results in **Table 7** illustrate the outcomes of examinations aimed at identifying regimes related to financial inclusion and financial stability across BRICS nations. According to the null hypothesis, a panel smooth transition (PSTR) model incorporates only one threshold, while the alternative hypothesis suggests the presence of multiple thresholds. The analysis reveals insufficient evidence to reject the null hypothesis (p-value > 5%), indicating that a single threshold ($r = 1$) characterizes the nonlinear relationship between financial inclusion and financial stability.

Table 7. Tests for the number of regimes ($m = 1$, $r = 1$).

Tests	Statistics	*p*-value
Wald Test	0.767	0.979
Fisher Test	0.114	0.989
Likelihood Ratio Test	0.771	0.979

Note: H_0: corresponds to a PSTR model with a single threshold ($r = 1$). H_1: suggests a PSTR model with a minimum of two thresholds ($r \geq 2$).

5.2.2. Results of financial inclusion on financial stability (PSTR Model)

After performing the necessary tests, the analysis investigates the influence of financial inclusion on the financial stability of BRICS countries using a panel smooth transition regression (PSTR) model. The findings, reported in **Table 8**, underscore a nonlinear association between financial inclusion and financial stability, characterized by a U-shaped pattern. In the initial stage of financial inclusion, the results indicate a negative relationship between financial inclusion and financial stability, suggesting that financial inclusion may initially compromise financial stability. This observation aligns with the findings of Barik and Pradhan (2020), particularly in the context of BRICS nations. Nevertheless, our results indicate that beyond a threshold of 44.7% (with an estimated slope parameter of 4.587), financial inclusion enhances financial stability. Our findings support the nonlinear relationship between financial inclusion and financial stability (Ofoeda et al., 2024; Saha and Dutta, 2021).

Table 8. The effect of financial inclusion on financial stability (*Z*_score): A panel smooth transition regression (PSTR) with $r = 1$ and $m = 1$.

Dependent variable: *Z*_score		
Variables	**Regime (1) (α'_0)**	**Regime (2) (α'_1)**
Financial_Inclusion	−0.346*** (3.846)	0.417*** (6.773)
KAOPEN	−0.115*** (2.982)	0.589*** (2.826)
INFL	−0.204*** (3.122)	0.264 (0.903)
TO	0.306*** (6.973)	−0.460*** (6.148)
COSTS	−0.347* (1.864)	2.434* (1.789)
Threshold level	0.447	
Slope parameter	4.587	

Note: This table presents results obtained through a panel smooth transition regression. Definitions for all variables are available in **Table 2**. Significance levels are denoted as ***, **, and * for statistical significance at the 1%, 5%, and 10% levels, respectively. Values within parentheses represent the corresponding *T*-statistics.

In the BRICS economies, the initial surge in financial inclusion spurs increased demand for financial services, prompting financial institutions to expand their operations. This expansion fosters rapid credit growth, an erosion of credit standards, and increased operational costs (Barik and Pradhan, 2021; Sathye and Sathye, 2017). However, beyond a critical threshold, the benefits of a broader and more diversified financial base begin to outweigh these risks. Enhanced financial inclusion can strengthen financial stability by mitigating concentration risks and promoting efficient allocation of resources. This is evidenced by diversified client portfolios, varied deposit sources, and the effective management of credit across diverse population segments and businesses. Specifically, expanding their customer base allows banks to accumulate significant volumes of low-cost retail deposits, reducing reliance on volatile wholesale funding sources (Demirgüç-Kunt and Huizinga, 2010). Moreover, improved bank-client relationships reduce information asymmetry and enhance client credibility. This, in turn, decreases marginal production costs and facilitates the adoption of innovative, affordable, and cost-effective financial delivery models (Ahamed and Mallik, 2019). A well-managed financial inclusion initiative can foster a resilient financial system, benefiting the entire BRICS economies.
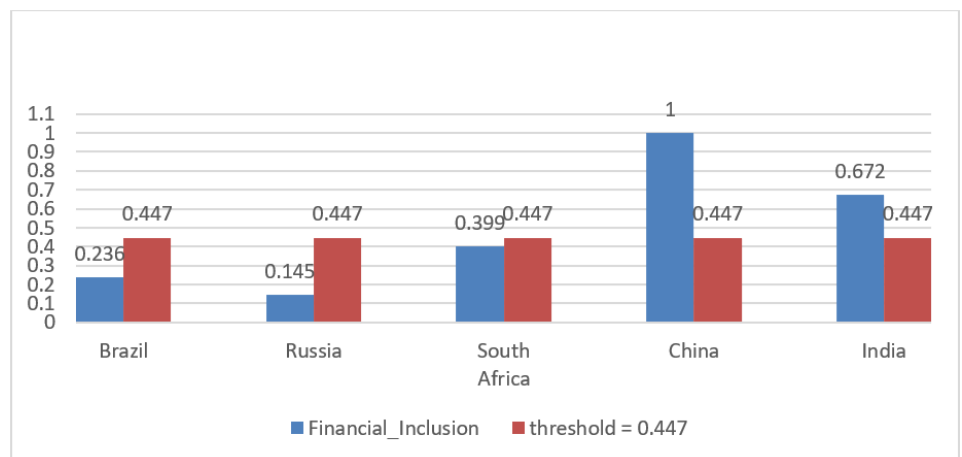

Figure 1. BRICS nations in 2020: Financial inclusion threshold comparison.

Figure 1 displays the positioning of BRICS countries in 2020, illustrating which nations exhibit levels of financial inclusion above or below the defined threshold of 44.7%. Notably, China and India have surpassed this threshold, while South Africa is on the verge of achieving it. In contrast, Brazil and Russia remain significantly behind. These observations highlight the critical need for policymakers to adopt cautious approaches to enhancing financial inclusivity. This, in turn, underscores the importance of robust regulatory frameworks and vigilant oversight to maintain financial stability within the BRICS nations.

5.2.3. Exploring the moderating effect of institutional quality on the relationship between financial inclusion and financial stability in BRICS countries

Examining whether institutional quality enhances or impedes financial inclusion (Anarfo et al., 2021; Zeqiraj et al., 2022) and financial stability (Boulanouar et al., 2021; Gani and Rasul, 2020) is crucial. Hawkins (2006) emphasizes that in an inclusive financial sector, strong institutional quality fosters efficient financial intermediation and promotes overall stability. This study aims to re-examine regression models, taking into account the role of institutional quality, such as rule of law, control of corruption, regulatory quality, government effectiveness, and political stability, in the association between financial inclusion and financial stability. Due to the high correlation among these indicators, principal component analysis (PCA) is employed to capture common variation and develop a composite index of institutional quality. The results of the PCA estimation are presented in **Table 9**. Following the same procedures described above, the institutional quality index is normalized on a scale from 0 to 1, where a value of 0 indicates weak institutional quality and a value of 1 signifies strong institutional quality. Additionally, both **Tables 10** and **11** demonstrate significant threshold effect tests at the 1% level, indicating a nonlinear effect (p-value < 5% in **Table 10**) with a single threshold (p-value > 5% in **Table 11**). This suggests the presence of two regimes characterized by logistic transitions ($m = 1$), consistent with our initial estimations.

Table 9. Principal component analysis: Institutional quality index of BRICS countries.

	PC_1	PC_2	PC_3	PC_4	PC_5
Eigen values	3.567	0.727	0.419	0.211	0.076
Percentage of variance	0.713	0.146	0.084	0.042	0.015
Cumulative percentage	0.713	0.859	0.943	0.985	1.000
Variables	**Comp_1**	**Comp_2**	**Comp_3**	**Comp_4**	**Comp_5**
Rule of law	0.420	−0.624	−0.349	0.326	0.455
Control of corruption	0.505	−0.129	−0.264	−0.050	−0.810
Regulatory quality	0.469	0.330	−0.220	−0.704	0.355
Political stability	0.411	0.657	0.033	0.622	0.101
Government effectiveness	0.424	−0.231	0.871	−0.086	0.022

Note: The data on institutional quality indices are collected from the WGI.

Table 10. Linearity versus non-linearity (with interaction effects).

Transition function	$m = 1$	$m = 2$
LMW	33.345*** (0.000)	45.231*** (0.000)
LMF	7.205*** (0.000)	6.078*** (0.000)
LR	44.106*** (0.000)	69.302*** (0.000)
AIC	−9.545	−9.525
BIC	−9.065	−9.056

Note: H_0: Linear model. H_1: Nonlinear model.

Table 11. Number of Regimes (with interaction effects).

Transition function	$m = 1, r = 1$
LMW	6.362 (0.498)
LMF	0.649 (0.713)
LR	6.648 (0.466)

Note: H_0: one threshold ($r = 1$) vs. H_1: minimum of two thresholds ($r \geq 2$).

The results from a panel smooth transition regression (PSTR) method, as provided in **Table 12**, indicate a consistently negative effect of financial inclusion on the financial stability of BRICS countries up to a certain threshold. Beyond this point, financial inclusion contributes positively to greater financial stability. The identified threshold for financial inclusion is 35.13% (with a slope parameter of 10.7447), indicating a slight adjustment from initial estimations.

Table 12. The role of institutional quality in financial inclusion and banking stability: A panel smooth transition regression (PSTR) with $r = 1$ and $m = 1$.

Dependent variable: Z_score		
Variables	**Regime (1) (α'_0)**	**Regime (2) (α'_1)**
Financial Inclusion	−0.296*** (3.984)	0.219*** (4.262)
Institutional quality	−0.017 (0.637)	−0.398*** (6.150)
Financial Inclusion * Institutional quality	0.180 (1.130)	0.316** (2.089)
KAOPEN	−0.045** (2.466)	0.701*** (3.426)
INFL	−0.180*** (3.547)	0.409*** (4.204)
TO	0.279*** (5.854)	−0.358*** (6.711)
COSTS	−0.158*** (5.841)	3.958*** (5.107)
Threshold level	0.3513	
Slope parameter	10.7447	

Note: This table presents results obtained through a panel smooth transition regression. Definitions for all variables are available in **Table 2**. Significance levels are denoted as ***, **, and * for statistical significance at the 1%, 5%, and 10% levels, respectively. Values within parentheses represent the corresponding *T*-statistics.

Regarding the interaction effects of institutional quality with financial inclusion, it is observed that the interaction effect is not significant below a certain threshold; however, it becomes positive and significant beyond a specific threshold. Specifically, stronger institutional quality effectively enhances the relationship between financial inclusion and financial stability within BRICS nations. This finding aligns with

Ahamed and Mallick's (2019) research, which emphasizes that the interaction between institutional quality and financial inclusion positively contributes to financial stability. Maintaining the same control variables: trade openness (TO), financial openness (KAOPEN), inflation (INFL), and the measure of bank efficiency (COSTS) suggest a significant impact on financial stability across both lower and upper regimes.

These results are crucial for regulatory authorities making decisions related to financial inclusion and stability. This study distinguishes itself from prior research, such as that of Barik and Pradhan (2021), which primarily identifies a negative effect in BRICS nations. Our results determine a specific threshold of financial inclusion, beyond which financial inclusion significantly enhances the financial stability of BRICS nations. Furthermore, our findings underscore the crucial role of institutional quality in strengthening the relationship between financial inclusion and stability, thereby ensuring its beneficial impact within the BRICS context, particularly beyond a certain point.

Figure 2 depicts the positioning of BRICS countries in 2020, indicating whether the development of financial inclusion surpassed or fell below the threshold of 35.13%, with particular emphasis on the interaction between institutional quality and financial inclusion. Notably, the levels of financial inclusion in South Africa, China, and India in 2020 exceeded the estimated threshold, while Brazil and Russia fall below it. This emphasizes the need to enhance institutional quality to promote financial stability within BRICS nations.
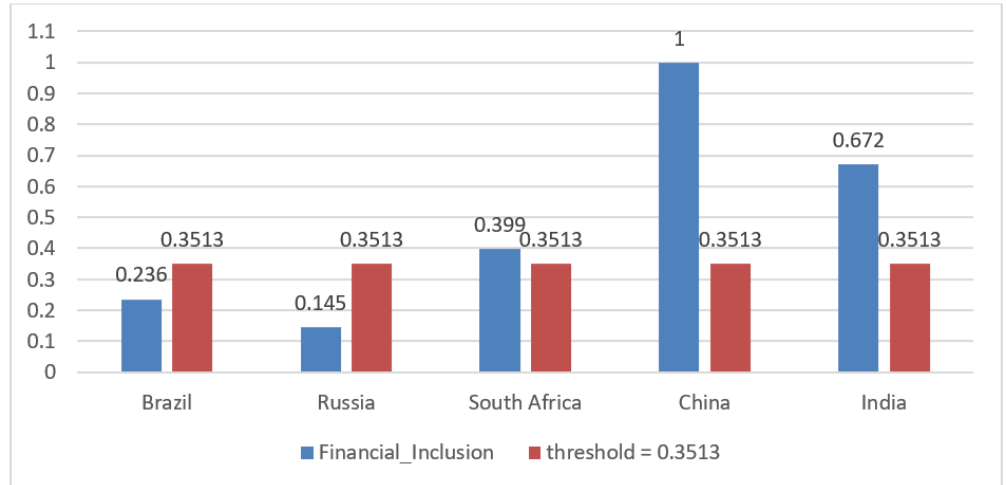

Figure 2. BRICS nations' positions in 2020 relative to the financial inclusion threshold with institutional quality interaction.

5.3. Robustness tests

In the following section, a series of robustness analyses are conducted to evaluate the sensitivity of the baseline results. The PSTR model is first re-estimated using an alternative measure of financial stability, and then with the inclusion of an additional control variable for economic stability, measured as the logarithm of GDP per capita.

5.3.1. Alternative measure of financial stability

As a preliminary robustness check, the model presented in Equation (1) is re-estimated using an alternative proxy for financial stability. Following Ahamed and

Mallick (2019), Feghali et al. (2021), an indicator reflecting banking profitability, specifically the return on assets (ROA) (The selection of this variable also depends on the availability of data for BRICS countries from 2004 to 2020.), is employed. The results confirm a progressive shift between regimes and a single threshold value (see **Table 13**). **Table 14** further supports the presence of a U-shaped nonlinear relationship between financial stability and financial inclusion, with the threshold level of financial inclusion identified at 55.63% and an estimated slope parameter of 3.676. These findings corroborate the initial estimates.

Table 13. Linearity and nonlinearity analysis using alternative measure of financial stability (ROA).

Tests	Linearity versus Nonlinearity		
	LMW	**LMF**	**LRT**
$m = 1$	16.301*** (0.004)	3.610*** (0.003)	18.379*** (0.000)
$m = 2$	25.898*** (0.006)	3.165*** (0.006)	31.769*** (0.003)
	RSS	**AIC**	**BIC**
$m = 1$	0.002	−10.177	−9.832
$m = 2$	0.002	−10.032	−9.659
	Number of regime H_0: $r = 1$ vs H_1: $r = 2$		
	LMW	**LMF**	**LRT**
$m = 1$	3.941 (0.558)	0.610 (0.693)	4.048 (0.543)

Note: Linearity tests are performed using the LMW, LMF, and LR tests for each model with $m= 1$ and $m = 2$. The numbers in parentheses represent *p*-values. The Akaike Information Criterion (AIC) and the Schwarz Information Criterion (BIC) are employed to distinguish between the logistic transition function ($m = 1$) and the logistic quadratic transition function ($m = 2$). r denotes the number of regimes.

Table 14. Impact of financial inclusion on financial stability (ROA): A panel smooth transition regression (PSTR) with $r = 1$ and $m = 1$.

Dependent variable: ROA		
Variables	**Regime (1) (α_0')**	**Regime (2) (α_1')**
Financial_Inclusion	−0.457*** (6.118)	0.259*** (5.839)
KAOPEN	−0.178*** (4.193)	0.902*** (4.029)
INFL	−0.081* (1.629)	0.264* (1.943)
TO	0.050 (1.369)	−0.007 (0.090)
COSTS	−0.333*** (2.843)	2.348** (2.645)
Threshold level	0.5563	
Slope parameter	3.6756	

Note: This table presents robustness results from a panel smooth transition regression using an alternative measure of financial stability (ROA). Definitions for all variables are available in **Table 2**. Significance levels are denoted as ***, **, and * for statistical significance at the 1%, 5%, and 10% levels, respectively. Values within parentheses represent the corresponding *T*-statistics.

5.3.2. Additional control variables

The second robustness analysis involves re-estimating the PSTR model by incorporating an additional control variable for economic stability, measured as the logarithm of GDP per capita. The existing literature indicates a significant link

between economic and financial stability (Neaime and Gaysset, 2018). **Table 15** illustrates a nonlinear effect, characterized by a gradual transition, as evidenced by a *p*-value below 5% and the lowest AIC and BIC values. Moreover, **Table 15** reveals a single threshold for financial inclusion, supported by a *p*-value > 5% when $m = 1$. **Table 16** presents the estimation results, confirming a U-shaped relationship between financial inclusion and financial stability. The threshold level of financial inclusion is identified at 38.31%, which aligns with the previous findings.

Table 15. Linearity and nonlinearity analysis using an additional control variable.

Tests	Linearity versus Nonlinearity		
	LMW	**LMF**	**LRT**
$m = 1$	26.138*** (0.000)	5.706*** (0.000)	32.137*** (0.000)
$m = 2$	29.468*** (0.003)	3.128*** (0.002)	37.430*** (0.000)
	RSS	**AIC**	**BIC**
$m = 1$	0.006	−9.017	−8.615
$m = 2$	0.006	−8.981	−8.550
	Number of regime H_0: $r = 1$ vs. H_1: $r = 2$		
	LMW	**LMF**	**LRT**
$m = 1$	4.142 (0.657)	0.507 (0.801)	4.261 (0.641)

Note: Linearity tests are performed using the LMW, LMF, and LR tests for each model with $m = 1$ and $m = 2$. The numbers in parentheses represent *p*-values. The Akaike Information Criterion (AIC) and the Schwarz Information Criterion (BIC) are employed to distinguish between the logistic transition function ($m = 1$) and the logistic quadratic transition function ($m = 2$). r denotes the number of regimes.

Table 16. Impact of financial inclusion on financial stability (*Z_score*), with additional control variables: A panel smooth transition regression (PSTR) with $r = 1$ and $m = 1$.

Dependent variable: *Z_score*		
Variables	**Regime (1) (α'_0)**	**Regime (2) (α'_1)**
Financial_Inclusion	−0.138** (2.165)	0.379*** (6.479)
Log (GDPPC)	0.006 (1.138)	−0.026** (2.462)
KAOPEN	−0.071*** (2.904)	0.502*** (2.713)
INFL	−0.151*** (2.883)	0.128 (0.625)
TO	0.273*** (3.963)	−0.296** (2.485)
COSTS	−0.151* (1.532)	1.927 (1.421)
Threshold level	0.3831	
Slope parameter	7.5831	

Note: This table shows robustness results from a panel smooth transition regression with an additional control variable for economic stability (Log of GDP per capita). Definitions for all variables are available in **Table 2**. Significance levels are denoted as ***, **, and * for statistical significance at the 1%, 5%, and 10% levels, respectively. Values within parentheses represent the corresponding *T*-statistics.

6. Conclusion

This paper examines the relationship between financial inclusion and financial stability within BRICS nations from 2004 to 2020 using a panel smooth transition

regression (PSTR) approach. Our empirical findings indicate a U-shaped relationship between financial inclusion and financial stability. In the early stages of financial inclusion, a negative effect on financial stability is observed, consistent with the findings of Barik and Pradhan (2020) in the context of BRICS countries. However, beyond a certain point, our results show that financial inclusion enhances financial stability. Furthermore, our study underscores the positive impact of institutional quality on the relationship between financial inclusion and financial stability, particularly beyond a specified threshold, as regulatory quality operates efficiently in these contexts. Overall, our results remain robust to an alternative measure of financial stability and an additional control variable.

Our findings are significant for financial regulators in BRICS countries as they provide a comprehensive framework for policymakers to develop policies aimed at establishing a robust and resilient financial landscape by identifying critical thresholds. Regulators may consider actively encouraging financial institutions to broaden their range and customize their offerings to better accommodate the diverse needs of clients. However, such expansion must be accompanied by rigorous risk management and heightened surveillance to ensure the stability of the financial system. Additionally, close collaboration among financial regulators in BRICS member countries is crucial for implementing robust regulations and strengthening the enforcement of institutional quality. Furthermore, enhancing financial education is crucial to helping individuals discern the opportunities and risks associated with banking products. It is equally important to encourage banks within BRICS economies to expand their branch networks and strengthen their local presence. By solidifying relationships with clients, banks can gain a deeper understanding of their financial histories, which enables more effective allocation of resources and supports overall financial stability. This approach allows policymakers to leverage these insights to develop effective strategies aimed at creating a robust inclusive financial environment.

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References

Acharya, V., & Naqvi, H. (2012). The seeds of a crisis: A theory of bank liquidity and risk taking over the business cycle. Journal of Financial Economics, 106(2), 349–366. https://doi.org/10.1016/j.jfineco.2012.05.014

Ahamed, M. M., & Mallick, S. K. (2019). Is financial inclusion good for bank stability? International evidence. Journal of Economic Behavior & Organization, 157, 403–427. https://doi.org/10.1016/j.jebo.2017.07.027

Allen, F., Demirguc-Kunt, A., Klapper, L., et al. (2016). The foundations of financial inclusion: Understanding ownership and use of formal accounts. Journal of Financial Intermediation, 27, 1–30. https://doi.org/10.1016/j.jfi.2015.12.003

Amatus, H., Alireza. (2015). Financial Inclusion and Financial Stability in Sub-Saharan Africa (SSA). The International Journal of Social Sciences, 36(1), 39–49.

Amidžic, G., Massara, A., & Mialou, A. (2014). Assessing Countries' Financial Inclusion Standing: A New Composite Index.

IMF Working Papers, 14(36), 1. https://doi.org/10.5089/9781475569681.001

Anarfo, E. B., Abor, J. Y., & Osei, K. A. (2020). Financial regulation and financial inclusion in Sub-Saharan Africa: Does financial stability play a moderating role? Research in International Business and Finance, 51, 101070. https://doi.org/10.1016/j.ribaf.2019.101070

Antwi, F., Kong, Y., & Gyimah, K. N. (2024). Financial inclusion, competition and financial stability: New evidence from developing economies. Heliyon, 10(13), e33723. https://doi.org/10.1016/j.heliyon.2024.e33723

Arcand, J. L., Berkes, E., & Panizza, U. (2015). Too much finance? Journal of Economic Growth, 20(2), 105–148. https://doi.org/10.1007/s10887-015-9115-2

Atellu, A. R., & Muriu, P. W. (2022). Does financial inclusion enhance financial stability? Evidence from a developing economy. Transnational Corporations Review, 14(3), 297–311. https://doi.org/10.1080/19186444.2021.2019555

Barik, R., & Pradhan, A. K. (2021). Does financial inclusion affect financial stability: Evidence from BRICS nations? The Journal of Developing Areas, 55(1). https://doi.org/10.1353/jda.2021.0023

Basty, N., & Ghazouani, I. (2023). Competition–banking stability: the moderating role of government intervention quality in North African countries. The Journal of Risk Finance, 24(2), 244–268. https://doi.org/10.1108/jrf-06-2022-0166

Ben Cheikh, N., Ben Zaied, Y., & Chevallier, J. (2021). On the nonlinear relationship between energy use and CO2 emissions within an EKC framework: Evidence from panel smooth transition regression in the MENA region. Research in International Business and Finance, 55, 101331. https://doi.org/10.1016/j.ribaf.2020.101331

Boulanouar, Z., Alqahtani, F., & Hamdi, B. (2021). Bank ownership, institutional quality and financial stability: evidence from the GCC region. Pacific-Basin Finance Journal, 66, 101510. https://doi.org/10.1016/j.pacfin.2021.101510

Cecchetti, S. G., Domanski, D., & von Peter, G. (2011). New Regulation and the New World of Global Banking. National Institute Economic Review, 216, R29–R40. https://doi.org/10.1177/0027950111411378

Demirgüç-Kunt, A., & Huizinga, H. (2010). Bank activity and funding strategies: The impact on risk and returns. Journal of Financial Economics, 98(3), 626–650. https://doi.org/10.1016/j.jfineco.2010.06.004

Elgharib, W. A. (2024). Financial inclusion, financial development and financial stability in MENA. Review of Accounting and Finance, 23(4), 489–505. https://doi.org/10.1108/raf-05-2023-0146

Feghali, K., Mora, N., & Nassif, P. (2021). Financial inclusion, bank market structure, and financial stability: International evidence. The Quarterly Review of Economics and Finance, 80, 236–257. https://doi.org/10.1016/j.qref.2021.01.007

Financial Access Survey. (2010). FAS (Financial Access Survey) (database). International Monetary Fund, Washington, DC.

Gani, A., & Rasul, T. (2020). The Institutional Quality Effect on Credits Provided by the Banks. International Advances in Economic Research, 26(3), 249–258. https://doi.org/10.1007/s11294-020-09794-0

González, A., Teräsvirta, T., Dijk, V. D. (2005). Panel Smooth Transition Regression Models. Quantitative Finance Research Centre, University of Technology, Sydney.

Grosse, R. (2012). Bank regulation, governance and the crisis: a behavioral finance view. Journal of Financial Regulation and Compliance, 20(1), 4–25. https://doi.org/10.1108/13581981211199399

Global Financial Index Database. (2011). Available online: https://www.worldbank.org/en/topic/financialinclusion/overview (accessed on 17 March 2024).

Global Financial Index Database. (2018). Available online: https://www.worldbank.org/en/publication/globalfindex (accessed on 17 March 2024).

Global Financial Index Database. (2021). Available online: https://www.worldbank.org/en/publication/globalfindex (accessed on 17 March 2024).

Hakimi, A., Boussaada, R., & Karmani, M. (2021). Are financial inclusion and bank stability friends or enemies? Evidence from MENA banks. Applied Economics, 54(21), 2473–2489. https://doi.org/10.1080/00036846.2021.1992342

Hannig, A., & Jansen, S. (2010). Financial Inclusion and Financial Stability: Current Policy Issues. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.1729122

Han, R., & Melecky, M. (2017). Broader use of saving products among people can make deposit funding of the banking system more resilient. Journal of International Financial Markets, Institutions and Money, 47, 89–102. https://doi.org/10.1016/j.intfin.2016.11.005

Hawkins, P. (2006). Financial access and financial stability. London: BIS.

Hua, X., Bi, J., & Shi, H. (2023). The appropriate level of financial inclusion: The perspective of financial stability. China Economic Quarterly International, 3(3), 167–178. https://doi.org/10.1016/j.ceqi.2023.08.001

Jia, P. F., Fan, C. L., Chu, J. (2021). Negative externalities of over-borrowing and optimal macroprudential policy. Economic Research Journal, 56(3), 32–47.

José, M., García, R. (2016). Can financial inclusion and financial stability go hand in hand? Economic Issues, 21(2), 81–103.

Khan, H. R. (2011). Financial Inclusion and Financial Stability: Are They Two Sides of the Same Coin? Available online: https://www.bis.org/review/r111229f.pdf (accessed on 13 May 2024).

Mehrotra, A. N., Yetman, J. (2015). Financial Inclusion-Issues for Central Banks. BIS Quarterly Review.

Morgan, P., & Pontines, V. (2014). Financial Stability and Financial Inclusion. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2464018

Neaime, S., & Gaysset, I. (2018). Financial inclusion and stability in MENA: Evidence from poverty and inequality. Finance Research Letters, 24, 230–237. https://doi.org/10.1016/j.frl.2017.09.007

Ofoeda, I., Mawutor, J. K. M., & Ohenebeng, D. N. F. H. (2023). Financial inclusion, institutional quality and bank stability: evidence from sub-Saharan Africa. International Economics and Economic Policy, 21(1), 27–64. https://doi.org/10.1007/s10368-023-00578-5

Saha, M., & Dutta, K. D. (2020). Nexus of financial inclusion, competition, concentration and financial stability. Competitiveness Review: An International Business Journal, 31(4), 669–692. https://doi.org/10.1108/cr-12-2019-0136

Sathye, S., & Sathye, M. (2016). Do ATMs Increase Technical Efficiency of Banks in a Developing Country? Evidence from Indian Banks. Australian Accounting Review, 27(1), 101–111. Portico. https://doi.org/10.1111/auar.12110

Shihadeh, F., Liu, B. (2019). Does financial inclusion influence the banks risk and performance? Evidence from global prospects. Academy of Accounting and Financial Studies Journal, 23(3), 1–12.

Smaoui, H., Mimouni, K., Miniaoui, H., et al. (2020). Funding liquidity risk and banks' risk-taking: Evidence from Islamic and conventional banks. Pacific-Basin Finance Journal, 64, 101436. https://doi.org/10.1016/j.pacfin.2020.101436

Soederberg, S. (2013). Universalising Financial Inclusion and the Securitisation of Development. Third World Quarterly, 34(4), 593–612. https://doi.org/10.1080/01436597.2013.786285

VanHoose, D. (2007). Theories of bank behavior under capital regulation. Journal of Banking & Finance, 31(12), 3680–3697. https://doi.org/10.1016/j.jbankfin.2007.01.015

Vo, D. H., Nguyen, N. T., & Thi-Hong Van, L. (2021). Financial inclusion and stability in the Asian region using bank-level data. Borsa Istanbul Review, 21(1), 36–43. https://doi.org/10.1016/j.bir.2020.06.003

Vuković, D. B., Hassan, M. K., Kwakye, B., et al. (2024). Does fintech matter for financial inclusion and financial stability in BRICS markets? Emerging Markets Review, 61, 101164. https://doi.org/10.1016/j.ememar.2024.101164

Wang, R., & Luo, H. (2022). How does financial inclusion affect bank stability in emerging economies? Emerging Markets Review, 51, 100876. https://doi.org/10.1016/j.ememar.2021.100876

Zeqiraj, V., Sohag, K., & Hammoudeh, S. (2022). Financial inclusion in developing countries: Do quality institutions matter? Journal of International Financial Markets, Institutions and Money, 81, 101677. https://doi.org/10.1016/j.intfin.2022.101677