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Article

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Threshold Analysis, Financial Inclusion and Financial Stability in Developing Economies: Assessing the Moderating Role of Digital Financial Inclusion

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Abstract

This study examines the relationship between financial inclusion and financial stability in developing economies, with a focus on the moderating role of digital financial inclusion (DFII) and the identification of threshold effects. Using a dynamic panel analysis with a two-step System GMM estimator, the analysis covers 72 developing countries from 2012 to 2022. A composite financial stability index (FSI) is developed using Principal Component Analysis (PCA) to capture financial soundness and market depth. The inclusion dimensions model results indicate that penetration and usability of financial services have a negative impact on financial stability (FSI). Conversely, accessibility has a positive influence on FSI. However, both indices traditional financial inclusion (TFII) and DFII in model 2 analysis reveal a negative relationship between both indices and financial stability. The results of the third moderation model show that DFII strongly moderates these TFII effects by enhancing access efficiency and transparency. A threshold effect is identified in model 5 analysis of this study, suggesting that the benefits of inclusion diminish and potentially reverse beyond a certain level. The findings suggest the need for balanced financial inclusion policies that integrate both traditional and digital financial services.

Keywords: Financial stability index, traditional financial inclusion, digital financial inclusion, governance quality, financial openness.

1. Introduction

Financial stability is crucial for economic growth, especially in developing economies that are susceptible to market fluctuations, weak institutions, and dependence on external capital. These economies frequently face challenges such as underdeveloped financial markets, political instability, and vulnerability to economic shocks. The significance of maintaining financial stability has been demonstrated by past crises, like the Asian Financial Crisis (1997–98) and the Global Financial Crisis (2007–08), which highlighted

major weaknesses in both international and domestic financial systems (Vo et al., 2019; Elgharib, 2024). These crises revealed the fragile condition of financial institutions in emerging economies, emphasizing the need for more robust, resilient financial systems capable of withstanding shocks and preventing systemic risk from spreading (Isukul & Tantua 2021; Wang & Luo 2022).

Financial instability in developing economies often results from factors such as insufficient regulatory frameworks, inadequate financial infrastructure, and the rapid growth of informal financial services (Ali & Sajid 2020; Ali & Mohsin 2023; Joudar & El Ghmari 2025). Therefore, a stable financial environment is crucial not only for preventing economic crises but also for promoting long-term growth and sustainable development. As a result, there is increasing recognition of the importance of financial inclusion, which provides access to affordable financial services for all sections of society, as a key strategy for fostering economic growth and alleviating poverty (Park & Mecado 2018; Ratnawati, 2020; Park & Mecado 2021; Demirgüç-Kunt et al., 2022). However, the relationship between financial inclusion and financial stability is complex, with both potential advantages and risks that require careful consideration in the context of financial intermediation (Xu et al., 2024; Thi, 2022; Shaai, 2022; Konstantakopoulou, 2023).

Financial inclusion involves providing access to a broad range of financial services, including savings, credit, insurance, and payments, to all individuals and businesses, particularly those who are underserved or excluded from formal financial systems (Sarma & País, 2011; Sharma & Kukreja 2013; Kim, 2016; Joudar & El Ghmari 2025). Recently, it has gained significant attention as a means to promote economic growth, reduce poverty, and enhance financial resilience. Governments and international organizations have sought to implement policies that improve access to financial services, especially in developing countries where large segments of the population remain unbanked or underbanked (Park & Mecado 2021; Ratnawati, 2020; Wang & Luo 2022).

The adoption of digital financial inclusion (DFI), encompassing mobile banking, mobile money, and online payment systems, has further facilitated access to financial services (Beck, 2020; Yue et al., 2022; Sadiq & Ali 2024). DFI expands the reach and reduces the cost of financial services, particularly for those who are remote or underserved, creating opportunities for users and small businesses to access products outside of bank branches (Pal & Bandyopadhyay, 2022). The rapid transformation towards digital financial services has yielded impressive results in financial inclusion, but also raised new challenges (Milana & Ashta, 2020; Song et al., 2025). For instance, although digital inclusion enhances convenience and efficiency, it may result in risks of cyber insecurity, over-indebtedness, and consumer grievances, especially when there is no comprehensive regulatory framework (Grohmann & Menkhoff, 2021; Aziz & Naima, 2021). In the case of the 2010 Andhra Pradesh microfinance crisis, if the volume becomes excessive and the credit becomes unreasonably unchecked, it may result in financial instability that can degenerate

(Ahmed & Isa 2023; Damane & Ho, 2024). Thus, although DFI holds the potential to add value to the stability of the financial system, if it is not regulated correctly or remains unregulated, its expansion will lead to the same outcome (Mpofu, 2022; Fischer & Storm, 2023; Maigari & Yelwa, 2023).

While several studies have examined the correlation between financial inclusion and financial stability, literature has primarily focused on linear relationships. It has not adequately investigated the moderating effects of digital financial inclusion (DFI). Additionally, few studies have examined threshold effects, where the impact of financial inclusion on stability may change as inclusion reaches certain levels. It remains unclear whether the expansion of financial inclusion continually enhances stability or whether there is a point beyond which further inclusion could destabilize financial systems, especially when there is a lack of appropriate oversight.

This study explores the complex relationship between financial inclusion and financial stability in developing economies. By incorporating both traditional and digital dimensions of inclusion and applying a System GMM estimator to panel data across 72 countries, we aim to assess whether digital financial inclusion moderates the impact of traditional inclusion and whether this relationship changes at different levels of inclusion. In doing so, the paper fills a key gap in the literature and offers new insights for inclusive finance policy.

2. Literature Review

This section presents an empirical review of past studies on financial inclusion and financial stability worldwide, with a particular focus on studies from developing countries. A study conducted by Joudar & El Ghmari (2025) analyzed the effects of financial inclusion (FI) on financial stability (FS) in 26 countries across the MENA and African regions. This study found that FI tends to increase stability, most notably through digital payments (DP) and access to bank branches. On the other hand, factors such as savings, ATMs, and the money supply (M2) weaken the stability of the financial system. The study's findings highlighted the importance of sound economic regulation in facilitating customer integration for financial inclusion, while preserving financial stability, and also in enhancing cybersecurity to manage, mitigate, and reduce the risks to which clients are exposed. Damane & Ho (2024) examined the relationship between financial inclusion (FI) and stability in 37 sub-Saharan African countries. This study found that FI leads to stability, particularly in low-income regions. They suggested a positive wave for the implementation of inclusive policy measures, which not only enhance skill sets but also do not disrupt the financial system, thus revealing the ways to achieve practical inclusiveness and financial stability.

Furthermore, Nguyen-Thi-Huong (2024) examined the challenges of digital transformation in Vietnam's banking sector, with a focus on commercial banks transitioning to digital banking. The study found that technological barriers were the most significant, such as integration of technology, cybersecurity, a lack of resources, and insufficient government support. The study emphasizes addressing technological barriers, improving government

policies, and investing in both human and technological resources to support the success of digital banking in emerging markets, such as Vietnam. Hua et al., (2023) examined the relationship between financial inclusion and regulation, utilizing data from 115 countries between 2004 and 2019. The outcome of this study found a nonlinear relationship in which FI initially has a positive effect on stability, but unnecessary access has negative consequences. This study suggested that efficient macro-regulation is necessary to strike a balance between the positive aspects of inclusion and its potential risks, particularly in the aftermath of the 2008 financial crisis.

The study by Chinoda & Kapingura (2023) focused on DFI and its impact on banking system stability in Sub-Saharan Africa from 2014 to 2020. They discovered that DFI has achieved stability, as evidenced by high z-scores, and NPLs are low. Nevertheless, they also warned that added competition between banks could be destabilizing. This showed that responsible banking and financial education lead to sustainable financial stability. Athari, (2022) demonstrated the significance of political stability in the effective delivery of financial inclusion, using panel data from 105 countries over the period 2009-2017. They found that FI is positively correlated to the stability of the banking systems, particularly in South and East Asia. They recommended that political transparency and stability are essential for this development.

Atellu & Muriu (2022) examined the broader impact of financial inclusion on stability, utilizing data from 40 banks spanning the period from 2004 to 2017. Their results provided evidence in support of the idea that inclusive finance leads to greater access to financial resources and increased stability. However, they emphasized that financial stability is closely linked to stability in the macroeconomy, and financial inclusion measures should be complemented by sound macroeconomic governance for a successful outcome. However, Yıldız & Awadh (2022) investigated the nexus between financial inclusion and financial stability from 2004 to 2020, employing the ARDL bounds testing technique. They also found a short- and long-term negative relationship between the concentration of ATMs and financial stability, implying that financial inclusion should be controlled and managed with caution if adverse stability effects are to be avoided, especially in the long-run perspective.

The impact of governance quality as a mediator of the nexus between financial inclusion and stability was discussed by Malik et al., (2022). According to their study, the quality of governance must be high to have a positive relationship with financial stability. This study found that FI plays a mediating role between governance and financial stability, providing further evidence that good governance is the main factor in implementing inclusive policies. Additionally, consolidating the role of financial inclusion as a catalyst for comprehensive changes in the financial sector, Sethy & Goyari (2022) ascertain the persistence of the positive effect of financial inclusion in promoting the stability of the financial sector in South Asia. They described the liberalization of capital account controls

and the hard reform of the financial sector to achieve sustainable, long-term economic growth. They emphasized the need for reforms, noting that financial inclusion alone would not be sufficient.

While Nguyen & Du (2022) found that increasing financial inclusion led to a reduction in non-performing loans and higher Z-scores across ASEAN nations, demonstrating a connection between inclusion and stability. Their study highlights the importance of coordinated policy efforts to maximize these benefits. When access to banking services expands to a broader population through strategic coordination, both the industry and financial soundness may prosper, as shown by their findings. However, some questions remain about how to structure inclusion initiatives to most effectively foster stability over the long term. Ekinci, (2021) conducted a study on the effects of financial inclusion on the stability of the OECD countries. The most important result was that inclusion leads to stability, in which an increase in the deposit base corresponds to a decrease in bank runs. On the other hand, over-inclusion that is not adequately regulated may lead to erratic situations, thus highlighting the role of balanced regulatory frameworks as a stabilizing factor.

Moreover, Feghali et al., (2021) examined the relationship between financial supply through monetary or savings services and the stability of systems. Nevertheless, with proper risk precautions, the transmission increases the prospect of instability. Their recommendations included the view that it is necessary to monitor carefully so that an excessive supply of easy credit does not cause trouble. Machdar, (2020) researched the relationship between financial inclusion and sustainable growth and stability in Indonesia. The author indicates that financial inclusion in developing countries might not result in rapid economic growth; however, it stabilizes the economy by raising the level of good governance. This is what has just been mentioned, thus confirming that a suitable institutional environment and regulations are required for the effective implementation of financial inclusion policies.

Alvi et al., (2020) found that providing banking services to those without access to banks can provide institutions with a source of stability outside the financial world and thereby limit their systemic risk. Their findings are consistent with the premise that embedding finance systems into economies leads to more sustainable development. Pham & Doan (2020) discovered a weak but positive connection between financial inclusion and stability in 42 countries in the Asia-Pacific Economic Cooperation (APEC) area. The results show that while building such infrastructure can lead to greater stability in national life, these effects are not uniform because there is no shared financial infrastructure or policy system (developed over Australia's years as a British colony) across all economies with different emphases.

Danisman & Tarazi (2020) investigated the influence of financial inclusion on credit risk in European banking. They further revealed that financial inclusion, through higher account ownership and the use of digital payments, dampens banking fragility, especially among

individuals who are less likely to borrow. This thus highlights the need for the strengthening of more than just stability. Frączek, (2019) explored the linkage between financial inclusion and monetary policy. Their findings show that financial inclusion raises both growth and stability. The undertaking of additional credit risk-taking, however, could result in the financial institution being exposed to risk. Their study outlined ways to balance policies that promote financial inclusion and stability in a planned manner.

El Said et al., (2019) investigated the effects of macroprudential policies on financial inclusion and stability in 67 countries. They showed that these policies are successful in the presence of financial institutions and when the financial sector reaches a certain level of development. The paper comments on the criticality of regulatory prescriptions being tailored to country-specific conditions to achieve the objectives of financial inclusion without compromising financial stability, particularly in countries with a weak institutional environment. Vo et al., (2019) examined the factors of financial instability in 17 developing economies. The researchers found a strong correlation between credit growth and the foreign exchange reserves of emerging economies, suggesting that these economies are more economically unstable relative to their peers. It is among the reasons why strong oversight is needed to make sure that, as the phrase goes, bringing people to the table does not leave them in debt.

While prior studies have examined the link between financial inclusion and stability (e.g., Damane & Ho, 2024; Hua et al., 2023), they have investigated the moderating role of governance, particularly through threshold analysis, yet a gap remains concerning the moderating role of digital financial inclusion. Furthermore, existing research frequently relies on static models or single indicators. This study addresses these gaps by applying a two-step System GMM approach and constructing a composite Financial Stability Index through principal component analysis (PCA), thereby facilitating a nuanced understanding of both linear and nonlinear dynamics in developing countries.

3. Data and Methodology

3.1 Data and Variables

This study examines a panel dataset of 72 developing countries from 2012 to 2022, drawing data from the World Bank (WDI), Global Financial Development Database, and International Monetary Fund (IMF). The selection of countries is based on data availability and their classification as developing economies. The dependent variable is financial stability, measured through a composite Financial Stability Index (FSI). The key independent variables are: traditional financial inclusion (FII), which encompasses access, usage, and penetration of financial services. Digital financial inclusion (DFI) encompasses the adoption and utilization of mobile banking and internet payments. In addition, the model includes control variables known to affect stability, such as financial openness (FO), measured using the Chinn-Ito Index. Income (INC) is measured by GDP per capita (log-

transformed). Foreign direct investment (FDI) is defined as net inflows as a percentage of GDP. Regulatory quality indicators from the Worldwide Governance Indicators measure governance (GOV).

3.2 Construction of Financial Stability Index by Two-Stage PCA

Since financial stability is a multidimensional concept, this study constructs a more robust indicator by combining several financial health measures into one index. A two-stage Principal Component Analysis (PCA) is used to capture the underlying structure.

Stage 1: Two separate sub-indices are built: Financial Market Index: based on indicators like domestic credit to private sector, interest rate spread, and market concentration (Herfindahl-Hirschman Index). Financial Soundness Index: based on return on assets, capital to asset ratios, liquid reserves to bank assets, bank regulatory capital to risk-weighted assets, liquid assets to total assets ratio and the Z-score of banks.

Stage 2: These two dimensions are then combined using PCA again to form a composite Financial Stability Index (FSI). This index helps reflect both the market's depth and the system's soundness in a single, statistically balanced measure.

Stage 1 PCA

As mentioned earlier, the first step of principal component analysis is to estimate the sub-indices of the two dimensions: the financial market index and the financial soundness index in equations (1) and (2).

$$\gamma_i^m = \beta_1 domestic\ credit_i + \beta_2 interest\ rate\ spread_i + \beta_3 HHI_i + \mu_i \quad \textbf{(1)}$$

$$\gamma_i^s = \alpha_1 bank\ capital\ to\ asset\ ratio_i + \alpha_2 liquid\ reserves\ to\ bank\ assets_i + \alpha_3 return\ on\ assets_i + \alpha_4 bank\ regulatory\ capital\ to\ risk\ weighted\ assets_i + \alpha_5 z\_score_i + \alpha_6 liquid\ assets\ to\ total\ assets\ ratio_i + \alpha_7 Z - Score + \mu_i \quad \textbf{(2)}$$

Here, (β and α) are the parameters to be estimated from the data, and μ_i is the error term following classical OLS assumptions.

Stage 2 PCA

$$FSI_i = w_i\gamma_i^m + w_i\gamma_i^s + \mu_i \quad \textbf{(3)}$$

Where.

FSI_i = the composite FS index of country i;

w_i = relative weight of each dimension.

γ_i^m = Financial market dimension.

γ_i^s = Financial soundness dimension.

3.3 Model Specification (Models 1–5)

To analyze the impact of financial inclusion on financial stability, this study employs a dynamic panel data approach using the two-step System Generalized Method of Moments

(System GMM). The datasets comprise 72 developing countries (Appendix I) with data spanning from 2012 to 2022.

This method is suitable because:

- Financial stability is persistent over time (today's stability depends on yesterday's).
- Some regressors may be endogenous (e.g., FI could be influenced by past stability).
- There are unobserved, country-specific effects that need to be accounted for.

3.4 Model Framework

Five models are tested, each adding new insights into how financial inclusion relates to stability:

Model 1: Individual Dimensions of Financial Inclusion

$$(FSI_{it}) = \beta_0 + \gamma\, log(FSI_{it-1}) + \beta_1 logPenetration_{it} + \beta_2 logAccessibility_{it} + \beta_2 logUsaibility_{it} + X'_{it}\beta + \mu_{it}$$

This baseline model includes three dimensions of financial inclusion: penetration, accessibility, and usability. It aims to identify which specific aspects of inclusion support or weaken financial stability.

Model 2: Composite Indices of Financial Inclusion (TFII & DFII)

$$(FSI_{it}) = \beta_0 + \gamma\, log(FSI_{it-1}) + \beta_1 logTFII_{it} + \beta_2 logDFII_{it} + X'_{it}\beta + \mu_{it}$$

This model shifts from individual indicators to two composite indices: traditional (TFII) and digital (DFII). It examines their overall impact on stability.

Model 3: Moderation Role of DFII

$$(FSI_{it}) = \beta_0 + \gamma\, log(FSI_{it-1}) + \beta_1 logTFII_{it} + \beta_2 logDFII_{it} + \beta_3 log(TFII_{it} * DFII_{it}) + X'_{it}\beta + \mu_{it}$$

Here, an interaction term (TFII × DFII) is added to see whether digital financial inclusion amplifies or mitigates the effect of traditional inclusion on financial stability.

Model 4: Nonlinear Effect of Traditional Financial Inclusion $TFII^2$

$$(FSI_{it}) = \beta_0 + \gamma\, log(FSI_{it-1}) + \beta_1 logTFII_{it} + \beta_2 logTFII_{it}^2 + \beta_3 logDFII_{it} + \beta_4 log(TFII_{it} * DFII_{it}) + X'_{it}\beta + \mu_{it}$$

A squared term for TFII is included to test whether the relationship between inclusion and stability is nonlinear, i.e., does inclusion help up to a point, but hurt after a threshold?

Model 5: Threshold-Based Groupings

$$FSI_{it} = \alpha_0 + \alpha_1 FSI_{it-1} + \beta_1 TFII\_Low_{it} + \beta_2 TFII\_High_{it} + \gamma_1 DFII\_Low_{it} + \gamma_2 DFII\_High_{it} + \delta_1 (TFII\_Low_{it} \times DFII\_Low_{it}) + \delta_2 (TFII\_High_{it} \times DFII\_High\_it) + X_{it}\theta + \varepsilon_{it}$$

This model categorises countries into low and high inclusion groups, and adds interaction terms (e.g., TFII_low × DFII_low) to examine whether the combined effects vary at different levels of inclusion.

4. Results and Discussion

This study employs dynamic panel system GMM estimations to investigate the effects of financial inclusion on financial stability, controlling for key macroeconomic and institutional variables. Four model specifications are presented, progressively incorporating disaggregated financial inclusion dimensions, composite indices, interaction terms, and nonlinear effects.

4.1 Descriptive Statistics

Table 1 presents descriptive statistics for the study variables of Model 1. The results from Model 1 show that the Financial Stability Index (FSI) has an average value of 0.21, with a standard deviation of 0.179 based on 792 observations. This indicates a relatively low average level of financial stability across the observed entities, with significant variability. The range of 0 to 1 suggests that financial stability is being captured on a scale, where value 1 represents the highest level of stability and value 0 represents the lowest level of stability. With a mean of 0.21, most observations are closer to the lower end of the scale, indicating financial instability in the sample, although there are notable differences across the entities. The dimensions of financial inclusion penetration, accessibility, and usability have mean values of 0.238, 0.209, and 0.039, respectively, with similar patterns. These dimensions of financial inclusion suggest that, although there is some level of financial access and penetration, the actual usability of financial services remains very limited, with usability particularly low. Financial Openness (FO), measured by the Kaufmann Index, has a mean value of −0.027 but a high standard deviation of 1.464, indicating substantial variation in openness. Foreign Direct Investment (FDI), with a mean of 0.948, suggests moderate foreign investment inflows, but the wide range (from -6.089 to 3.662) and high standard deviation (0.984) indicate significant variation. This variability in FDI could impact financial stability in different ways. The Income (INC), measured by GDP per capita, has a mean of 8.102, indicating relatively consistent income levels across the sample, with a low standard deviation of 0.906. This suggests that, despite variations in financial stability and openness, the income levels are more stable. Finally, Governance (GOV), measured by regulatory quality, shows a mean of 3.571, indicating moderate governance quality with some variation. Good governance can positively influence financial stability, though the variability here suggests room for improvement.

Table 1: Descriptive Statistics (Model 1: Basic Dimensions of Financial Inclusion)

Variable	Obs	Mean	Std. Dev.	Min	Max
FSI	792	.21	.179	0	1
PENETRATION	792	.238	.197	0	1
ACCESSIBILITY	792	.209	.178	0	1
USABILITY	792	.039	.069	0	1
FO	792	-.027	1.464	-1.935	2.29
FDI	752	.948	.984	-6.089	3.662
INC	792	8.102	.906	6.01	9.675
GOV	792	3.571	.603	1.045	4.455

Table 2 presents descriptive statistics for the study variables of Model 2. The FSI (Financial Stability Index) remains like that in Model 1, with a mean of 0.21, indicating a continued low level of financial stability across the observed sample. The introduction of two separate indices: the traditional financial inclusion index (TFII) and digital financial inclusion index (DFII), further highlights the difference in accessibility between traditional and digital financial services. The TFII has a mean of 0.29, which is slightly higher than the DFII's mean of 0.04, indicating that traditional financial services are more accessible than digital ones in this sample. The descriptive analysis of the control variable outcomes (Financial Openness (FO), FDI, Income (INC), and Governance (GOV)) in Model 2 is consistent with the results of Model 1.

Table 2: Descriptive Statistics (Model 2: TFII & DFII Indices)

Variable	Obs	Mean	Std. Dev.	Min	Max
FSI	792	.21	.179	0	1
TFII	792	.29	.2	0	1
DFII	792	.04	.106	0	1
FO	737	-.027	1.464	-1.935	2.29
FDI	752	.948	.984	-6.089	3.662
INC	792	8.102	.906	6.01	9.675
GOV	792	3.571	.603	1.045	4.455

4.2 Correlation Analysis

The correlation matrix (Table 3) reports Pearson correlation coefficients among the principal variables of Model 1. The Financial Stability Index (FSI) is positively correlated

with Penetration at 0.361, Accessibility at 0.484 and Usability at 0.404, indicating a positive relationship between financial stability and the dimensions of financial inclusion. FSI also correlates moderately with Income (INC) at 0.457 and Governance (GOV) at 0.420, indicating that stronger economic performance and regulatory quality are associated with enhanced financial stability.

The financial inclusion dimensions of Penetration and Accessibility are strongly correlated at 0.726, implying a high degree of overlap. Both dimensions correlate positively with Income (0.655 and 0.704, respectively) and Governance (0.350 and 0.451, respectively), consistent with theoretical expectations that economic and governance factors facilitate inclusion. Usability exhibits comparatively moderate, yet positive, correlations with Penetration (0.554), Accessibility (0.459), and Income (0.409), and a weaker correlation with Governance (0.263).

Financial Openness (FO) exhibits weak positive correlations with FSI (0.052), Accessibility (0.142), Usability (0.040), Income (0.241), and a moderate correlation with Governance (0.451), but a weak negative correlation with Penetration (-0.008), suggesting nuanced relationships that may warrant further investigation. Foreign Direct Investment (FDI) exhibits negligible correlations with most variables, with the strongest being with Financial Openness (FO), at 0.198, and Governance, at 0.190. However, it shows a weak negative correlation with FSI (-0.022), indicating a limited association with financial inclusion and stability in this sample.

Income strongly correlates with Penetration and Accessibility, reinforcing the linkage between economic prosperity and financial inclusion. Governance quality is positively associated with most variables, especially Accessibility, FO, and Income, highlighting the role of regulatory frameworks in financial development.

These findings reveal an interconnected system of financial and economic variables, where financial stability, inclusion, income, and governance exhibit mutually reinforcing associations. In contrast, financial openness and foreign direct investment (FDI) show weaker and more complex linkages. The strong correlations among financial inclusion dimensions suggest the need to consider multicollinearity in subsequent multivariate analyses.

Table 3: Matrix of Correlations (Model 1: Basic Dimensions of Financial Inclusion)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) FSI	1.000							
(2) PENETRATION	0.361	1.000						
(3) ACCESSIBILITY	0.484	0.726	1.000					
(4) USABILITY	0.404	0.554	0.459	1.000				
(5) FO	0.052	-0.008	0.142	0.040	1.000			
(6) FDI	-0.022	0.019	-0.002	0.032	0.198	1.000		
(7) INC	0.457	0.655	0.704	0.409	0.241	0.004	1.000	
(8) GOV	0.420	0.350	0.451	0.263	0.451	0.190	0.480	1.000

Table 4 presents the correlation analysis related to Model 2. In this table, the Financial Stability Index (FSI) is positively and moderately correlated with the traditional financial inclusion index (TFII), with a correlation coefficient of 0.516. There is a weak negative correlation with the Digital Financial Inclusion Index (DFII) at -0.04.

The traditional financial inclusion index (TFII) exhibits weak positive correlations with FO (0.033) and FDI (0.012) and is moderately positively correlated with INC (0.678) and GOV (0.387). On the other hand, the digital financial inclusion index (DFII) exhibits weak negative correlations with FO (-0.114), FDI (-0.122), INC (-0.188), and GOV (-0.045).

Table 4: Matrix of Correlations (Model 2: TFII & DFII Indices)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) FSI	1.000						
(2) TFII	0.516	1.000					
(3) DFII	-0.041	-0.118	1.000				
(4) FO	0.052	0.033	-0.114	1.000			
(5) FDI	-0.022	0.012	-0.122	0.198	1.000		
(6) INC	0.457	0.678	-0.188	0.241	0.004	1.000	
(7) GOV	0.420	0.387	-0.045	0.451	0.190	0.480	1.000

4.3 Multicollinearity VIF Test

Table 5 shows the VIF values for both Model 1 and Model 2, which are used to evaluate the potential problem of multicollinearity. In Model 1, the variance inflation factors (VIFs) for the independent variables range from 1.074 to 2.782, with an average VIF of 1.929. The relatively low VIF values suggest minimal multicollinearity among the variables. Specifically, penetration (VIF = 2.782) and accessibility (VIF = 2.728) show moderate

collinearity with other predictors, but these values are still within an acceptable limit. Other variables, including GOV (VIF = 1.659), USEABILITY (VIF = 1.464), FO (VIF = 1.383), and FDI (VIF = 1.074), display low collinearity, indicating they are mostly independent of each other. Since the mean VIF is below 5, multicollinearity does not pose a major concern in this model.

In Model 2, the VIF values for the variables range from 1.068 to 2.202, with an average VIF of 1.559. These values are even lower than those in Model 1, indicating that multicollinearity is less of a concern in this model. Variables such as INC (VIF = 2.202) and TFII (VIF = 1.986) show moderate collinearity, but they remain within acceptable limits. Other variables like GOV (VIF = 1.645), FO (VIF = 1.368), FDI (VIF = 1.085), and DFII (VIF = 1.068) display minimal collinearity. With an average VIF well below 2, this model also does not suffer from problematic multicollinearity.

Finally, both models show acceptable levels of multicollinearity, with average VIF values well below the threshold of 5. Although Model 1 has slightly higher VIFs, neither model presents significant concerns about multicollinearity, making both suitable for interpretation and analysis.

Table 5: Variance Inflation Factor (VIF)

Model 1		
Variables	VIF	1/VIF
PENETRATION	2.782	.359
ACCESSIBILITY	2.728	.367
INC	2.411	.415
GOV	1.659	.603
USEABILITY	1.464	.683
FO	1.383	.723
FDI	1.074	.931
Mean VIF	1.929	
Model 2		
Variables	VIF	1/VIF
INC	2.202	.454
TFII	1.986	.504
GOV	1.645	.608
FO	1.368	.731
FDI	1.085	.922
DFII	1.068	.937
Mean VIF	1.559	

4.4 GMM Regression Results

Table 6 reports the results of the dynamic panel GMM regressions examining the determinants of financial stability (FSI). Models 1 through 4 progressively incorporate different specifications of financial inclusion measures alongside key control variables.

- **Model 1:** Basic Dimensions of Financial Inclusion

FSI = 0.235*** + 1.069($\boldsymbol{FSI_{it-1}}$)*** - 0.0558(**PENETRATION)*** +
0.0737(**ACCESSIBILITY)*** -0.0111(**USABILITY)*** + 0.0019(**FO)*** -
0.0035(**FDI)*** -0.0344(**INC)*** + 0.0089(**GOV)***

The results from Model 1 offer a nuanced understanding of the relationship between financial inclusion and financial stability in developing countries, aligning closely with the foundational concepts of financial intermediation theory and Minsky's financial instability hypothesis. The regression analysis indicates strong persistence in financial stability, evidenced by the highly significant coefficient on the lagged dependent variable with the value of β (1.069) & P-value (0.000). This implies that current levels of financial stability are heavily shaped by past dynamics, which is typical in macro-financial systems where institutional inertia and delayed policy impacts prevail. The fact that the coefficient exceeds one raises concerns about potential non-stationarity or explosive behavior, suggesting that, without corrective measures, financial stability could develop in a non-mean-reverting manner. This supports the use of a dynamic GMM estimator and necessitates validation through autocorrelation and instrument validity tests such as the Arellano-Bond and Hansen statistics.

Focusing on the core variable dimensions of financial inclusion, the results offer distinct insights. Firstly, penetration with a value of β (–0.0558) & P-value (0.000) is a negative and highly statistically significant impact on the stability of the financial system (FSI). This dimension of financial inclusion, which represents the inclusion into the formal sector, poses a stability question mark in times when people acquire financial products without the necessary financial literacy or institutional support to operate them effectively, leading to phenomena such as defaults, account inactivity, and operational inefficiency (Joudar & El Ghmari 2025; Antwi et al., 2024; Chinoda & Kapingura 2023; Yildiz & Awadh 2022). Conversely, accessibility has a positive impact on financial stability (FSI), with a value of β (0.0737) & P-value (0.000). It suggests that easier access to physical or digital financial services, such as ATMs, mobile banking agents, and bank branches, promotes meaningful participation in the financial system, encourages regular transactions, and strengthens household resilience, especially during times of economic stress (Koudalo & Toure 2023; Wang & Luo 2022; Atellu & Muriu 2022; Ahamed & Mallick 2019; Neaime & Gaysset 2018; Morgan & Pontines 2018). Furthermore, usability with a value of β (-0.0111) & P-value (0.000) has a small but statistically significant adverse effect on financial stability. It is suggested that inclusion is often viewed as beneficial, but heavy usage, especially of

credit products, can increase moral hazard risks (Joudar & El Ghmari 2025; Naceur et al., 2024; Chinoda & Kapingura 2023; Olusegun et al., 2021).

Among the control variables, financial openness (FO), with a value of β (0.0019) & P-value (0.002) has a positive and statistically significant effect on financial stability (FSI). This indicates that an open financial system, characterized by the free movement of capital, is believed to enhance financial stability by facilitating access to various types of financing (Dienillah et al., 2018; Morgan & Pontines 2018). Conversely, foreign direct investment (FDI) inflows with a value of β (-0.0035) & P-value (0.000) slightly weaken stability, which may reflect the volatile nature of such capital and its tendency to fuel boom-bust cycles in local credit markets (Alzarooni et al., 2024; Morgan & Pontines 2018; Morgan & Pontines 2014). Similarly, Income per capita with a value of β (-0.0344) & P-value (0.000) exhibits a negative relationship with the stability of the financial system (FSI). This counterintuitive finding may suggest that as economies develop and become more financially sophisticated, they may also become more vulnerable to systemic financial risks, particularly if regulatory frameworks fail to keep pace with innovation and credit expansion (Damane & Ho 2024; Hua et al., 2023; Koudalo & Toure 2023; Pham & Doan 2020). Furthermore, governance quality with a value of β (0.0089) & P-value (0.000) supports financial stability, emphasising that well-regulated environments with consistent enforcement and credible institutions are fundamentally more stable. This results in a resounding endorsement of Minsky's hypothesis, while advocating for the role of proactive regulation in containing speculative excess (Malik et al., 2025; Ullah et al., 2024; Alzarooni et al., 2024; Malik et al., 2022).

- **Model 2:** FII & DFI Indices

FSI = 0.161*** +1.080($\boldsymbol{FSI_{it-1}}$)*** -0.0505(**TFII)***** -0.0205(**DFII)***** -
0.00117(**FO)**** -0.00429(**FDI)***** -0.0215(**INC)***** -0.00492(**GOV)****

Model 2 replaces the disaggregated financial inclusion measures with composite indices representing traditional (FII) and digital (DFI) inclusion. The results from Model 2 show that, similarly to Model 1, the lagged value of financial stability (FSI) remains highly persistent over time, as evidenced by the significantly positive coefficient of the lagged dependent variable (L.FSI = 1.080, p = 0.000). This confirms the dynamic nature of financial systems, where past stability greatly influences current outcomes. The core variables, traditional and digital financial inclusion indices TFII and DFII are negatively and significantly related to financial stability. Specifically, the coefficient for TFII is β (-0.0505) & P-value (0.000) suggesting that traditional financial inclusion, such as increasing access to banking and credit can weaken stability when credit is misallocated or when financial intermediaries lack sufficient capacity to manage increased risks, aligning with financial intermediation theory and Minsky's idea that credit booms often trigger instability (Elgharib, 2024; Olusegun et al., 2021; Danisman & Tarazi 2020). Conversely, DFII has a coefficient of β (-0.0205) & P-value (0.000) indicating that digital financial inclusion, despite improving access, may also create systemic vulnerabilities through unregulated

fintech activities, rising consumer over-indebtedness, and greater exposure to cyberattacks, data breaches, and digital fraud (Raza et al., 2024; Barik & Pradhan 2021; Ozili, 2018). These risks are especially pronounced in emerging markets, where regulatory frameworks and cybersecurity measures often lag behind rapid technological advances, further supporting Minsky's view that financial innovation, without strong oversight, can be destabilizing.

Control variables retain their statistically significant impacts. Financial openness (FO) has a statistically significant but modest adverse effect on financial stability (FSI), with the value of β (-0.0011) & P-value (0.025) suggesting that increased integration with global financial markets may introduce volatility (Morgan & Pontines 2018). Similarly, foreign direct investment (FDI) has a negative impact on financial stability at high significance levels with the value of β (-0.0043) & P-value (0.000), likely due to the destabilizing nature of short-term capital inflows or speculative investments (Alzarooni et al., 2024; Morgan & Pontines 2018). INC continues to exhibit a negative and highly significant relationship with financial stability (FSI), with the value of β (-0.0218) & P-value (0.000), which may reflect structural inequalities or heightened consumer leverage not captured by aggregate income metrics (Hua et al., 2023; Pham & Doan 2020). In contrast, governance quality (GOV), assessed through regulatory effectiveness, positively influences financial stability with the value of β (0.0049) & P-value (0.023), highlighting the vital role of institutional strength and regulatory frameworks (Malik et al., 2025; Ullah et al., 2024; Alzarooni et al., 2024; Malik et al., 2022).

- **Model 3:** Moderation Effect of DFII

FSI = 0.173*** + 1.076($\boldsymbol{FSI_{it-1}}$)*** - 0.0552(**TFII)***** -0.0543(**DFII)***** + 0.109**(TFII*DFII)***** - 0.00132(**FO)**** - 0.00447(**FDI)***** - 0.0229(**INC)***** + 0.00575(**GOV)*****

Model 3 introduces an interaction term between traditional and digital financial inclusion (FII*DFI), which is positive and significant with the value of β (0.109) & P-value (0.000), indicating a strengthened moderating effect of digital financial inclusion (DFII). This indicates that digital financial inclusion mitigates the destabilizing effects of traditional inclusion, likely by enhancing transparency, reducing transaction costs, and improving monitoring through digital channels. This synergy likely arises from the way traditional financial systems provide regulatory credibility and depositor security, while digital platforms offer reach, efficiency, and data-driven oversight. Together, they form a resilient, hybrid ecosystem that reduces the risks each would carry independently (Ullah & Begum 2025; Ullah et al., 2025; Mutanda & Nomlala, 2025). Control variables remain consistent with the Model 2 outcomes significant and relationship, with FO negatively impacting stability with the value of β (-0.0013) & P-value (0.040), FDI also negatively affecting stability with the value of β (-0.0045) & P-value (0.000), income negatively associated to stability with the value of β (-0.0229) & P-value (0.000), and governance quality

continuing its significant positive effect on stability with the value of β (0.00575) & P-value (0.007).

- **Model 4:** Nonlinearities of TFII_SQ

FSI = 0.231** +1.075($\boldsymbol{FSI_{it-1}}$)*** +0.180(**TFII)***** -0.0544(**DFII)***** +0.120**(TFII*DFII)***** -0.233**(TFII_SQ)***** +0.00201(**FO)***** - 0.00451(**FDI)***** -0.0352(**INC)***** +0.00541(**GOV)*****

Model 4 adds a quadratic term for traditional financial inclusion (FII_SQ), which is negative and highly significant with the financial stability (FSI), with the value of β (-0.233) & P-value (0.000), revealing an inverted U-shaped relationship with financial stability. This suggests that while initial increases in inclusion bolster stability by extending formal finance and broadening the financial base, beyond a certain threshold excessive inclusion may exacerbate risks such as over-indebtedness and strain on regulatory frameworks (Kebede et al., 2025; Sebai et al., 2025; Hua et al., 2023). Control variables maintain their expected signs and significance except the sign of financial openness (FO) with the outcomes of Model 3: FO positively affects stability with the value of β (0.00201) & P-value (0.000), FDI negatively influences stability with the value of β (-0.00451) & P-value (0.000), income retains a negative association to stability with the value of β (-0.0352) & P-value (0.000), and governance quality remains significantly positive relationship with stability of financial system with the value of β (0.00541) & P-value (0.003).

Finally, these findings of all models 1-4 illustrate a complex and nuanced relationship between financial inclusion and financial stability. While effective utilisation and digital financial inclusion enhance resilience, indiscriminate expansion of access can introduce systemic risks. Furthermore, integration with global financial markets enhances stability, whereas volatile capital inflows and higher income levels, reflecting more complex financial systems, pose challenges (Ogunbiyi-Badaru et al., 2024). The shifting role of governance quality highlights the adaptive regulatory policies that evolve in response to changing financial landscapes (Raza et al., 2024).

- **Diagnostic Tests**

Robust econometric diagnostics underpin the reliability of these findings. The Arellano-Bond AR(2) test reports a high p-value in all models 1-4 (0.800, 0.979, 0.984 and 0.648, respectively), indicating no second-order autocorrelation and validating the model's moment conditions. The Hansen J-test p-values in models 1-4 (0.395, 0.235, 0.217, and 0.258, respectively) confirm that the instruments used are valid and not overidentified, alleviating concerns about instrument proliferation and reinforcing the overall integrity of the system-GMM estimation. Together, these diagnostics confirm the reliability of the model and strengthen the credibility of the empirical results.

Table 6: Regression Analysis System GMM Two-Step

VARIABLES	Model (1) FSI	Model (2) FSI	Model (3) FSI	Model (4) FSI
L.FSI	1.069*** (0.00367)	1.080*** (0.00370)	1.076*** (0.00453)	1.075*** (0.00616)
PENETRATION	-0.0558*** (0.00601)	-	-	-
ACCESSIBILITY	0.0738*** (0.00603)	-	-	-
USABILITY	-0.0111*** (0.00261)	-	-	-
TFII	-	-0.0505*** (0.00227)	-0.0552*** (0.00289)	0.180*** (0.00707)
DFII	-	-0.0205*** (0.00372)	-0.0543*** (0.00882)	-0.0544*** (0.0113)
TFIIxDFII	-	-	0.109*** (0.0239)	0.120*** (0.0300)
TFII_SQ	-	-	-	-0.233*** (0.00491)
FO	0.00196*** (0.000606)	-0.00117** (0.000512)	-0.00132** (0.000630)	0.00201*** (0.000456)
FDI	-0.00354*** (0.000246)	-0.00429*** (0.000276)	-0.00447*** (0.000263)	-0.00451*** (0.000216)
INC	-0.0345*** (0.00214)	-0.0215*** (0.00121)	-0.0229*** (0.00126)	-0.0352*** (0.00231)
GOV	0.00896*** (0.00181)	0.00492** (0.00211)	0.00575*** (0.00207)	0.00541*** (0.00177)
Constant	0.235*** (0.0170)	0.161*** (0.00953)	0.173*** (0.00950)	0.231*** (0.0201)
AR (1)	0.005	0.005	0.005	0.005
AR (2)	0.800	0.979	0.984	0.648
Hansen Test	0.395	0.235	0.217	0.258

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

4.5 Threshold Model Analysis

The threshold model results in table 7 indicate that financial stability is highly persistent, demonstrated by the strong positive and statistically significant coefficient on the lagged financial stability index (1.063291***). Consistent with previous findings on risks associated with rapid financial expansion, traditional financial inclusion has a negative impact on financial stability at both low (-0.17356***) and high (-0.11468***) levels, suggesting that increased access to conventional financial services may undermine systemic stability, potentially due to regulatory challenges or heightened financial vulnerabilities. Similarly, digital financial inclusion has a significant negative impact at

low levels (-0.13429***), but this adverse effect changes to a positive effect at high levels, remaining statistically significant (0.415068***). Importantly, the interaction between traditional and digital financial inclusion is positive and highly significant at low level (0.755935***) and negative highly significant at high level (-0.65873**) levels, implying that when both forms of inclusion coexist, they work together to mitigate their individual adverse effects and contribute to enhancing financial stability. Control variables, FO negatively impacting stability with the value of β (-0.00325) & P-value (0.000), FDI also negatively affecting stability with the value of β (-0.00161) & P-value (0.002), income positively associated to stability with the value of β (0.009281) & P-value (0.000), and governance quality continuing its significant positive effect on stability with the value of β (0.003044) & P-value (0.004).

Diagnostic tests confirm the model's reliability, showing no evidence of second-order autocorrelation (AR(2) = 0.787) and supporting the validity of instruments (Hansen test p = 0.271). These findings expose a nuanced, threshold-dependent relationship between financial inclusion and financial stability. While both traditional and digital financial inclusion individually pose risks to stability, their combined interaction appears to have a stabilizing effect across various levels of inclusion. This highlights the importance of policies that encourage balanced development of both traditional and digital financial sectors to enhance systemic stability.

Table 7: Threshold Model (GMM Regression Results)

Variables	Coef.	St.Err.	t-value	p-value	Sig
L.FSI	1.063291	0.003698	287.52	0.000	***
TFII_Low	-0.17356	0.006582	-26.37	0.000	***
TFII_High	-0.11468	0.004236	-27.07	0.000	***
DFII_Low	-0.13429	0.023607	-5.69	0.000	***
DFII_High	0.415068	0.10696	3.88	0.000	***
TFIIxDFII_Low	0.755935	0.137292	5.51	0.000	***
TFIIxDFII_High	-0.65873	0.167109	-3.94	0.000	***
FO	-0.00325	0.000645	-5.04	0.000	***
FDI	-0.00161	0.000494	-3.25	0.002	***
INC	0.009281	0.0008	11.6	0.000	***
GOV	0.003044	0.00102	2.98	0.004	***
Constant	-0.05073	0.005972	-8.49	0.000	***
Mean - Dependent Variable	0.216		**SD - Dependent Variable**	0.184	
Number of Obs.	643		**F-test**	532685.651	
AR(1)	0.003				
AR(2)	0.868				
Hansen Test	0.442				

*** p<.01, ** p<.05, * p<.1

5. Conclusion

This paper examines the relationship between financial inclusion and financial stability in developing countries, with a specific focus on the role of digital financial inclusion. Applying a dynamic panel system GMM methodology to 72 countries from 2012 to 2022, this study reveals the diversified effects of both traditional and digital financial inclusiveness on financial stability. The conclusion is that while financial inclusion helps bring about stability by enabling people to access the formal tools necessary for financial transactions, it can also increase instability when not adequately regulated. It is pertinent to mention that digital financial inclusion serves as a cushioning factor, alleviating some of the drawbacks of financial inclusion by enhancing accountability and reducing the cost of transfers. However, excessive inclusion (particularly without solid institutional foundations) can increase systemic risks, as suggested by the quadratic relationship between traditional financial inclusion and stability. The report emphasizes the importance of developing sound, balanced financial inclusion policies that address both the

opportunities and risks associated with scaling digital financial services. The results suggest that regulation should follow as financial inclusion expands into areas with underdeveloped financial structures and their associated risks.

5.1 Recommendations and Suggestions

- Attention needs to be placed by policymakers at the top of their list to develop a regulatory framework that can effectively manage the risk dimensions of Trinidadians and digital financial inclusion. This is particularly important early on in financial inclusion because rapid numerical growth without appropriate oversight can become a systemic problem.
- Given the limited effects observed, a measured strategy is the most suitable one, whereby both digital and traditional financial services are being developed in parallel. This will not only reduce risks but will still enable the provision of financial access to the populations and regions that are most in need of it.
- Raising the level of financial literacy and ensuring that effective consumer protection mechanisms are in place are crucial to preventing increased access to financial services from leading to over-indebtedness or financial instability.
- Different countries may encounter various challenges in implementing financial inclusion policies. Therefore, there is a need for targeted and custom-made initiatives for each country, which will consider the specific financial infrastructure and the quality of the governance. Thus, the risks can be minimized while the benefits can be maximized at the same time.
- Continuous follow-up of the financial system's stability is of prime importance, especially in the case of changing forms of financial inclusion. Instruments such as the Financial Stability Index (FSI) can facilitate tracking the efficiency of inclusion strategies as well as their impact on the overall stability situation.

5.2 Limitations of the Study

This study has several limitations. First, it employed only regulatory quality as a proxy for governance. The second limitation concerns macroeconomic variables such as inflation, the real interest rate, and money supply. Future research can incorporate all these variables into a model. Another limitation is related to sample size; therefore, the findings may support future studies with different samples, such as those from ASEAN, Asian countries, the MENA region, BRICS, SAARC, and developed nations. However, future research may also include other factors and data, as well as expanding the sample size.

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Appendix I

List of Countries

Albania	Algeria	Angola	Argentina	Armenia	Azerbaijan
Bangladesh	Belarus	Bolivia	Bosnia and Herzegovina	Botswana	Brazil
Bulgaria	Cambodia	Cameroon	China	Colombia	Congo (Dem. Rep)
Costa Rica	Dominican Republic	Ecuador	Egypt (Arab Republic)	El Salvador	Eswatini
Gabon	Gambia	Georgia	Ghana	Guatemala	Guinea
Honduras	India	Indonesia	Iraq	Jordan	Kazakhstan
Kenya	Kosovo	Lesotho	Madagascar	Malawi	Malaysia
Maldives	Mauritania	Mauritius	Mexico	Moldova	Montenegro
Mozambique	Namibia	Nepal	Nicaragua	Nigeria	North Macedonia
Pakistan	Panama	Paraguay	Peru	Philippines	Romania
Russian Federation	Rwanda	South Africa	Tajikistan	Tanzania	Thailand
Türkiye	Uganda	Ukraine	Uzbekistan	Vietnam	Zambia