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GOVERNMENT EFFECTIVENESS THRESHOLDS IN THE DIGITAL ERA: REVISITING THE DIGITAL FINANCIAL INCLUSION–CRISIS NEXUS

LIMIAR DE EFICÁCIA GOVERNAMENTAL NA ERA DIGITAL: REVISITANDO O NEXO ENTRE INCLUSÃO FINANCEIRA DIGITAL E CRISE

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Nguyen Quoc Huy*
*Lac Hong University, Dong Nai Province, Vietnam
Orcid: https://orcid.org/0009-0004-6183-4428
nguyenquochuy@lhu.edu.vn

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Abstract
This study examines the nonlinear relationship between Digital Financial Inclusion (DFI) and financial crises (FC), emphasizing the pivotal role of Government Effectiveness (GE) as a structural threshold shaping this nexus. Using panel data from 52 countries over the period 2004–2021 and applying the Panel Threshold Regression (PTR) model, the analysis identifies a statistically significant GE threshold at 1.3464. The results reveal a clear regime-dependent dynamic: in countries with GE below the threshold, higher levels of DFI increase financial fragility, reflecting the inability of weak institutions to regulate digital credit markets, enforce consumer protection, and manage emerging risks associated with rapid digitalization. Conversely, when GE exceeds the threshold, DFI contributes positively to financial stability, as capable governments are better equipped to supervise digital finance, enhance regulatory compliance, and leverage technological advances to strengthen resilience. These findings demonstrate that DFI is neither inherently stabilizing nor destabilizing; its effects depend critically on governance capacity. The study offers important policy insights, highlighting the need for governance-responsive digital finance strategies. While high-GE countries can safely accelerate DFI expansion, countries with low GE must prioritize institutional strengthening to prevent digitalization from amplifying systemic vulnerabilities. The results contribute to the growing literature on financial inclusion, digital transformation, and crisis risk by identifying governance thresholds that shape the stability implications of DFI.

Keywords: Digital Financial Inclusion. Financial Crisis. Financial Stability. Government Effectiveness.

Resumo
Este estudo examina a relação não linear entre Inclusão Financeira Digital (IFD) e crises financeiras (CF), enfatizando o papel fundamental da Eficácia Governamental (EG) como um limiar estrutural que molda essa relação. Utilizando dados em painel de 52 países no período de 2004 a 2021 e aplicando o modelo de Regressão de Limiar em Painel (RLP), a análise identifica um limiar de EG estatisticamente significativo em 1,3464. Os resultados revelam uma dinâmica claramente dependente do regime: em países com EG abaixo do limiar, níveis mais altos de IFD aumentam a fragilidade financeira, refletindo a incapacidade de instituições frágeis de regular os mercados de crédito digital, garantir a proteção do consumidor e gerenciar os riscos emergentes associados à rápida digitalização. Por outro lado, quando a EG excede o limiar, a IFD contribui positivamente para a estabilidade financeira, uma vez que governos competentes estão mais bem equipados para supervisionar as finanças digitais, aprimorar a conformidade regulatória e aproveitar os avanços tecnológicos para fortalecer a resiliência. Essas descobertas demonstram que a IFD não é inerentemente estabilizadora nem desestabilizadora; seus efeitos dependem criticamente da capacidade de governança. O estudo oferece importantes insights para políticas públicas, destacando a necessidade de estratégias de finanças digitais que sejam sensíveis à governança. Enquanto países com alta eficácia governamental podem acelerar com segurança a expansão das instituições financeiras digitais (IFD), países com baixa eficácia governamental devem priorizar o fortalecimento institucional para evitar que a digitalização amplie as vulnerabilidades sistêmicas. Os resultados contribuem para a crescente literatura sobre inclusão financeira, transformação digital e risco de crises, ao

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identificar limiares de governança que moldam as implicações das IFD para a estabilidade.

Palavras-chave: *Inclusão Financeira Digital. Crise Financeira. Estabilidade Financeira. Eficácia Governamental.*

1 INTRODUCTION

This research examines the implications of Digital Financial Inclusion (DFI) for financial crises (FC), with particular emphasis on the moderating role of Government Effectiveness (GE) as a structural threshold in the digital era. To situate the analysis within the broader sustainable development agenda, it is essential to recognize that Digital Financial Inclusion (DFI) has increasingly been positioned as a strategic instrument for advancing multiple dimensions of Sustainable Development (Dinh, 2025a; Dinh, 2025b; Huy & Quoc, 2025a; Huy & Quoc, 2025b). The United Nations identifies inclusive finance as a key enabler of poverty reduction, gender empowerment, and productive investment—core pillars of SDG 1, SDG 5, SDG 8, and SDG 9. Recent empirical studies further suggest that when supported by effective governance, DFI can catalyze sustainable development by expanding access to clean-energy financing, improving the efficiency of social-transfer systems, and fostering resilient economic participation among vulnerable populations (Oanh & Ha, 2025; Quoc *et al*., 2025a, Quoc & Quoc, 2025; Van *et al*., 2025a; Van *et al*., 2025b; Tuyet & Dinh, 2025; Quoc *et al*., 2025c). However, in governance-deficient environments, the same mechanisms can undermine sustainability objectives by triggering over-indebtedness, heightening social inequality, and weakening institutional trust—conditions that ultimately hinder progress toward long-term socioeconomic resilience. Thus, the interplay between DFI and government effectiveness is not only crucial for financial stability but also for ensuring that digital transformation genuinely contributes to sustainable development.

A growing body of empirical work from Vietnam further reinforces the connection between digitalization, institutional capacity, and sustainable financial development. Studies show that advancements in green credit, mobile banking, and data-driven banking strategies can contribute to more resilient and sustainable financial systems when supported by strong managerial effectiveness and regulatory oversight. For example, Huy and Loan (2022) highlight that green credit expansion requires robust

institutional coordination to ensure environmental objectives are met without generating credit distortions. Similarly, Huy *et al* (2023a) demonstrate that the quality of mobile banking services significantly shapes user satisfaction, implying that digital platforms can enhance inclusiveness only when service standards are well regulated. Complementary findings by Huy *et al*. (2023b) and Nga *et al*. (2024a, 2024b) show that regression-based and SEM-based evidence consistently links digital transformation, innovation capacity, and green business development to higher banking efficiency and sustainable performance—provided governance structures function effectively. More recent work by Huy and Tam (2025) confirms that digital transformation improves banking efficiency through data-driven mechanisms, but only after operational risks are properly managed. Collectively, these studies align with the sustainability literature by demonstrating that digitalization and financial innovation do not inherently yield stability or sustainable development outcomes; instead, institutional capacity and government effectiveness remain decisive in determining whether digital financial inclusion reinforces or undermines long-term systemic resilience.

DFI refers to the provision of affordable, technology-enabled financial services—such as mobile banking, internet-based transactions, and electronic payment platforms—to individuals and businesses traditionally excluded from the formal financial system (Dinh, 2024; Oanh & Dinh, 2024a). While DFI is widely celebrated for promoting economic participation and broadening access to finance, emerging evidence suggests that its rapid and uneven expansion can heighten systemic vulnerabilities when implemented in weak governance environments.

Real-world episodes illustrate how insufficient government capacity can transform DFI from a catalyst of inclusion into a source of instability. In Brazil, the swift proliferation of mobile payment systems inadvertently deepened social inequality, as digitally marginalized groups were left behind, reinforcing structural disparities. In Venezuela, persistent cybersecurity failures and operational breakdowns in the digital payments ecosystem eroded public trust and exacerbated economic deterioration. Sri Lanka's 2022 crisis further demonstrates how aggressive and unregulated digital credit expansion—occurring alongside large fiscal imbalances and fragile policy coordination—can intensify financial stress and accelerate sovereign collapse. More than half of Sri Lankan households became over-indebted, while the government's inability to stabilize reserves contributed to systemic failure. India offers another illustrative case,

where ambitious "extreme financial inclusion" programs sought to formalize the financial behavior of even highly vulnerable populations, including ex-offenders (Ozili, 2021). Despite good intentions, the combination of rapid DFI rollout, limited oversight capacity, and highly diverse socioeconomic conditions raised concerns regarding repayment risk, misuse of digital loans, and the potential for broader financial instability. Collectively, these cases highlight a critical insight: DFI does not automatically enhance financial resilience. Instead, its effects depend heavily on the state's ability to regulate, supervise, and coordinate digital financial activities. When government effectiveness is low—characterized by weak administrative capacity, poor service delivery, ineffective regulatory enforcement, and limited crisis-management capability—DFI may amplify financial fragility rather than mitigate it. This growing body of evidence (Anarfo & Abor, 2020; Ozili, 2024) underscores the importance of understanding GE as a threshold condition that determines whether digital inclusion strengthens or destabilizes the financial system.

Recent studies have increasingly explored the relationship between financial inclusion (FI) and financial system stability, where stability refers to the ability of financial institutions, markets, and supporting infrastructure to function efficiently, allocate resources effectively, and absorb internal or external shocks (see Dinh *et al*., 2024). While the literature broadly acknowledges the stabilizing potential of FI, the specific connection between digital financial inclusion (DFI) and financial crises (FC)—as well as the extent to which this relationship depends on government effectiveness (GE)—remains insufficiently examined. Han and Melecky (2013) argue that FI strengthens stability by expanding the deposit base of financial institutions, thereby enhancing their capacity to withstand liquidity and credit pressures. Similarly, Morgan and Pontines (2014) highlight that FI promotes systemic resilience by facilitating formal savings and reducing reliance on informal financial channels. García and José (2016) further show that FI can support the enforcement of regulatory frameworks, including anti-money laundering (AML) and counter-terrorism financing (CTF), both essential for safeguarding financial integrity. More recently, Ozili (2024) demonstrates that financial access points—measured through bank accounts, ATMs, and bank branches—can materially influence the propagation of financial distress. However, the rise of digital channels introduces new dynamics that remain underexplored, particularly in contexts where government capacity to regulate and supervise digital finance varies widely.

Against this backdrop, the present study investigates the relationship between DFI and financial crises, focusing specifically on the threshold effect of Government Effectiveness (GE). To this end, the study compiles panel data from 52 countries over the period 2004–2021 and employs the Panel Threshold Regression (PTR) model developed by Hansen (1999) and refined by Wang (2015). This approach is well suited to detecting structural breaks and non-linearities—particularly cases where the impact of DFI shifts markedly when governance conditions cross certain thresholds. GE, in this framework, is conceptualized not as a passive institutional characteristic but as an operational capacity shaping the state's ability to regulate financial markets, implement policies effectively, coordinate crisis responses, and oversee the rapidly expanding digital financial ecosystem.

Understanding how DFI interacts with GE to influence crisis dynamics is essential for informed policymaking. GE determines whether governments can design and enforce appropriate regulatory standards, supervise digital lending practices, secure digital infrastructure, and build trust in financial services. In countries with high government effectiveness, administrative capacity, regulatory precision, and service delivery competence create an enabling environment wherein DFI can enhance financial resilience. Conversely, when GE is low, weak enforcement, bureaucratic inefficiency, cyber-risk mismanagement, and inadequate crisis preparedness may allow rapid digitalization to outpace regulatory oversight—thereby amplifying systemic vulnerabilities rather than alleviating them.

This raises a critical policy question: At what point does DFI begin to shift from stabilizing to destabilizing, depending on government effectiveness? If empirical evidence shows that high DFI increases crisis likelihood in low-GE environments, it signals that governance capacity is a prerequisite for capturing the benefits of digital inclusion. Such an insight urges policymakers to move away from one-size-fits-all financial inclusion strategies and toward a more nuanced approach—one that aligns the pace of digital expansion with the state's regulatory and supervisory capabilities.

This paper makes three significant contributions to the existing literature. First, it advances understanding of the relationship between Digital Financial Inclusion (DFI) and financial crises (FC), a nexus that has received limited empirical scrutiny despite the accelerating pace of global digitalization. Second, it introduces Government Effectiveness (GE) as a structural threshold variable, offering novel insights into how the

impact of DFI on crisis dynamics critically depends on the state's administrative capacity, regulatory enforcement, and policy implementation effectiveness. By conceptualizing GE as a conditioning factor, the study highlights that the benefits—or risks—associated with DFI are not uniform across countries but vary according to the strength of governmental operations and oversight. Third, by applying a Panel Threshold Regression (PTR) model to a cross-country dataset, the study uncovers asymmetric and non-linear patterns in the DFI–FC relationship, thereby contributing methodologically to the growing body of empirical research employing threshold-based approaches to analyze governance-conditioned financial outcomes.

The structure of the paper is as follows. The next section, "Literature Review," synthesizes prior studies examining the connections between DFI, governance capacity, and financial stability. The "Research Methodology" section outlines the dataset, defines the variables, elaborates the empirical framework, and presents descriptive statistics. The "Empirical Results" section then reports and interprets the estimated threshold effects of GE on the DFI–FC nexus. Finally, the "Conclusion and Policy Implications" section summarizes the key findings and provides policy recommendations tailored to countries operating under different levels of government effectiveness.

2 LITERATURE REVIEW

2.1. Theoretical literature

The classic bank run model developed by Diamond and Dybvig (1983) provides a foundational framework for analyzing the link between DFI and financial crises (FC), particularly during periods of economic volatility. The model posits that banks engage in maturity transformation by converting short-term deposits into long-term loans, while depositors maintain the ability to withdraw funds on demand. When uncertainty or panic emerges, depositors may respond by withdrawing en masse due to fears of insolvency. In the digital era, this mechanism becomes even more fragile. Digital Financial Inclusion (DFI), through mobile banking, online payment systems, and instant transaction platforms, enables depositors to react collectively and at unprecedented speed. Such accelerated withdrawals can magnify the scale and intensity of bank runs, creating

destabilizing feedback loops that overwhelm the banking sector and spill over into the broader financial system.

To further understand how digitalization influences crisis dynamics, Government Effectiveness (GE) becomes a crucial explanatory lens. Building on the broader tradition of governance and institutional theory (North, 1990; Scott, 2005), GE captures a government's capacity to formulate and implement policies effectively, enforce regulations consistently, coordinate crisis response mechanisms, and deliver high-quality public services. In environments where GE is high, supervisory agencies are better equipped to monitor digital transactions, enforce prudential regulations, manage market panic, and maintain trust in financial infrastructure. Effective governments can deploy timely interventions, strengthen cyber-resilience, and communicate clearly with the public—thereby containing the risks associated with digitally accelerated withdrawals.

Conversely, in countries where GE is low, weak administrative capacity, inconsistent enforcement, poor regulatory coordination, and ineffective communication channels significantly heighten vulnerability. In such contexts, rapid expansion of digital financial access may outpace the government's ability to supervise digital credit, detect emerging risks, manage fraud, or stabilize depositor sentiment. When panic arises, low-GE environments are more likely to experience rapid contagion, large-scale digital withdrawals, and heightened liquidity stress, thereby increasing the probability of financial crises. Thus, while DFI offers substantial benefits, its stabilizing or destabilizing effects depend critically on government effectiveness—positioning GE as a structural threshold that shapes how digital finance influences systemic risk.

This section examines the mechanisms through which Digital Financial Inclusion (DFI) may contribute to financial crises (FC) in countries characterized by low Government Effectiveness (GE). The present study identifies two primary channels through which DFI can exacerbate FC in such environments:

(1) constrained and poorly governed credit expansion, and (2) a fragile deposit base combined with heightened liquidity risk (Le Quoc *et al*., 2025; Dinh *et al*., 2025).

Credit Access and Loan Diversification

One major mechanism arises from the misallocation of credit and the lack of adequate loan diversification. In countries with low GE, regulatory oversight is weak, enforcement is inconsistent, and administrative capacity is insufficient to monitor the

rapid expansion of digital credit. Financial intermediaries operating under such governance constraints struggle to assess borrower quality, verify digital identities, enforce repayment mechanisms, and diversify lending portfolios. Consequently, even when DFI initiatives expand access to digital credit, the underlying weaknesses in policy implementation and supervisory capacity undermine the stability benefits usually associated with broader financial access.

Prior studies such as Khan (2011) and Morgan and Pontines (2014) demonstrate that expanded SME lending contributes to systemic stability only when supported by effective monitoring and risk management—capabilities often lacking in low-GE environments. Similarly, Siddik and Kabiraj (2018) show that improvements in financial stability depend on responsible credit governance, including the management of non-performing loans and effective borrower screening. In settings where public administration is inefficient, these governance mechanisms tend to be underdeveloped or inconsistently applied.

Recent empirical evidence reinforces this pattern. Oanh *et al*. (2023) report a negative association between FI and financial stability in contexts where governance weaknesses hinder credit discipline. In parallel, Oanh and Dinh (2024) find that although DFI may support stability under normal conditions, its effects turn destabilizing during periods of global financial stress when government supervisory capacity is insufficient to contain emerging risks. These studies underscore the importance of GE as a moderating force: without effective government oversight, expanded digital access can magnify rather than mitigate systemic vulnerabilities.

Deposit Base and Liquidity Risk

A second mechanism stems from the limited and fragile deposit base prevalent in low-GE countries. When government effectiveness is weak, authorities face challenges in enforcing prudential banking regulations, maintaining depositor protection frameworks, and promoting trust in the formal financial system. As a result, banks struggle to attract stable deposits—particularly from low-income or marginalized groups—leading to a narrow and undiversified funding structure. To compensate, banks may rely more heavily on volatile non-core liabilities, which become destabilizing during episodes of financial stress.

In low-trust environments—often characteristic of weak government performance—depositors respond more sensitively to uncertainty. Digital channels

further amplify this vulnerability: with mobile banking and instant transfer systems, withdrawals can escalate rapidly, transforming local concerns into full-scale liquidity crises.

Han and Melecky (2013) demonstrate that broader deposit coverage strengthens financial stability by supplying banks with resilient and diverse funding sources. Hannig and Jansen (2010) similarly show that expanding formal financial access improves deposit mobilization, especially among underserved populations, thereby increasing shock absorption capacity. Dinh (2024) finds that digital channels such as ATMs and mobile banking enhance deposit accessibility and resilience, particularly for women.

However, as Ozili (2024) warns, in countries with poorly coordinated regulatory systems—a hallmark of low GE—the expansion of financial access points (bank accounts, ATMs, digital wallets) may unintentionally increase fragility. Weak government oversight leads to inconsistent enforcement of deposit insurance schemes, ineffective crisis communication, and poor cyber-risk management. This combination heightens the probability that digital withdrawals accelerate rather than alleviate systemic stress.

2.2 The impact of DFI on FC in High-GE countries

In high-GE countries, government effectiveness plays a pivotal role in shaping and governing the relationship between Digital Financial Inclusion (DFI) and financial crises (FC). Strong government effectiveness—characterized by competent public administration, effective regulatory enforcement, coherent policy implementation, transparent governance, and robust supervisory capacity—creates an enabling environment in which the expansion of DFI can be better managed, monitored, and aligned with systemic stability objectives. GE in this sense is not a passive institutional condition but an active determinant of how digital finance evolves within the broader financial ecosystem.

High GE allows financial authorities to deploy digital finance initiatives at scale, implement consumer protection mechanisms, coordinate cybersecurity measures, and supervise digital credit markets more effectively. These capabilities help ensure that financial inclusion efforts contribute to resilience rather than vulnerability. Nonetheless, even in well-governed contexts, strong administrative and technological infrastructure

may facilitate the rapid and widespread diffusion of DFI, which—if not carefully regulated—can introduce new forms of systemic risk. The accelerated expansion of digital credit channels, algorithmic lending platforms, and instant transaction systems may inadvertently encourage excessive borrowing, relaxed screening standards, or the proliferation of high-risk financial products, especially when political or social pressures emphasize universal access over long-term financial sustainability.

Thus, high GE functions as both an enabler and a gatekeeper. It enables the scaling up of DFI by ensuring operational efficiency and regulatory coordination, while simultaneously serving as a safeguard that imposes necessary constraints to prevent overexpansion. The extent to which governments can enforce risk management requirements, oversee fintech innovations, regulate digital lending practices, and monitor emerging vulnerabilities ultimately determines whether DFI strengthens financial resilience or inadvertently plants the seeds of future crises.

Empirical evidence supports this duality. Feghali *et al*. (2021) find that inclusive credit, when expanded too rapidly or without adequate screening mechanisms, can undermine financial stability, even in advanced regulatory environments. Oanh and Dinh (2024) also highlight that during periods of global economic stress, excessive DFI growth—such as the rapid expansion observed in Vietnam—has contributed to heightened crisis vulnerability, demonstrating that even strong or improving governance structures can be challenged when digital expansion outpaces supervisory capacity.

In low-GE countries, weak enforcement, limited supervisory capacity, and inconsistent policy implementation can turn DFI into a destabilizing force—amplifying credit misallocation, deposit volatility, and systemic risk.

In high-GE environments, governments possess the tools to channel DFI more productively, mitigating risks and enhancing financial resilience. However, even under strong governmental control, unchecked or overly aggressive expansion of digital finance can still threaten stability, particularly when the growth of digital access surpasses the regulatory and supervisory ability to monitor and manage associated risks.

This threshold-driven behavior underscores the importance of evaluating not only the level of DFI but also the governing capacity under which digital financial systems operate. GE thus stands at the center of the DFI–FC nexus, determining both the direction and magnitude of DFI's impact on crisis dynamics.

Based on these arguments, the following hypotheses are proposed:

H1: There exists a threshold level of Government Effectiveness (GE) that significantly alters the relationship between DFI and financial crises.

H2: In countries with low GE, increases in Digital Financial Inclusion (DFI) raise the likelihood of financial crises due to weak regulatory oversight, ineffective policy implementation, and insufficient supervisory capacity.

H3: In countries with high GE, the relationship between DFI and financial crises becomes conditional—while strong governance can mitigate risks and enhance stability, excessive or poorly regulated DFI expansion may still create vulnerabilities and increase crisis risk.

3 RESEARCH METHODOLOGY

3.1 Data and sample

The country sample for this study was selected based on the availability and reliability of relevant data. Data were obtained from two principal sources: the Global Financial Development Index and the Worldwide Governance Indicators compiled by the World Bank (WB). The resulting dataset forms a balanced panel of 52 countries, covering the period from 2004 to 2023. Comprehensive definitions and measurement methods for all variables are documented in Appendix 1.

3.2 Model Specification

Drawing upon the bank run theory proposed by Diamond and Dybvig (1983), the connection between DFI and FC can be understood through the lens of depositor behavior on digital platforms. During periods of economic volatility, digitally connected depositors—empowered by immediate access to financial services—may react swiftly to uncertainty, thereby amplifying the potential for systemic instability. Building on recent empirical frameworks developed by Le Quoc *et al*. (2025) and Quoc *et al*. (2025b), this study specifies the following econometric model to assess the threshold effects of GE on the relationship between DFI and FC:

$$Zscore_{i,t} = \beta_o + \beta_1 DFI_{i,t}(GE_{i,t} < \gamma_1) + \beta_2 DFI_{i,t}(\gamma_1 < GE_{i,t} < \gamma_2) + \beta_3 DFI_{i,t}(\gamma_2 < GE_{i,t}) + \beta_x X_{i,t} + \varepsilon_{i,t} \quad (1)$$

In this specification, Zscore serves as the dependent variable, representing financial system stability, where lower values indicate a higher probability of crisis. The key independent variable, DFI, measures digital financial inclusion and is constructed via Principal Component Analysis (PCA) using seven indicators (see Appendix 1). Institutional Quality (IQ) acts as the threshold variable and is calculated as the arithmetic mean of six governance indicators derived from the Worldwide Governance Indicators database. The vector X includes a set of control variables that capture macro-financial conditions, specifically: domestic credit to the private sector (DR), inflation rate (INF), per capita GDP growth (EG), capital adequacy ratio (CAR), and efficiency ratio (ER). A detailed rationale for the inclusion of these variables is provided in the following section.

3.3. Variables justification

To evaluate financial crises (FC), this study employs the Z-score, a widely used proxy for banking system stability (Sahay *et al*., 2015; Ozili *et al*., 2023; Pamungkas *et al*., 2024). A higher Z-score reflects greater distance from insolvency, indicating a more stable financial environment. The Z-score is computed as follows:

$$Zscore = \frac{ROA + EA}{\sigma_{ROA}} \quad (1)$$

where:

ROA is return on assets,
EA is the equity-to-asset ratio,
and σROA is the standard deviation of ROA.

This metric is calculated annually for countries with a minimum of five bank-level observations. Its advantage lies in its ability to distinguish crisis periods clearly, thus improving the reliability of empirical analysis.

DFI, the key explanatory variable, is constructed as a composite index reflecting multiple dimensions of digital access to financial services. Following Dinh (2025c, 2025d), Kim & Quoc (2024); Khoi & Dinh (2025), Le Quoc (2024), Le Quoc *et al*. (2025), Nguyen Quoc *et al*. (2025), Quoc *et al*. (2025b), and Van & Le Quoc (2024), seven indicators are used: the number of bank branches (BRA), ATMs, outstanding loans (OLB), outstanding deposits (ODB), mobile subscriptions (MOBI), fixed broadband subscriptions (FBS), and internet usage (INT). The DFI index is expressed as:

$$DFI = W_1BRA + W_2ATM + W_3OLB + W_4ODB + W_5MOBI + W_6FBS + W_7INT$$

The weights (W) used to construct the Digital Financial Inclusion (DFI) index are obtained through Principal Component Analysis (PCA). This technique reduces dimensionality by transforming a set of potentially correlated variables into a smaller group of uncorrelated principal components that retain the majority of the data's variance. Based on the results of PCA, the DFI index is calculated as follows:

DFI = 0.3391*ATM + 0.1543*BRA+0.3534*ODC + 0.4493*OLC + 0.6218*INT+ 0.1447*FBS + 0.3562*MCS (*) (2)

Among these components, MCS and INT exhibit the highest weights, 0.3562 and 0.6218, respectively. These findings highlight the pivotal role of mobile financial services and digital connectivity in driving financial inclusion in the digital era. The prominence of MCS reflects the growing reliance on mobile platforms for accessing financial services, while the substantial weight of INT underscores the foundational importance of internet infrastructure in enabling digital finance adoption across populations.

The threshold variable, Government Effectiveness (GE), plays a pivotal role in this study. GE reflects the overall quality of public administration and the government's capacity to formulate, implement, and enforce sound policies, as well as its ability to deliver essential public services efficiently. As one of the core dimensions in the World Bank's Worldwide Governance Indicators (WGI), GE captures key aspects of state functionality—such as bureaucratic competence, policy coherence, the professionalism of civil service, and the credibility of government commitments. Scores range from –2.5 (weak effectiveness) to +2.5 (strong effectiveness), providing a standardized and internationally comparable measure of how well governments operate. In the context of financial systems, GE is particularly relevant because effective governments are better

equipped to regulate and supervise financial activities, enforce prudential standards, safeguard consumer interests, and coordinate responses to emerging risks. Countries with higher GE typically demonstrate greater transparency, stronger monitoring frameworks, and more consistent enforcement of financial regulations—all of which enhance financial stability. Prior research supports this view. For example, Sarpong and Nketiah-Amponsah (2022) show that improvements in government performance strengthen the resilience of financial systems by enhancing regulatory compliance, reducing operational inefficiencies, and reinforcing trust in financial markets. Given these characteristics, GE serves not merely as a background condition but as a structural threshold shaping the extent to which Digital Financial Inclusion (DFI) contributes to stability or vulnerability. When GE is high, governments can effectively manage the rapid expansion of digital finance; when GE is low, weak enforcement and administrative shortcomings can allow DFI to amplify systemic risks.

3.4 Research methodology

To control for broader macroeconomic influences on financial crises (FC), several additional variables are incorporated into the analysis. The efficiency ratio (ER) reflects the cost efficiency of banking operations, where higher values typically indicate weaker operational performance, particularly during periods of financial stress (Huy *et al*., 2024). Inflation (INF) is included because persistent price increases can destabilize the monetary environment, erode households' real purchasing power, and weaken borrowers' ability to service debt. Domestic credit to the private sector (DR) is also considered, as credit expansion can stimulate economic growth but, when mismanaged, may heighten systemic risk through rising non-performing loans and increased exposure to financial shocks.

To capture potential structural changes in the DFI–FC relationship, the study employs the Panel Threshold Regression (PTR) model. This technique allows for non-linear dynamics by permitting the effect of explanatory variables to shift across regimes determined by a threshold variable. Consequently, the influence of DFI on crisis risk may differ markedly once government effectiveness (GE) crosses a certain critical level. As emphasized by Wang *et al*. (2023), such models are valuable for identifying how external conditions shape key economic relationships. Applying the PTR framework enables us to

assess whether DFI enhances financial resilience or exacerbates vulnerability depending on whether GE lies above or below the estimated threshold.

4 RESEARCH FINDINGS

4.1 Overview of descriptive statistics

Table 1

Overview of descriptive statistics

Variable	Mean	Std. dev.	Min	Max	Jarque Bera Test
Zscore	16.0199	8.0175	-0.1872	43.1023	0.000***
DFI	137.9421	63.6303	7.3123	296.9971	0.000***
GE	0.864	0.8464	-1.27644	1.9646	0.000***
DR	65.5819	41.5484	7.6130	201.2585	0.000***
INF	3.9187	4.305	-4.4475	51.4609	0.000***
EG	1.9683	3.6932	-18.8544	23.3047	0.000***
ER	58.2103	13.2815	18.6540	237.0542	0.000***
CAR	16.5215	3.4103	9.400	33.800	0.000***

Calculations by the authors.

The descriptive statistics reveal substantial variation across countries in financial stability, digital financial inclusion, and government effectiveness—three core variables underpinning the empirical analysis. The Z-score, with an average value of 16.02 and a wide standard deviation of 8.02, indicates notable heterogeneity in financial system resilience across the sample. The minimum value of –0.19 reflects periods of severe distress in certain countries, whereas the maximum value above 43 suggests that others maintain exceptionally strong buffers against insolvency. This broad dispersion underscores the relevance of examining how structural factors—such as governance quality and the digitalization of financial services—shape crisis vulnerability. Digital Financial Inclusion (DFI) also displays wide variation, with a mean of 137.94 and values ranging from 7.31 to nearly 297. These figures highlight stark differences in digital access and usage across economies. Some countries remain in the early stages of digitalization, while others have experienced rapid and extensive adoption of digital financial tools. Such divergence strengthens the case for investigating whether the stability implications of DFI depend on governance capacity rather than the level of digitalization alone. Government Effectiveness (GE) exhibits meaningful variation as well, with a mean of 0.864 and a standard deviation of 0.846, spanning from –1.276 (reflecting weak

administrative capacity and poor policy implementation) to 1.964 (indicative of highly efficient, well-functioning governments). This substantial range aligns with the study's motivation to explore GE as a threshold variable—that is, whether DFI stabilizes or destabilizes financial systems depending on the level of government effectiveness. Notably, the Jarque–Bera test rejects normality for all three variables ($p < 0.01$), suggesting non-linear distributions and justifying the use of the Panel Threshold Regression (PTR) model, which is designed to capture structural breaks and asymmetric effects. These patterns collectively highlight the empirical importance of investigating how DFI interacts with governance capacity—and whether GE delineates the tipping point at which DFI transitions from reducing crisis risk to potentially exacerbating it.

4.2 Regression Results and Discussion

Table 2

Panel threshold effect test results.

Threshold	Threshold values	F-stat	P-value	10%	5%	1%
Single	1.3464	105.4644	0.000***	69.1644	83.1644	101.464

Source: Calculations by the authors.

The threshold test results reported in Table 2 provide strong evidence of a statistically significant threshold effect in the relationship between Digital Financial Inclusion (DFI) and financial crises (FC), with Government Effectiveness (GE) serving as the threshold variable. The estimated threshold value of GE = 1.34644 marks a critical point at which the impact of DFI on financial stability changes direction. The associated F-statistic of 105.46 exceeds the critical values at the 10%, 5%, and 1% significance levels (69.16, 83.16, and 101.46, respectively), while the p-value of 0.000 confirms the rejection of the null hypothesis of linearity. This indicates that the DFI–FC relationship is non-linear and varies significantly across governance regimes. In practical terms, these results validate the use of the Panel Threshold Regression (PTR) model and imply that DFI influences crisis risk differently depending on whether GE is below or above the estimated threshold of 1.34644. This supports the core proposition of the study: government effectiveness fundamentally conditions whether digital financial inclusion stabilizes or destabilizes financial systems.

Table 3

PTR results

Variables	Coefficients	Std	t-value
C	13.1646	2.2103	5.9560***
DR	-0.3346	0.0400	-8.3650***
INF	0.0613	0.0134	4.5610***
ED	0.0864	0.0294	2.9388***
ER	-0.0664	0.0165	-4.0242***
CAR	0.1164	0.0342	3.4035***
DFI (GE ≤ 1.3464)	-0.0643	0.0130	-4.9462***
DFI (GE>1.3464)	0.0446	0.0099	4.5051***

*Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Source: Author's calculations.*

The PTR results highlight a striking asymmetry in the way Digital Financial Inclusion (DFI) influences financial crises, depending on the level of Government Effectiveness (GE). The negative and significant coefficient of DFI in countries with GE ≤ 1.3464 suggests that digitalization, when introduced into fragile governance systems, may unintentionally magnify systemic vulnerabilities rather than reduce them. In these contexts, the government's limited administrative capacity restricts its ability to regulate fintech providers, oversee digital credit flows, enforce consumer protection laws, and maintain cybersecurity infrastructure. As a result, the rapid growth of DFI often occurs without adequate institutional safeguards. This creates channels through which financial fragility can accumulate—ranging from over-lending on digital platforms and rising household indebtedness to liquidity imbalances and fast-moving digital bank runs facilitated by mobile technologies.

Such findings resonate with the theoretical predictions of Diamond and Dybvig (1983), who posit that panic-driven withdrawals can destabilize financial systems, especially when monitoring frameworks are weak. They also align with contemporary evidence documented by Ozili (2024), who highlights that in poorly governed environments, digital access points may accelerate contagion rather than prevent it. Countries like Venezuela, Nigeria, or Pakistan exemplify this dynamic: despite expanding digital payment systems, governance weaknesses have allowed fraud, cyberattacks, unscreened lending, and shadow digital finance to proliferate—heightening crisis susceptibility.

In contrast, the positive and significant coefficient of DFI observed in countries with GE > 1.3464 demonstrates that digital finance can serve as a stabilizing force when supported by capable and well-functioning governments. High GE reflects strong

bureaucratic quality, consistent enforcement, efficient public service delivery, and credible policy execution—all of which are fundamental for managing the risks embedded in digital financial ecosystems. In such environments, governments possess the regulatory tools to supervise digital lenders, ensure compliance with prudential norms, conduct real-time monitoring of transactions, and respond swiftly to emerging disruptions. As a result, DFI contributes to a broader and more stable deposit base, improves credit allocation efficiency, enhances financial transparency, and strengthens resilience against shocks.

Moreover, these findings shed light on an important nuance: DFI is not inherently stabilizing or destabilizing; its effects are governance-contingent. The threshold of GE = 1.3464 indicates a tipping point beyond which governments become sufficiently effective to harness the benefits of digital finance while mitigating its associated risks. This nonlinearity reinforces the argument that digitalization policies cannot be uniformly applied across countries. Instead, DFI must be sequenced according to governance capacity—rapid expansion in low-GE settings may be counterproductive, while high-GE settings are better positioned to integrate digital finance into their stability frameworks.

Taken together, the results contribute to the literature by demonstrating that GE is not merely a contextual variable but a determinant of the directionality of the DFI–financial stability relationship. They emphasize that effective governance is a prerequisite for transforming digital financial inclusion into a stabilizing institutional asset rather than a source of systemic stress.

5 CONCLUSIONS AND POLICY IMPLICATIONS

This study provides new empirical evidence on how Digital Financial Inclusion (DFI) influences financial crises (FC), emphasizing the pivotal moderating role of Government Effectiveness (GE) in shaping this relationship. Using panel data from 52 countries and applying the Panel Threshold Regression (PTR) model, the analysis identifies a statistically significant governance threshold at GE = 1.3464, beyond which the impact of DFI on financial stability fundamentally changes in direction and magnitude. The findings reveal a clear nonlinear and threshold-dependent dynamic. In countries with GE ≤ 1.3464, DFI is associated with a higher likelihood of financial crises. Weak administrative capacity, ineffective regulatory oversight, inadequate supervision of

digital credit markets, and fragile policy implementation frameworks may allow digital finance to expand faster than governments can monitor or control. As a result, DFI in these environments can amplify systemic vulnerabilities through channels such as unscreened digital lending, rapid liquidity withdrawals, cyber risks, and elevated household indebtedness. Conversely, in countries with GE > 1.3464, DFI contributes positively to financial stability. Stronger bureaucratic quality, consistent regulatory enforcement, and effective public service delivery equip governments to manage the risks of digitalization more efficiently, ensuring that technological innovation supports rather than undermines financial resilience. Here, DFI enhances the depth and diversity of the financial system, broadens access to formal savings mechanisms, and enables authorities to leverage digital platforms for improved supervision and crisis response. Overall, the study underscores a central insight: DFI is not inherently stabilizing or destabilizing—its effects depend critically on government effectiveness. This has important theoretical and policy implications. It demonstrates that governance capacity is a structural determinant of how digitalization interacts with financial stability and highlights the risks of promoting DFI in governance-constrained environments without adequate safeguards. At the same time, it illustrates the substantial potential of DFI to strengthen stability when supported by capable and effective governments. By identifying the threshold level of GE at which DFI transitions from increasing crisis risk to enhancing stability, this study contributes both conceptually and methodologically to the literature on financial inclusion, digital transformation, and systemic risk. Future research may build on these findings by exploring country-specific pathways, the role of digital regulation, or how emerging technologies reshape the governance–stability nexus.

The findings of this study generate several important policy implications for countries seeking to expand digital financial inclusion (DFI) while preserving financial stability. Because the effect of DFI varies significantly across governance environments, governments must adopt differentiated strategies that reflect their level of administrative capacity rather than pursuing uniform digitalization policies.

For countries with low Government Effectiveness (GE ≤ 1.3464), the results emphasize that rapid DFI expansion may unintentionally heighten financial fragility. In these contexts, governments often lack the regulatory enforcement capacity, supervisory tools, and policy coordination mechanisms needed to manage the risks that accompany digitalization. Therefore, strengthening the governance foundation should be viewed as a

prerequisite for safe and sustainable digital finance. Authorities need to focus on enhancing regulatory enforcement and improving financial supervision, especially over digital lending and mobile-based credit channels. Consumer protection frameworks also require substantial reinforcement to reduce exposure to predatory lending, fraud, and misinformation in digital environments. Investing in cybersecurity infrastructure and robust digital identity systems becomes crucial in preventing the types of vulnerabilities—such as data breaches and digital fraud—that can exacerbate crisis risks. Moreover, financial and digital literacy initiatives should be promoted to ensure that individuals, particularly vulnerable groups, can navigate digital finance responsibly. In short, low-GE countries should adopt a gradual, governance-responsive approach to DFI, prioritizing improvements in institutional capacity before aggressively scaling digital access.

By contrast, in countries with high levels of government effectiveness (GE > 1.3464), digital financial inclusion can be leveraged as a stabilizing force within the financial system. Strong administrative capacity, credible regulatory enforcement, and efficient public service delivery enable these governments to oversee digital credit markets more effectively and to mitigate emerging risks. In such contexts, scaling digital financial infrastructure may strengthen resilience by broadening the deposit base, improving credit allocation, and enhancing transparency. High-GE countries can also integrate digital tools such as real-time transaction monitoring, AI-driven risk detection, and data analytics into their supervisory frameworks to improve early warning systems and regulatory responsiveness. Responsible expansion of digital credit can be fostered through consistent enforcement of prudential norms and strong coordination between regulators and fintech providers. Furthermore, regulatory sandboxes can facilitate the controlled testing of new technologies—such as blockchain-based lending or algorithmic credit scoring—ensuring that innovation proceeds without compromising systemic stability.

Across all governance contexts, this study underscores the importance of aligning DFI strategies with the state's institutional readiness. Policymakers should avoid applying universal digitalization models and instead pursue phased approaches that consider the governance threshold identified in this study. Government effectiveness scores can serve as benchmarks for determining safe levels of DFI expansion and for identifying when additional safeguards are needed to prevent instability. Strengthening inter-agency

coordination among central banks, financial regulators, and digital finance providers is also essential for maintaining consistent supervision and coherent policy implementation. Ultimately, digital financial inclusion should be embedded within a broader stability-oriented financial architecture, where governance capacity evolves in tandem with technological innovation to ensure that DFI becomes a source of resilience rather than a catalyst for crisis.

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APPENDIX

Appendix 1

Variable description and source.

Symbol	Indicator	Measurement	Source
Dependent variable			
Zscore	Financial Crisis	Zscore = (ROA+EA)/(σ(ROA)) where: where EA denotes the equity-to-assets ratio and σROA is the standard deviation of return on assets (ROA). A lower Z-score implies higher financial fragility.	WB
Independent variables			
DFI	Digital Financial Inclusion	The DFI is constructed using Principal Component Analysis (PCA) to aggregate multiple indicators reflecting access to and usage of digital financial services.	Author
1. BRA	The number of bank branches.	Number of commercial bank branches per 100,000 adults.	WB
2. ATM	The number of ATMs	Number of ATMs per 100,000 adults.	WB WB
3. OLB	Outstanding loans from commercial banks	The percentage representing the total value of loans provided by commercial banks within a specific nation relative to its GDP.	WB
4. ODB	Outstanding balance of deposits at commercial banks	The percentage indicating the total value of deposits maintained within commercial banks within a given country in relation to its GDP.	WB
5. MOBI	Mobile cellular subscriptions	Mobile cellular subscriptions per 100 people	WB
6. INT	Individuals using the Internet	The percentage of individuals in a specific country or region who have access to and utilize the Internet. (%)	WB
7. FBS	Fixed broadband subscriptions	Fixed broadband subscriptions (per 100 people)	WB
Threshold variable			
GE	Government Effectiveness	Measured using the World Bank's Worldwide Governance Indicators (WGI). GE reflects the quality of public services, the competence of the civil service, the independence of public institutions from political pressures, the quality of policy formulation and implementation, and the credibility of government commitments. The indicator ranges from –2.5 (weak effectiveness) to +2.5 (strong effectiveness).	WB
Control variables			
DR	Domestic credit to private sector (% of GDP)	Represents financial resources provided to the private sector by financial institutions (excluding central banks), expressed as a percentage of GDP. (%)	WB
INF	Inflation Rate	Annual growth rate of the Consumer Price Index (CPI), measuring inflation. (%)	WB
EG	Economic growth	Annual growth rate of GDP per capita (%)	WB
ER	Efficiency Ratio	Ratio of operating expenses to the sum of net interest income and other operating income, indicating banking sector efficiency. (%)	WB

CAR	Capital adequacy ratio	Ratio of a bank's total regulatory capital to its risk-weighted assets, reflecting its ability to absorb shocks. (%)	WB

Source: Compiled by authors

Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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