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Threshold effects of institutional quality on the financial inclusion and stability nexus: International evidence

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ABSTRACT

This study employs the dynamic panel threshold estimation technique to examine whether the influence of financial inclusion on stability varies across countries with different levels of institutional development. This study analyzes 11,209 observations of bank-level data from 78 developed and developing countries from 2004 to 2022. The findings indicate a threshold effect in the relationship between financial inclusion and stability. Specifically, for institutional quality below the threshold, financial inclusion has an insignificant stability effect. However, after reaching a certain threshold of institutional development, the effect of financial inclusion on financial stability becomes positive and significant. These findings suggest that the impact of financial inclusion on stability is contingent on institutional quality. Enhancing institutional quality to minimize risk can enhance the stability benefits of expanding financial inclusion. These findings remain robust across alternative empirical approaches and disaggregated measures of financial inclusion and institutional quality. These findings have important implications for policymakers formulating strategies for improving financial inclusion and economic stability.

1. Introduction

Financial inclusion and financial stability are significant public policy priorities in many countries seeking to guarantee that every individual in the economy can access official financial services and utilize them efficiently. Simultaneously, the rapid expansion of financial inclusion can lead to structural changes in financial systems, potentially increasing vulnerability (Mehrotra & Yetman, 2015). Consequently, speculation about how the expansion of financial inclusion might impact financial service providers is growing. A stable and well-functioning financial system is essential to promote balanced and sustainable economic growth. Instability can cause stock market crashes, bank failures, and hyperinflation, which can drastically undermine trust in financial systems. Therefore, maintaining financial stability is a primary goal of financial and monetary authorities (Morgan & Pontines, 2018).

Theoretically, expanding access to financial services should enhance bank stability. However, the effects of financial inclusion and bank stability have been ambiguous in recent studies. The empirical literature that finds a positive effect of financial inclusion on financial stability argues that greater access to bank deposits improves the resilience of the banking sector's deposit funding base during crises. Improved resilience of bank financing can promote the stability of the banking sector and broader financial systems (Han & Melecky, 2013). Additionally, banks may gain market share by leveraging scale efficiency and lowering marginal costs through financial inclusion (Ahamed & Mallick, 2019). Similarly, Vo et al. (2021) argue that banks can gain higher profits from less expensive sources of deposits and customized lending mechanisms based on specific purposes can reduce moral hazard issues.

However, financial inclusion may harm financial stability due to the potential for unanticipated losses, particularly those related to credit, capital, and liquidity buffers (Cihak et al., 2016). Moreover, based on an international study, Cihak et al. (2016) highlight the presence of trade-offs and synergies between financial inclusion and stability, depending on the specific indicator being analyzed. In times of normalcy, financial inclusion contributes to stability by reducing operational costs and expected losses as well as stabilizing the growth and rate of deposits. Conversely, financial inclusion could threaten financial stability because of the potential for unforeseen losses, particularly those concerning credit, capital, and liquidity reserves. Additionally, Feghali et al. (2021) find that credit inclusion negatively affects bank

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performance and stability. They contend that unrestricted access to credit may undermine financial stability if lending growth continues without considering the borrowers' repayment capacity.

These varying empirical results point to disparities in the management quality of financial institutions when they leverage increased access to financial services. Financial inclusion can be influenced by the institutional framework that governs bank activities. This influence can be strengthened by improving the quality of institutions. For instance, stronger rule of law could restrict banks' involvement in correlated risk-taking activities even in situations of low financial inclusion. A good institutional environment is expected to foster robust financial institutions, such that the intermediary function can run optimally. Quality institutions reduce transaction costs and the symmetry of information problems as the main issues in channeling funds to borrowers (Cohen et al., 1983; Ho & Michaely, 1988; Jude & Levieuge, 2017). Moreover, better institutional quality encourages the formation of quality regulations and monitoring, including regulations in the financial and banking sectors, fostering a robust risk culture within banks and ensuring that the intermediation function runs smoothly (Phuc Canh et al., 2019; Su et al., 2019).

However, it is crucial to note that there is limited direct evidence verifies that institutions have a definitive impact on how financial inclusion influences financial stability. An exception is the research conducted by Ahamed and Mallick (2019), using a linear interaction model, discover that the impact of financial inclusion on financial stability is more significant when the financial system is integrated into a strong institutional framework. However, this modeling approach has limitations. The interaction term, formed by multiplying financial inclusion by institutional quality, represents how the impact of financial inclusion on financial stability changes depending on institutional development, imposing the predetermined limitation that the influence of financial inclusion on stability will consistently increase or decrease depending on institutional quality (Azman-Saini et al., 2010). The stability effect of financial inclusion could be significant only if the quality of the institutions reaches a certain level. This idea requires a modeling approach that is more adaptable and can handle the different relationships between financial inclusion, stability, and institutional quality.

This article presents fresh findings that offer insights into how institutional quality determines the relationship between stability and inclusion in the banking system. In particular, this study investigates the presence of an institutional quality threshold in the inclusion–stability nexus. If we identify a threshold of institutional quality in the stability effect of financial inclusion–that is, if the stability effect of financial inclusion only occurs in countries above certain institutional quality levels–then this research will have important implications for policymakers. If low institutional quality hinders the stability effect of expanding financial services, policies and actions must be implemented immediately to improve institutional quality and establish well-functioning and stable financial institutions.

This study contributes to the existing body of literature in four ways. First, it provides evidence of a threshold effect of institutional quality on the relationship between financial inclusion and stability. Existing studies on the financial inclusion–stability nexus show mixed results and do not address the contingent role of institutional quality in this relationship. Second, this study implements the most recent dynamic panel data threshold estimation technique developed by Kremer et al. (2013) and Seo and Shin (2016) in its main analysis. The model represents the relationship between financial inclusion and stability as piecewise linear, with institutional quality triggering regime switching. Compared with linear interaction and static models, the dynamic panel threshold model permits more effective modeling of the threshold effect because of its flexibility. It captures nonlinear relationships in which the explanatory variables change and their impacts vary depending on the different levels of the threshold variable. Flexibility is vital, particularly when the relationships between these variables vary across different regimes. Third, this study utilized multiple indicators of financial inclusion and institutional quality. In addition to the institutional quality index, a combination of six indicators from the World Bank Worldwide Governance Indicators (WGIs), this study also analyzes each indicator, which prior works do not. Fourth, this study utilized a sufficiently extensive international dataset to ensure robust findings. In particular, the sample for this study comprises two datasets: a bank-level dataset for analysis using Kremer et al. (2013) and a country-level dataset for analysis using Seo and Shin (2016). The data were collected yearly from 78 countries from 2004 to 2022.

This paper is organized as follows. Section 2 provides a review of the current literature. Section 3 introduces the empirical model, which includes threshold regressions and associated data. Section 4 describes the empirical findings. Finally, Section 5 presents a summary and conclusions.

2. Literature review

2.1. Financial inclusion and stability

The relationship between financial inclusion and stability has been the subject of two main streams of research. One area of the academic literature suggests that financial inclusion can strengthen and enhance financial stability, especially within the banking sector. However, an opposing view presented in another area of research suggests that increased financial inclusion may lead to instability within the banking sector. This review discusses both perspectives.

Ahamed and Mallick (2019), Han and Melecky (2013), López and Winkler (2019), Morgan and Pontines (2018), Neaime and Gaysset (2018a), and Vo et al. (2021) support the positive impact of expanding access to financial services on financial stability. Several theoretical arguments explain financial inclusion's influence on firm stability. Han and Melecky (2013) suggest that expanding financial inclusion allows for a wider availability and usage of bank deposit services, leading to an increase in retail deposits, which are less costly than wholesale funding. This creates more opportunities for banks to access inexpensive funding while diversifying their funding streams. Furthermore, economic fluctuations tend to have little effect on retail deposit behavior, while large depositors are more likely to withdraw funds in response to downturns and crises. The increasing number and diversity of retail depositors in bank portfolios also reduce the correlation of deposit withdrawals. Hence, expanding access to retail deposits is beneficial for increasing the resilience of bank funding sources and strengthening the stability of the banking sector (Cull et al., 2012). Additionally, inclusion in the financial sector improves the relationship between banks and clients, which helps reduce the risk of deposit withdrawals by depositors, especially those in the retail sector (Brown et al., 2020). In terms of loans, a larger distribution of credit to the micro sector can lower the risk of non-performing loans and credit defaults by decreasing reliance on a single large borrower, thus enhancing the bank's credit portfolio in its productive assets (H. R. Khan, 2011).

However, financial inclusion can negatively affect financial stability. Koong et al. (2017) confirm that the expansion of business credit is harmful to financial stability. Sahay et al.'s (2015) panel data analysis indicates a trade-off between financial access and risk. They show that increased credit access increases the probability of bank default, particularly in countries with inadequate regulation and supervision of the banking system. Dabla-Norris et al. (2015) identify the crucial role of certain country-specific factors in moderating the trade-offs between financial inclusion and stability.

In this strand of the literature, researchers primarily discuss the potential risks associated with low-income demographic groups. Cihak et al. (2016) posit that expanding financial inclusion could increase borrowing risk because of extensive borrowing by individuals and businesses. They suggest that financial inclusion may threaten financial stability by increasing the likelihood of unforeseen losses, particularly in relation to credit, capital, and liquidity buffers (Cihak et al., 2016).

Furthermore, Feghali et al. (2021) demonstrate that the accessibility of credit without considering borrowers' capacity to repay could undermine financial stability. Hence, Kraft and Jankov (2005b) contend that policymakers face dilemmas due to credit expansion. This expansion increases the likelihood that credit quality declines, and is crucial for promoting long-term economic growth through financial deepening.

2.2. Institutional quality (IQ)

Institutions can be defined as cohesive social systems or regulations that form the basis of social, political, and economic interaction frameworks, thereby reducing economic uncertainty and minimizing economic risk (Alexiou et al., 2020; Levchenko, 2004). Several key factors shape institutional quality. Each of these aspects, such as the prevention of voice and accountability, political stability, the absence of violence, control of corruption, regulatory quality, government effectiveness, and the rule of law, are essential for promoting economic growth, enhancing productivity, ensuring sustainability, and achieving overall macroeconomic stability (Ahmed et al., 2022; Apergis et al., 2021; Azam et al., 2021; Boulanouar et al., 2021; Nguyen & van Dijk, 2012).

According to Azfar (2006) institutions can be classified as political, legal, and economic. Political institutions minimize uncertainty by establishing laws, rules, and regulations; safeguarding property rights; and advancing the welfare of society. Economic institutions contribute to the efficient distribution of resources through physical capital, human capital, technology, and innovation. Legal institutions enforce the laws, rules, and regulations established by political institutions. Weak institutions can lead to ineffective policymaking, inefficient resource allocation, and poor law enforcement, all of which can hinder economic development (Infante & Smirnova, 2009).

Several studies emphasize the significance of institutional quality in advancing financial development and long-term economic growth (e.g., Arvin et al., 2021; Bayraktar et al., 2023; Corradini, 2021; Doré & Teixeira, 2023; Law et al., 2013). Additionally, Fengju and Wubishet (2024) report that financial development positively impacted economic growth. This impact is notably strengthened in nations with solid institutional structures, suggesting that strong institutions act as accelerators amplifying the beneficial effects of financial development on economic growth. Slesman et al. (2015) suggest that political institutions are the most important factors for economic growth in the OIC and developing countries. Additionally, in OIC countries, economic institutions positively affect growth only after political institutions reach a certain level of quality. Furthermore, Khan et al. (2019) confirmed that high-quality institutions are an important requirement for financial development in the United States.

Ginsburg (2000) emphasizes the significance of legal systems in advancing economic growth in Asia, noting that banks and other financial intermediaries play a crucial role in resource allocation. They serve both business and retail consumers in financing, saving, and transaction activities. One of the important contributions of financial institutions is that they make transaction costs more efficient and minimize information asymmetry. Additionally, well-functioning and extensive financial markets enable financial entities to manage risk efficiently and contribute to economic activities (Goodhart, 2006). La Porta et al. (1998) argue that nations' poor legal and governance systems lead to less resilient banking systems because of weak regulations, inconsistent law enforcement, and corruption. In addition, Demirguc-Kunt and Detragiache (1998) highlight that financial sector fragility is linked to less effective institutions, particularly those related to corruption, the legal system, and contract enforcement.

The literature also indicates that the institutional environment significantly influences financial stability (Barth et al., 2004; Klomp & de Haan, 2014). Additionally, countries with strong institutional qualities can promote institutions' supervision and monitoring (Anginer et al., 2014; Hoque et al., 2015). In the midst of a financial crisis, Klomp and de Haan (2014) emphasize the significance of institutional quality. Nations with robust institutional quality are better equipped to develop effective policies to address the negative impacts than those with weaker institutional quality. Uddin et al. (2020) confirm that adherence to the rule of law, the eradication of corruption, and government effectiveness decrease banks' exposure to risk and enhance stability, highlighting the essential role of institutions in influencing bank stability.

The role of institutional quality in determining the link between financial inclusion and stability has not received much attention in the theoretical and empirical literature. Strong institutions are crucial because they enhance the stabilizing impact of financial inclusion, particularly in banking. Without strong institutions, financial inclusion could pose a risk to financial stability. As substantial funds accumulate from banks and other financial institutions, they can be mismanaged without implementing prudential principles. Strong institutions are essential for ensuring good governance, rule enforcement, and adherence to prudential principles, guaranteeing effective and efficient intermediation and resource allocation by financial institutions.

Most research on the influence of financial inclusion on stability uses a linear regression model augmented with interaction terms. One significant drawback of this approach is that it enforces preexisting restrictions on the impact of financial inclusion on stability. The interaction term constrains the impact of financial inclusion on stability to either monotonically increases or decreases based on the contingent variables under investigation.

This study offers a unique perspective on financial inclusion by investigating how institutional quality serves as a mechanism through which financial inclusion affects stability. We do this by employing a flexible nonlinear econometric model that explicitly accommodates the possibility of threshold effects induced by institutional quality in the relationship between financial inclusion and stability.

3. Methodology

3.1. Empirical model

The empirical model is derived from Ahamed and Mallick (2019), Feghali et al. (2021), and Wang, Luo, and Robin (2022). They suggest a linear equation to analyze the connections between financial inclusion and stability.

$$FS_{i,c,t} = \beta_1 FI_{c,t} + \gamma_1 X_{i,c,t} + \varepsilon_{i,c,t}, \quad (1)$$

where $FS_{i,t}$ is the Z-score used to measure financial stability in the banking system of bank i, country c at time t, and $FI_{c,t}$ represents the country's level of financial inclusion. Financial inclusion assesses the inclusiveness of a country's financial sector as described in Section 3.3. X represents the set of control variables. These include bank size as the natural logarithm of total assets (size), capitalization as the equity to asset ratio (capital), loan ratio as the ratio of total loans to total assets (loan), deposit ratio as the ratio of total deposit to total assets (deposit), income diversification as the ratio of non-interest income to total income (divers), and growth as annual growth rate of bank' total assets (growth). The macroeconomic variables are the GDP growth rate (gdpgrowth) and inflation (inflation). Finally, ε_{ict} is an error term.

Our statistical analysis aims to determine whether a specific level of institutional quality affects financial inclusion. We believe that Equation (2) is well suited for capturing the presence of possible threshold effects and modeling the impact of financial inclusion on stability in a comprehensive manner. Therefore, we employ the dynamic panel threshold regression method recommended by Kremer et al. (2013) and Seo and Shin (2016) to investigate the nonlinear relationship between financial inclusion and stability. Seo and Shin (2016) expand on the previous threshold estimation method (Caner & Hansen, 2004; Hansen, 1999; Kremer et al., 2013) to develop a new dynamic panel threshold model. They address the limitations of existing approaches and suggest a

model that allows both regressors and threshold effects to be endogenous. Their model is based on the first-difference GMM estimator and includes a linearity test to detect the presence of a threshold effect.

$$FS_{ict} = \alpha_i + \widetilde{\beta} FS_{ic,t-1} + \beta_1 FI_{ct} \bullet I(INS_{ct} \le \gamma) + \delta_1 \bullet I(INS_{ct} \le \gamma) + \beta_2 FI_{ct} \bullet I(INS_{ct} > \gamma) + \theta' X_{ict} + \mu_i + \varepsilon_{ict}, \quad (2)$$

where FS_{ict} denotes financial stability, FI_{ct} represents the financial inclusion index, INS_{ct} denotes the institutional quality measures, and INS_{ct} is the threshold variable used to measure the level of institutional development. The indicator functions $I(\bullet)$represent two distinct regimes based on the institutional quality INS_{ct} threshold denoted by γ. These regimes are characterized by whether the value of γ is above or below the threshold and are associated with different regression slopes, represented by β_1 and β_2. X_{ict} is a vector of control variables.

3.2. Data and descriptive statistics

The models in this study are estimated using panel data from 73 developed and developing countries at the bank level from 2004 to 2022. To enrich the analysis, we use an aggregate dataset of 78 countries over 18 years, from 2004 to 2021. The sample countries were selected based on data availability, primarily to construct a financial inclusion index. The banking sector's Z-score is the dependent variable used to represent financial stability (FS). Financial inclusion (FI) is the independent variable, measured using the financial inclusion index, consisting of outreach and usage dimensions of financial services. Section 3.3 provides details on the construction of the financial inclusion index. The data for this study are gathered from the Global Findex database and Financial Access Survey (FAS).

The threshold variable, institutional quality indicator (INS), was constructed using WGI data. Six indicators were created, each reflecting a distinct aspect of institutional quality and governance, to represent institutions: (i) voice and accountability (VA), (ii) political stability and the absence of violence (PS), (iii) government effectiveness (GE), (iv) regulatory quality (RQ), (v) rule of law (RL), and (vi) control of corruption (CC). We assess institutional quality using two measures provided by the WGI: the Estimate and the Percentile Rank. The estimate reflects a country's score on a standard normal distribution, ranging from about −2.5 to 2.5. The Percentile Rank indicates a country's position relative to others, with 0 being the lowest and 100 the highest. We construct an institutional quality index using Principal Component Analysis (PCA) instead of simple averaging. PCA allows us to identify the primary component that captures shared variation across indicators, making the index more interpretable and comparable, while efficiently reducing dimensionality. We estimate year-specific weights to create a time-varying index that better captures the changing dynamics of institutional quality indicators. Several studies also apply the PCA approach to measure institutional quality (e.g., Chang, 2023; Dosso, 2023; Marchionne et al., 2024; Roudari et al., 2023; Sun et al., 2025).

We collect the bank-level data from the Refinitiv DataStream database and the country-level data from Global Financial Development, World Development Indicators, and WGI. The Appendix presents details of the variables and data sources.

Table 1 presents the descriptive statistics of the main and control variables used in model estimation. Bank stability is measured using the natural logarithm of the Z-score, which averaged 3.907. A higher Z-score indicates that the bank is more stable and has lower financial risk. The financial inclusion index has an average of 0.223 and ranges between 0 and 1, where a value closer to 1 indicates a higher level of financial inclusion in the country. In this study, Hong Kong has the highest financial inclusion index and Malawi has the lowest. The access and usage dimensions have average index values of 0.151 and 0.164, respectively. The institutional quality index based on estimate value ranges from −1.512 to a maximum of 1.966, with an average of 0.312 and a standard deviation of 0.858. Moreover, institutional quality based on percentile rank has a mean of 58.325, with a standard deviation of 24.323.

Table 1
Summary statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
ln zscore	11269	3.907	1.25	−4.45	10.414
financial inclusion index	11269	0.223	0.191	0	1
outreach dimension	11269	0.151	0.159	0	1
usage dimension	11269	0.164	0.143	0	1
institutional quality (estimate)	11269	0.312	0.858	−1.512	1.966
institutional quality (percentile rank)	11269	58.325	24.323	5.954	99.767
size	11269	22.965	2.021	14.148	28.755
capital	11269	0.106	0.071	−1.547	0.914
loan	11269	0.636	6.127	0.000	0.997
deposit	11269	0.736	0.162	0.000	0.998
growth	11269	0.139	1.689	−0.997	4.565
diversification	11269	0.303	0.844	0.00014	0.998
gdpgrowth	11269	0.033	0.039	−0.259	0.281
inflation	11269	0.048	0.13	−0.049	5.572

We also use control variables at the bank and country levels. The control variable size is the natural logarithm of total bank assets, with an average of 22.965 and standard deviation of 2021. Capital (capital) is the ratio of total equity to total assets. An average of 0.106 indicates that total equity contributes to 10.6% of total bank assets. Loan (loan) is the ratio of total credit to assets; an average value of 0.636 suggests that 63% of a company's total assets are credit. Deposit (deposit) is the ratio of total deposits to total assets. An average deposit ratio of 0.736 indicates that the deposit amount is 73% of the bank's total assets. The average growth variable (growth) is 0.139, indicating that the average annual growth in bank assets is 13.9%. Variable income diversification (diversification) averages 0.303, meaning that 30.3% of banks' income comes from non-interest income. The country-level control variables are GDP growth (gdpgrowth) and inflation (inflation), with averages of 3.3% and 4.8%, respectively.

The correlation matrix provides an initial indicator of the relationship between financial inclusion and bank stability. Table 2 shows a weak positive correlation between financial inclusion and bank stability. Tentatively, this finding indicates that financial inclusion increases bank stability. Meanwhile, we see a high correlation between the financial inclusion index and its components, dimensions of access, and usage. The overall correlation matrix suggests no significant multicollinearity issues among the explanatory variables.

3.3. Developing the financial inclusion index

The literature lacks consensus on how to measure the degree of financial inclusion. Camara and Tuesta (2017) construct financial indexes using a two-stage PCA. The first begins by calculating the sub-indices (usage, access, and barriers), then estimates the weight for each dimension, and finally calculates the composite financial inclusion index. The weights are estimated based on the available data rather than on personal judgment. The PCA approach has two advantages: it does not employ any exogenous, subjective information, and covers demand-and supply side information in constructing the index (Camara & Tuesta, 2017). Therefore, several studies adopt the PCA method to measure the degree of financial inclusion (e.g., Ahamed & Mallick, 2019; Vo et al., 2021; Wang et al., 2022). Based on these advantages, we measure the degree of financial inclusion using PCA.

We use the FAS database to calculate the financial inclusion index for 78 countries from 2004 to 2022. It is widely agreed that financial access and usage are the two essential dimensions for measuring financial inclusion, especially from the regulatory perspective. Access measures how extensively the financial sector reaches people in terms of the

Table 2
Matrix of correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) ln_zscore	1.000													
(2) fin. Inclusion	0.169	1.000												
(3) outreach	0.113	0.904	1.000											
(4) usage	0.192	0.880	0.592	1.000										
(5) iq (estimate)	0.198	0.545	0.551	0.416	1.000									
(6) iq (pct. rank)	0.195	0.551	0.550	0.428	0.975	1.000								
(7) size	0.146	0.287	0.286	0.223	0.331	0.386	1.000							
(8) capital	−0.008	−0.168	−0.151	−0.149	−0.227	−0.239	−0.452	1.000						
(9) loan	−0.007	0.003	0.003	0.002	0.001	0.002	−0.000	−0.005	1.000					
(10) deposit	0.076	0.098	0.055	0.124	0.030	0.019	−0.098	−0.258	0.002	1.000				
(11) growth	−0.063	−0.031	−0.024	−0.031	−0.048	−0.050	−0.034	0.036	−0.000	−0.024	1.000			
(12) divers	−0.026	0.003	0.008	−0.003	0.033	0.031	0.021	−0.022	−0.001	−0.024	0.007	1.000		
(13) gdpgrowth	−0.033	−0.219	−0.202	−0.189	−0.286	−0.284	−0.173	0.081	0.009	0.021	−0.017	−0.018	1.000	
(14) inflation	−0.142	−0.163	−0.141	−0.152	−0.260	−0.266	−0.109	0.096	−0.005	−0.050	0.307	−0.029	0.001	1.000

physical presence of banks. Proximity to the nearest location where services are available is an essential factor that affects financial inclusion. Following Ahamed and Mallick (2019) and Beck et al. (2007), we examine two types of banking service penetration: the demographic and geographic reach of bank branches and ATMs. To assess demographic penetration, we consider the number of bank branches and ATMs per 100,000 people. For geographic penetration, we assess the number of bank branches and ATMs per 1000 km. For the second dimension, usage, we use the outstanding deposits with commercial banks (% of GDP), and outstanding loans from commercial banks (% of GDP) (Foguesatto et al., 2024; Kumar Lenka & Kumar Bairwa, 2016; Sarma, 2016; Tram et al., 2023; Wang et al., 2022).

The steps are as follows. Before applying PCA, to eliminate any cross-variable discrepancy, the indicators of each dimension are normalized using the min-max method to ensure that their values fell within the range of zero to one, making the measurement scale irrelevant. In the first stage of PCA, we estimate the weights for the four outreach indicators to construct the financial outreach dimension. Next, we estimate the weights of the two usage indicators and construct the usage dimension. In the final stage, we estimate the weights of each dimension to develop a financial inclusion index. Following Amidžić et al. (2014), we estimate year-specific weights rather than across the entire sample period to capture temporal changes in financial access and usage, ensuring the index reflects annual shifts in financial inclusion indicators. The financial inclusion index is then determined linearly as follows:

Table 3
Baseline model results: Financial inclusion, Institutional quality, and financial stability.

	OLS		FE		RE		S-GMM	
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L.ln_zscore	–	–	–	–	–	–	0.669***	0.662***
							(0.023)	(0.011)
fin. Inclusion (FI)	0.378***	0.077	1.041*	1.703***	0.270*	0.362**	3.859**	1.947**
	(0.072)	(0.130)	(0.569)	(0.640)	(0.147)	(0.157)	(1.583)	(0.955)
Ins. Quality (INS)	0.189***	0.144***	0.389**	0.239	0.198***	0.126***	0.844	0.342**
	(0.017)	(0.023)	(0.171)	(0.196)	(0.034)	(0.045)	(1.363)	(0.164)
FI × INS	–	0.269***	–	0.854**	–	0.426**	–	2.959***
		(0.097)		(0.400)		(0.177)		(0.743)
size	0.096***	0.098***	0.361***	0.375***	0.175***	0.180***	0.170***	0.155***
	(0.007)	(0.007)	(0.038)	(0.039)	(0.012)	(0.013)	(0.045)	(0.024)
capital	2.640***	2.636***	3.465***	3.538***	3.201***	3.216***	6.999***	6.779***
	(0.212)	(0.212)	(0.572)	(0.573)	(0.259)	(0.259)	(0.745)	(0.543)
loan	−0.002	−0.001	−0.001***	−0.0008***	−0.001	−0.001	0.0001	0.00008
	(0.002)	(0.002)	(0.0001)	(0.0001)	(0.002)	(0.002)	(0.0001)	(0.00005)
deposit	0.861***	0.860***	−0.012	−0.009	0.336***	0.333***	0.221	0.148
	(0.076)	(0.076)	(0.193)	(0.192)	(0.104)	(0.104)	(0.233)	(0.186)
growth	−0.019***	−0.019***	−0.020*	−0.020*	−0.020***	−0.019***	−0.011	−0.020***
	(0.007)	(0.007)	(0.012)	(0.012)	(0.006)	(0.006)	(0.0091)	(0.007)
diversification	−0.044***	−0.045***	−0.012	−0.012	−0.019	−0.019	−0.027***	−0.028***
	(0.013)	(0.013)	(0.009)	(0.009)	(0.012)	(0.012)	(0.008)	(0.005)
gdpgrowth	0.931***	0.817***	1.525***	1.549***	1.176***	1.137***	2.643***	2.522***
	(0.307)	(0.310)	(0.319)	(0.321)	(0.288)	(0.289)	(0.349)	(0.225)
inflation	−0.795***	−0.827***	−0.741***	−0.794***	−0.724***	−0.759***	−0.059	−0.358**
	(0.095)	(0.096)	(0.195)	(0.205)	(0.088)	(0.089)	(0.235)	(0.163)
Constant	0.677***	0.676***	−4.642***	−4.911***	−0.773**	−0.820***	−4.661***	−3.023***
	(0.191)	(0.191)	(0.896)	(0.905)	(0.317)	(0.318)	(0.976)	(0.533)
Observations	11,209	11,209	11,209	11,209	11,209	11,209	10,496	10,496
R-squared	0.079	0.079	0.048	0.049	0.040	0.041		
Number of groups			680	680	680	680	680	680
No. of instruments							27	27
AR(2) p-value							0.223	0.178
Hansen p-value							0.526	0.243

Notes: Dependent variable is financial stability (z-score). Institutional Quality: Estimate. Standard errors in parentheses. Standard errors in parentheses. ***, **, * indicate the significance at the 1%, 5%, and 10% levels, respectively.

$$\textit{Financial inclusion index} = \sum_{i=1}^{n} \omega_{ij} Y_i, \tag{3}$$

where ω_{ij} is the relative weights of each dimension, Y_i is the dimension that consists of outreach (access) and usage of the financial services.

4. Empirical results and discussion

First, we employ ordinary least squares (OLS), fixed effects (FE), random effects (RE), and a two-step system generalized method of moments (SGMM) model as baseline specifications to examine the effect of financial inclusion on bank stability and the role of institutional quality in determining the relationship. In Table 3, the coefficient of financial inclusion is positive and significant, suggesting that financial inclusion positively impacts bank stability based on estimations using static models (OLS, FE, and RE) and dynamic models (SGMM). These results support the notion that a financial system that offers inclusive services contributes to more robust banking stability (Ahamed & Mallick, 2019; Han & Melecky, 2013; Morgan & Pontines, 2018). Moreover, the positive and significant interaction coefficient between financial inclusion and institutional quality (FI × INS) indicates that higher institutional quality strengthens the positive impact of financial inclusion on financial stability.

All specification tests indicate that the system GMM estimator is appropriate and consistent, as indicated by the Hasen test of over-identifying restrictions that fail to reject the null hypothesis. The result implies that the model is valid and correctly specified. The serial correlation test also failed to reject the absence of a second-order correlation (AR2). Additionally, the significant lagged dependence in all specifications confirms the choice of dynamic specification for this analysis model.

4.1. Dynamic panel threshold regression

We next estimate Equation (2) to test the effect of threshold institutional quality on the relationship between financial inclusion and bank stability. Table 4 presents the coefficients estimated using Kremer et al.'s (2013) dynamic panel threshold specification for two measures of institutional quality: the Estimate and the Percentile Rank. The top of the table shows the estimated value of the institutional quality threshold and the corresponding 95% confidence interval. The middle of the table reports the regime-dependent coefficients of financial inclusion on bank stability. More specifically, $\widehat{\beta}_1$ and $\widehat{\beta}_2$ represent the coefficient or marginal effect of financial inclusion on bank stability in low and high institutional quality regimes, respectively. The bottom of the table shows the coefficients of the control variables.

Specifications (1) and (2) in Table 4 present the estimation results using the Estimate as a measure of institutional quality, whereas specifications (3) and (4) use the Percentile Rank as a measure of institutional quality. The estimated institutional quality threshold value is 1.245, consistent across specifications (1) and (2). Meanwhile, with the percentile rank measure, specifications (3) and (4) have estimated threshold values of 85.710. Figs. 1 and 2 show that the likelihood ratio statistic value crosses the critical value line, indicating that the estimated institutional quality threshold value is significant. After confirming the existence of this threshold, we focus on the effect of financial inclusion on bank stability.

Analysis of the impact of financial inclusion on bank stability yields interesting findings. The financial inclusion coefficient in the lower regime ($\widehat{\beta}_1$) for specifications (1) and (2) is 0.550 and 1.262, respectively; however, neither value is statistically significant. In contrast, the coefficients for the upper regime of institutional quality ($\widehat{\beta}_2$) are 3.829 and 3.348, respectively, both significant at the 5% level. In specifications (3) and (4), the values for ($\widehat{\beta}_1$) are 0.428 and 1.182, which are also not statistically significant. Meanwhile, the coefficient values for the upper regime of institutional quality ($\widehat{\beta}_2$) are 3.568 and 3.233, respectively, both significant at the 5% level. These findings suggest that, when institutional quality is low, the stability benefits of financial inclusion are not evident. Only after the institutional quality index value reaches 1.245 (rank 85.710) does the positive impact of financial inclusion on

Table 4
Kremer et al. (2013) dynamic panel threshold regression on the impact of financial inclusion on stability (Threshold: Institutional quality).

Dependent: Bank Stability	Institutional Quality: Estimate		Institutional Quality: Percentile Rank	
	(1)	(2)	(3)	(4)
Threshold estimates				
$\widehat{\lambda}$	1.245	1.245	85.710	85.710
95% confidence interval	[1.243-1.246]	[1.243-1.246]	[85.710-85.842]	[85.710-85.842]
Impact of financial inclusion				
$\widehat{\beta}_1$	0.550	1.262	0.428	1.182
	(1.378)	(1.348)	(1.374)	(1.346)
$\widehat{\beta}_2$	3.829**	3.348**	3.568**	3.233**
	(1.584)	(1.449)	(1.554)	(1.434)
Impact of covariates				
L.ln_zscore	0.5411***	0.558***	0.545***	0.561***
	(0.042)	(0.041)	(0.042)	(0.040)
size	0.031	0.134**	0.033	0.136**
	(0.061)	(0.058)	(0.061)	(0.058)
capital	13.407***	11.657***	13.384***	11.577***
	(4.163)	(3.329)	(4.106)	(3.286)
loan	−0.004	−0.015	−0.007	−0.016
	(0.044)	(0.021)	(0.042)	(0.020)
deposit	0.037	0.202	0.039	0.218
	(1.009)	(0.714)	(1.044)	(0.718)
growth	−0.085	−0.117**	−0.087	−0.116**
	(0.071)	(0.050)	(0.072)	(0.051)
diversification	0.015	0.001	0.013	0.001
	(0.056)	(0.053)	(0.054)	(0.051)
gdp_growth	–	3.832***	–	3.839***
		(0.476)		(0.473)
inflation	–	−1.891***	–	−1.896***
		(0.558)		(0.557)
Constant	−0.715	−3.169**	−0.736	−3.217**
	(1.600)	(1.514)	(1.590)	(1.510)
Observations	10,496	10,496	10,496	10,496
Number of groups	680	680	680	680

Notes: Results for the dynamic panel threshold model using only one instrument lag (p = 1). ***, **, and * denote significant at 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses. Time dummies are insignificant, hence dropped from the model estimations.

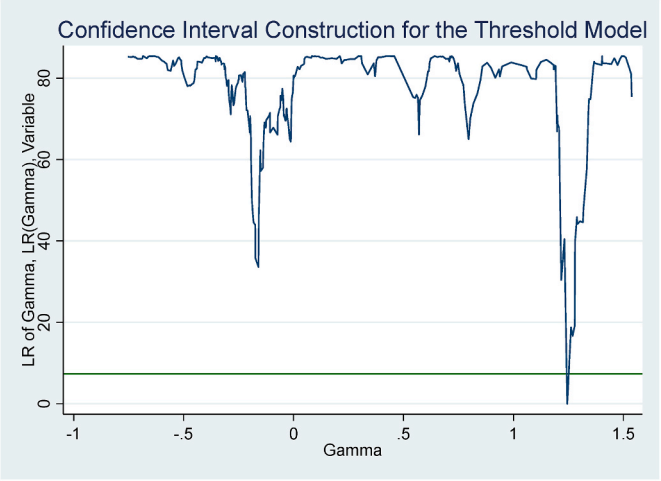

Fig. 1. Threshold estimate of Institutional Quality (Estimate).

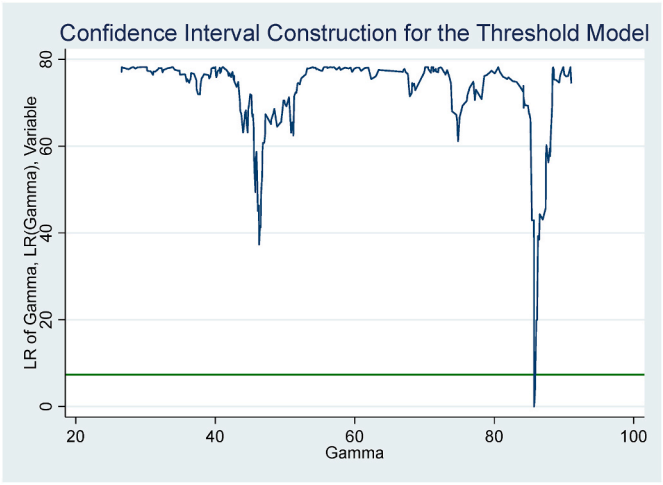

Fig. 2. Threshold estimate of Institutional Quality (Percentile rank).

bank stability become significant.

The estimation results reveal several major findings. First, financial inclusion positively affects financial stability, indicating that improving financial inclusion enhances bank stability and leads to greater bank resilience. These results are consistent with Ahamed and Mallick (2019), Wang et al. (2022), Han and Melecky (2013), Vo et al. (2021), López and Winkler (2019), and Neaime and Gaysset (2018b). Second, an institutional quality threshold exists in the relationship between financial inclusion and stability. Third, the estimation results indicate that financial inclusion does not significantly affect financial stability at institutional quality levels below the threshold. However, once the institutional quality surpasses the threshold level, the effect of financial inclusion on financial stability becomes positive and significant. These results suggest that the stability impact of financial inclusion does not exist at a low institutional quality level, and that financial inclusion promotes financial stability only after institutional quality passes the threshold level.

This important finding emphasizes that good institutions benefit the economy by exploiting the financial stability effects of increased financial inclusion. High-quality financial institutions are crucial for promoting economic and financial stability. In contrast, poor institutional quality hinders financial institutions from playing their role as intermediaries in efficiently allocating resources to productive economic activities.

4.2. Robustness check

4.2.1. The Kremer et al. (2013) dynamic panel threshold regression with individual dimension

We also examine the components of the financial inclusion index that contribute to its influence on financial stability, namely, the outreach and usage dimensions. Table 5 presents the results of the dynamic panel threshold regression analysis of the impact of the financial access dimensions on bank stability. In specifications (1) and (2), the estimated institutional quality threshold value is 1.245, which is significant at the 95% confidence level. Specifications (3) and (4) report threshold estimate of 85.710. These values correspond to the threshold estimates derived from the financial inclusion index presented in Table 4.

Analyzing the impact of the outreach dimension on bank stability also reveals interesting findings. In specifications (1) and (2) of Table 5, we observe that in low institutional quality regimes ($\widehat{\beta}_1$), the access dimension shows positive coefficients of 0.881 and 1.108. However, these coefficients are not statistically significant. In contrast, the upper regime ($\widehat{\beta}_2$) presents coefficient values of 4.519 and 3.291, both of which are significant at the 1% level. In specifications (3) and (4), which measure institutional quality using percentile ranks, the outreach dimension's influence in the lower regime ($\widehat{\beta}_1$) again shows non-significant coefficients of 0.811 and 1.039. However, in the upper regime ($\widehat{\beta}_2$), the outreach dimension has a positive and statistically significant impact on stability, with coefficient values of 4.209 and 3.157. These results suggest that increasing access to financial services positively impacts bank stability only after exceeding the institutional quality threshold. The outreach dimension does not affect bank stability in regimes with lower institutional quality. This aligns with the estimation results obtained using the financial inclusion index.

Table 5
Kremer et al. (2013) dynamic panel threshold regression on the impact of outreach dimension on stability (Threshold: Institutional quality).

Dependent: Bank Stability	Institutional Quality: Estimate		Institutional Quality: Percentile Rank	
	(1)	(2)	(3)	(4)
Threshold estimates				
$\widehat{\lambda}$	1.245	1.245	85.710	85.710
95% confidence interval	[1.143-1.246]	[1.143-1.246]	[85.710-85.842]	[85.710-85.842]
Impact of outreach dimension				
$\widehat{\beta}_1$	0.881	1.108	0.811	1.039
	(0.937)	(0.868)	(0.932)	(0.870)
$\widehat{\beta}_2$	4.519***	3.291***	4.209***	3.157***
	(1.140)	(0.968)	(1.089)	(0.939)
Impact of covariates				
L.ln_zscore	0.553***	0.577***	0.557***	0.579***
	(0.045)	(0.042)	(0.045)	(0.041)
size	0.136*	0.223***	0.131*	0.222***
	(0.070)	(0.065)	(0.068)	(0.064)
capital	15.833***	13.060***	15.751***	12.971***
	(4.849)	(3.706)	(4.785)	(3.656)
loan	−0.008	−0.014	−0.009	−0.014
	(0.028)	(0.015)	(0.027)	(0.015)
deposit	−0.220	0.194	−0.229	0.211
	(1.060)	(0.809)	(1.063)	(0.801)
growth	−0.101	−0.129**	−0.102	−0.127**
	(0.080)	(0.057)	(0.081)	(0.057)
diversification	0.016	0.002	0.015	0.0014
	(0.060)	(0.056)	(0.058)	(0.054)
gdp_growth	–	3.921***	–	3.934***
		(0.466)		(0.464)
inflation	–	−1.862***	–	−1.871***
		(0.544)		(0.544)
Constant	−3.192*	−5.298***	−3.049	−5.255***
	(1.932)	(1.795)	(1.900)	(1.786)
Observations	10,496	10,496	10,496	10,496
Number of groups	680	680	680	680

Notes: Results for the dynamic panel threshold model using only one instrument lag (p = 1). ***, **, and * denote significant at 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses. Time dummies are insignificant, hence dropped from the model estimations.

Furthermore, we estimate the threshold effect of institutional quality using the usage dimension as the independent variable. Table 6 provides the estimation results for the models using the Estimates (specifications 1 and 2) and Percentile Ranks (specifications 3 and 4) of institutional quality. The institutional quality threshold value remains consistent with the previous estimates in Tables 4 and 5, namely 1.245 and 85.710. These values are significant at the 95% confidence level. From the estimated coefficient of the usage dimension for specifications (1) and (2), we observe that, in a low institutional quality regime ($\widehat{\beta}_1$), the usage dimension of institutional quality negatively affects bank stability. The coefficients are −11.701 and −7.883, respectively, which are significant at the 1% level. In a high institutional quality regime ($\widehat{\beta}_2$), the usage dimension also has a negative effect on bank stability, but with a smaller magnitude and a lower level of significance, −6.809 and −4.432, significant at the 5% and 10% levels, respectively. In specifications 4 and 5,

Table 6
Kremer et al. (2013) dynamic panel threshold regression on the impact of usage dimension on stability (Threshold: Institutional Quality).

Dependent: Bank Stability	Institutional Quality: Estimate		Institutional Quality: Percentile Rank	
	(1)	(2)	(3)	(4)
Threshold estimates				
$\widehat{\lambda}$	1.245	1.245	85.710	85.710
95% confidence interval	[1.143-1.246]	[1.143-1.246]	[85.710-85.842]	[85.710-85.842]
Impact of usage dimension				
$\widehat{\beta}_1$	−11.701***	−7.883***	−11.384***	−7.642***
	(2.610)	(2.304)	(2.580)	(2.268)
$\widehat{\beta}_2$	−6.809**	−4.432*	−6.724**	−4.307*
	(2.747)	(2.335)	(2.742)	(2.336)
Impact of covariates				
L.ln_zscore	0.558***	0.559***	0.562***	0.563***
	(0.042)	(0.041)	(0.041)	(0.040)
size	0.486***	0.426***	0.481***	0.423***
	(0.125)	(0.106)	(0.126)	(0.107)
capital	14.302***	12.542***	14.192***	12.363***
	(3.938)	(3.193)	(3.922)	(3.162)
loan	−0.009	−0.0101	−0.010	−0.011
	(0.023)	(0.018)	(0.023)	(0.017)
deposit	0.273	0.616	0.249	0.601
	(1.159)	(0.779)	(1.198)	(0.781)
growth	−0.101	−0.134**	−0.101	−0.132**
	(0.068)	(0.062)	(0.069)	(0.062)
diversification	−0.011	−0.017	−0.010	−0.016
	(0.057)	(0.057)	(0.056)	(0.055)
gdp_growth	–	3.284***	–	3.330***
		(0.480)		(0.474)
inflation	–	−2.467***	–	−2.448***
		(0.558)		(0.555)
Constant	−9.461***	−8.711***	−9.371***	−8.647***
	(2.681)	(2.378)	(2.707)	(2.384)
Observations	10,496	10,496	10,496	10,496
Number of groups	680	680	680	680

Notes: Results for the dynamic panel threshold model using only one instrument lag (p = 1). ***, **, and * denote significant at 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses. Time dummies are insignificant, hence dropped from the model estimations.

the coefficient ($\widehat{\beta}_1$) of usage dimension in the lower regime of institutional quality rank is −11.384 and −7.642, both significant at a 1 percent level. The upper regime's coefficient values ($\widehat{\beta}_2$) are −6.724 and −4.307, respectively significant at the 5% and 10% levels.

These results differ from those of the models using the financial inclusion index and financial outreach dimensions in Tables 4 and 5, respectively. Previous studies (e.g., Cihak et al., 2016; Cihák et al., 2021; Feghali et al., 2021; Kraft & Jankov, 2005a; Sahay et al., 2015) also identify a negative effect of the usage dimension on bank stability. This finding suggests that, if financial inclusion leads to aggressive lending practices without adequate risk assessment, then it can contribute to financial instability by increasing the likelihood of loan defaults and non-performing assets. Additionally, in weak institutional settings with inadequate regulation and supervision of the banking system, rapid increases in financial inclusion, particularly credit, can impair financial stability because of a lack of creditworthiness and responsible credit management. Moreover, poor quality financial institutions can undermine depositor confidence, leading to liquidity issues and potential bank runs. Therefore, the usage dimension of financial inclusion can negatively affect bank stability, especially in the context of poor institutional quality. Emphasizing the critical role of institutional quality, this study finds that robust institutional quality dampens the negative impact in situations in which the usage dimension adversely affects bank stability. Thus, robust institutions play a crucial role in both favorable and unfavorable conditions.

4.2.2. *Estimation using the country-level dataset and Seo and Shin's (2016) dynamic panel threshold model*

As an additional robustness test and to ensure that the conclusions do not rely solely on a single analysis technique or measurement, we also estimate using country-level datasets and the latest dynamic panel threshold regression estimation technique suggested by Seo and Shin (2016). We did not apply this approach in the previous analysis because it requires a balanced panel data format. Furthermore, we conduct an analysis using six individual indicators of the institutional quality index as threshold variables.

We estimate the models in this step using panel data from 78 countries over 18 years, from 2004 to 2021. The banking sector's Z-score is the dependent variable used to represent FS. FI is the independent variable. Additionally, the institutional quality indicator (INS) was established using data from the WGIs, which were developed using data collected from various cross-country surveys and expert polls. The control variables, including the loan-to-deposit ratio (LDR), net interest margin (NIM), and income diversification (DIV), were obtained from the World Bank's Global Financial Development database, whereas population growth (POP) and GDP growth rate (GDP) were obtained from the World Development Indicators.

Table 7
Results of the Seo and Shin (2016) dynamic panel threshold regression based on Country level data (Threshold: Institutional quality).

	Institutional Quality: Estimate	Institutional Quality: Percentile Rank
Variables	(1)	(2)
Lower regime		
Lag_FS	0.479***	0.079*
	(0.056)	(0.043)
Financial inclusion	−0.419**	−0.445***
	(0.184)	(0.166)
Loan to deposit	0.0005***	0.001***
	(0.0001)	(0.0002)
Net interest margin	0.027***	0.026***
	(0.002)	(0.003)
Diversification	0.007***	−0.001**
	(0.0004)	(0.0005)
Population growth	−0.017***	−0.007*
	(0.005)	(0.004)
gdpgrowth	0.0003	0.004***
	(0.0008)	(0.0006)
Difference between regime		
cons	1.018***	−0.945***
	(0.287)	(0.124)
Lag. FS	−0.322***	−0.190***
	(0.058)	(0.034)
Financial inclusion	1.134***	2.126***
	(0.234)	(0.213)
Loan to deposit	0.002**	−0.004***
	(0.001)	(0.0006)
Net interest margin	−0.076	−0.112***
	(0.052)	(0.028)
Diversification	0.020***	0.0263***
	(0.001)	(0.001)
Population growth	0.171***	0.060***
	(0.045)	(0.018)
gdpgrowth	0.013***	−0.002
	(0.002)	(0.002)
r (Threshold value)	1.204***	76.81***
	(0.074)	(1.845)
No. of groups	78	78
No. observation	1404	1404
Number of moment condition	416	400
Bootstrap p-value for linearity test	0.000***	0.000***

Notes: Standard errors in parenthesis. ***, **, * indicate significance at the 1, 5 and 10% levels, respectively. The linearity test p-value is obtained via a bootstrap procedure with 1000 replications. "r" is the threshold level of institutional quality (INS).

Table 7 presents the results based on the dynamic panel data threshold estimator developed by Seo and Shin (2016) and Seo et al. (2019). The institutional quality variable (INS) is the transition/threshold variable between different scenarios in the model. The "lower regime" section in Table 7 shows the model's results for the lower institutional quality regime. It presents the impact of explanatory variables, such as financial inclusion and control variables, on financial stability when institutional quality (INS) is low. Meanwhile, the values presented in the "difference between regime" section reflect the coefficient gap between the upper and lower institutional quality regime. It shows the disparity between the coefficient in the upper scenario and the value of the coefficient in the lower scenario.

If the coefficient of difference between regimes (δ) is statistically significant, then the coefficients on the upper and lower threshold variables are different. A negative value indicates that the coefficient in the upper regime of institutional quality is lower than that in the lower regime. Conversely, if the coefficient (δ) is positive, then the coefficient in the upper regime is greater than that in the lower regime. Finally, if the coefficient value (δ) is insignificant, meaning that the influence of the independent variable does not depend on the threshold regime, then the estimated coefficient in the lower regime does not change, or the independent and dependent variables have a linear relationship.

Focusing on the r-value in Table 7, using institutional quality as the transition variable, the threshold estimate is 1.204 and percentile rank is 76.81, such that approximately 79.10% of the observations fall into the lower institutional quality regime. These results suggest that most countries in the sample are below the threshold value. Additionally, the lagged financial stability coefficients (lagFS) value is notably greater for nations with weak institutional quality, indicating that the accelerator effect of financial stability is more pronounced in countries with weaker institutional quality.

The coefficient of (FI) is the main focus of this study. Interestingly, these findings differ slightly from those presented in Table 4. The coefficient value is positive (1.134 and 2.126) in the "difference between regimes" section and statistically significant at the 1% level. These results suggest that financial inclusion has a positive impact on financial stability in higher-quality institutional regimes. By contrast, the impact of financial inclusion on financial stability is negative in the lower regimes, as indicated by the negative coefficient values (−0.149 and −0.445).

These results indicate that institutions can replicate the nonlinear relationship between financial inclusion and stability. Based on aggregate data, increasing financial inclusion in economies with poor institutional quality negatively affects bank stability. However, once institutional quality surpasses a certain threshold, the financial inclusion effect becomes positive. These findings align with those of Cihak et al. (2021), who find that, on average, financial inclusion has a negative relationship with stability. However, this relationship varies systematically across firm and country contexts. La Porta et al. (1998) argue that nations with weak legal and governance systems have less resilient banking systems because of inadequate regulation, inconsistent law enforcement, and corruption. Additionally, Demirguc-Kunt and

Table 8
Robustness check using each of the six dimensions of governance indictors as the threshold variable (institutional quality: estimate).

Threshold Variables:	CC	GE	PS	RQ	RL	VA
	(1)	(2)	(3)	(4)	(5)	(6)
Lower regime						
Lag_FS	0.055	0.263***	0.373***	0.182***	0.372***	0.358***
	(0.040)	(0.045)	(0.051)	(0.023)	(0.039)	(0.039)
Financial inclusion	0.960***	0.448	−0.386**	0.186	0.474*	0.256***
	(0.261)	(0.324)	(0.175)	(0.158)	(0.246)	(0.091)
Loan to deposit	0.0002**	−0.0009***	0.0006***	−0.0005***	0.0008***	0.0007***
	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.00009)	(0.0002)
Net interest margin	0.040***	0.028***	0.002	0.009***	0.001	−0.014***
	(0.002)	(0.002)	(0.005)	(0.003)	(0.005)	(0.005)
Diversification	0.00003	−0.003***	−0.0003	0.002***	−0.002***	0.0001
	(0.0006)	(0.0005)	(0.0007)	(0.0005)	(0.0007)	(0.001)
Population growth	0.018***	0.034***	0.019**	0.012***	−0.040***	0.009
	(0.004)	(0.009)	(0.008)	(0.005)	(0.004)	(0.007)
gdpgrowth	0.0003	0.004***	−0.008***	−0.001	0.003***	−0.002
	(0.0008)	(0.001)	(0.001)	(0.0009)	(0.0008)	(0.001)
Difference between regime						
cons	−0.597***	−1.367***	−1.013***	−2.578***	−1.142***	−2.303***
	(0.138)	(0.189)	(0.162)	(0.152)	(0.158)	(0.223)
Lag. FS	−0.152***	−0.479***	−0.105**	0.271***	−0.102**	−0.053
	(0.044)	(0.040)	(0.049)	(0.032)	(0.048)	(0.045)
Financial inclusion	2.556***	2.534***	0.819***	1.762***	−0.370	0.285
	(0.606)	(0.516)	(0.172)	(0.288)	(0.405)	(0.217)
Loan to deposit	0.003***	0.005***	0.0004***	−0.0008	−0.00009	−0.001
	(0.0009)	(0.0015)	(0.00007)	(0.0007)	(0.0003)	(0.0008)
Net interest margin	−0.189***	0.0337	0.154***	0.118***	0.310***	0.223***
	(0.029)	(0.029)	(0.018)	(0.0131)	(0.023)	(0.021)
Diversification	0.0239***	0.030***	0.014***	0.0310***	0.021***	0.018***
	(0.001)	(0.002)	(0.0007)	(0.001)	(0.0009)	(0.002)
Population growth	−0.017**	0.111***	−0.073***	0.135***	0.034***	−0.138***
	(0.009)	(0.031)	(0.012)	(0.038)	(0.012)	(0.030)
gdpgrowth	0.025***	0.004	0.012***	0.021***	−0.003	0.003*
	(0.003)	(0.003)	(0.001)	(0.004)	(0.002)	(0.002)
r (Threshold value)	1.435***	1.274***	0.197**	1.205***	0.852***	0.528***
	(0.112)	(0.065)	(0.097)	(0.045)	(0.106)	(0.093)
No. of countries	78	78	78	78	78	78
Linearity (p-value)	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
No of moment conditions	400	400	400	400	400	400

Notes: Standard errors in parenthesis. ***, **, * indicate significance at the 1, 5 and 10% levels, respectively. The linearity test p-value is obtained via a bootstrap procedure with 1000 replications. CC: control of corruption; GE: government effectiveness; PS: political stability and absence of violence, RQ: regulatory quality, RL: rule of law; VA: voice and accountability (VA). "r" is the threshold level of institutional quality (INS).

Detragiache (1998) emphasize that fragility in the financial sector is associated with ineffective institutions, particularly those pertaining to corruption, the legal system, and contract enforcement. Moreover, countries with strong institutional quality can supervise and monitor financial institutions (Anginer et al., 2014; Hoque et al., 2015).

The information presented in Table 7 indicates that a linearity test was conducted to assess the relevance of the estimated institutional quality threshold model. The test involved a bootstrap procedure with 1000 replications, and the p-values obtained suggested the presence of a threshold effect. Additionally, the p-value from the J-test indicated that the instruments used were appropriate and valid.

For additional robustness tests, Table 8 displays the outcomes of repeated examinations that utilized each of the six individual governance indicators as threshold variables. These findings closely resemble those derived from the institutional quality index (Table 7). The findings regarding the nonlinear relationship between financial inclusion and financial stability hold when CC, GE, political stability and the absence of violence (PS), and RQ are the threshold variables. The estimated CC threshold is 1.435; approximately 79.7% of the observations fall under the lower control of the corruption regime. For GE as a threshold variable, the estimated threshold value is 1.274, where approximately 77.21% of observations fall within the lower regime of government effectiveness. The threshold value for political stability is 0.197, with 47.44% of observations falling below this value. The threshold value for regulatory quality is 1.205, and 75.43% of observations are below this threshold. The proportion of observations within the upper and lower regimes is close to the proportion in the model with the institutional quality index as the transition variable. These findings highlight the influence of these governance indicators in shaping financial stability and underscore the relevance of our research for economists and policymakers.

Focusing on the coefficients of the independent variables of stability in the lower and higher regimes of each indicator, we find that the past financial stability (lag.FS) in countries with lower governance indicators has a significantly greater positive impact on current financial stability. This finding implies that countries with lower governance standards experience greater fluctuations in stability. The main variable of interest, financial inclusion, has a stronger effect on improving financial stability in countries with strong corruption controls, effective governance, stable political conditions, and good regulatory quality. Collectively, these factors foster a stable financial environment by enhancing transparency, accountability, and policy implementation, thereby reducing risk and maintaining investor confidence. These findings support the institutional quality index model presented in Table 7.

However, using the transition variables are indicators of the RL and VA, the coefficient of FI in the difference between the regimes is not statistically significant. This result suggests that the impact of the FI does not rely on these transition regimes, implying that the impact of financial inclusion on financial stability remains positive. However, we find no significant differences in the magnitude of the coefficients between the lower and higher regimes of these indicators.

Table 8 shows that the impact of financial inclusion measures on financial stability varies based on institutional disparities as transitional elements. Financial stability is more closely linked to the control of corruption, government effectiveness, political stability, and regulatory standards than to rules of law and accountability. Enhanced institutional quality is essential to ensure that financial institutions facilitate effective borrowing, thereby avoiding the allocation of credit to unproductive investment ventures.

5. Conclusion

This study examines the influence of financial inclusion on financial stability and the threshold effect of institutional quality on this relationship. The rapid expansion of financial inclusion may cause structural changes in the financial system, potentially increasing its vulnerability. Cihak et al.'s (2016) trade-off and synergy theory of financial inclusion emphasizes the potential benefits (synergy) and risks (trade-offs) that may arise from expanding financial inclusion. The empirical literature also suggests that the effect of financial inclusion on financial stability can be either negative or positive depending on certain contingent factors. This study makes a novel contributes to the literature on financial inclusion by exploring the possible nonlinear effects of financial inclusion on financial stability. We analyze employing bank-level data from developed and developing countries for the period 2004–2022 using a dynamic panel threshold regression to test the threshold effect of institutional quality on the financial inclusion–bank stability nexus.

The estimation results revealed several major findings. First, financial inclusion has a positive effect on financial stability. Strong evidence suggests that improving financial inclusion enhances bank stability and leads to greater resilience. Second, an institutional quality threshold exists in the relationship between financial inclusion and stability. Third, the estimation results indicate that financial inclusion does not significantly affect financial stability at institutional quality levels below the threshold. However, once the institutional quality surpasses the threshold level, the effect of financial inclusion on financial stability becomes positive and significant. These results suggest that the stability impact of financial inclusion does not exist at a low institutional quality level, and that financial inclusion promotes financial stability only after institutional quality passes the threshold level. The robustness tests indicate that the positive impact of financial inclusion on stability is stronger for banks operating in countries with good institutional quality.

Given that the impact of financial inclusion on stability becomes more pronounced after institutions surpass a certain level, decision makers should enhance institutional development. These include improving government efficiency and transparency, eradicating corruption, maintaining political stability, and ensuring regulatory quality to harness the advantages of inclusion in fostering stability. Despite these significant findings, this study revealed another interesting outcome. We find that certain aspects of financial inclusion respond more strongly to improvements in institutional development. Different financial inclusion indicators show varying degrees of responsiveness to the quality of an institution, and various institution types may have different impacts on financial inclusion. We believe that this area is worthy of further exploration.

CRediT authorship contribution statement

Rahmat Heru Setianto: Conceptualization, Methodology, Investigation, Data curation, Validation, Formal analysis, Writing – original draft. **W.N.W. Azman-Saini:** Conceptualization, Formal analysis, Methodology, Supervision, Writing – review & editing. **Siong Hook Law:** Conceptualization, Formal analysis, Methodology, Supervision, Writing – review & editing.

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Declarations of interest

The authors declare that they have no competing interests.

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APENDIX.

Table A1
List of variables

Variable	Description	Source
Dependent variables		
Bank Z-score (bank level)	Measures the defaults probability of a bank. Calculated by buffer of bank (ROA + Equity/Assets) divided by standard deviation of ROA	Author's calculation
Bank Z-score, log	Natural logarithm of the Bank Z-score	Author's calculation
Bank Z-score (country level)	Measures the defaults probability of a country's banking system. Calculated by buffer of bank (ROA + Equity/Assets) divided by standard deviation of ROA	Global Financial Development
Main Explanatory variables		
Financial Inclusion	Financial inclusion index is constructed using principal component analysis consist of outreach and usage dimensions	Author's calculation using data from IMF-FAS
Threshold variable		
Institutional Quality	Institutional quality index is constructed using principal component analysis consist of six indicators	Author's calculation using data from World Governance Indicators
Other explanatory variables (bank level)		
Bank size	Natural logarithm of total assets	DataStream
Capitalization	The ratio of total equity to total assets	DataStream
Loan ratio	The ratio of net loan to total assets	DataStream
Deposit ratio	The ratio of total deposits to total asset	DataStream
Growth	Total assets growth	DataStream
Revenue diversification	Non-interest income divided by total operating income	DataStream
Macroeconomic factors		
Economic growth	The growth rate of GDP	World Development Indicators
Inflation	The rate of inflation	World Development Indicators
Aggregate data sets		
Loan to Deposit Ratio	The financial resources provided to the private sector by banks as a share of total deposits	Global Financial Development database
Net Interest Margin	Banks' net interest revenue as a share of its average interest-bearing (total earning) assets	Global Financial Development database
Diversification	Bank's income that has been generated by noninterest related activities as a percentage of total income	Global Financial Development database
Population growth	Annual population growth rate	World Development Indicators

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