ISSN 1533-9211

DOI: 10.5281/zenodo.20712923

DIGITAL BANKING, ENERGY CONSTRAINTS, AND FINANCIAL STABILITY: EVIDENCE FROM NIGERIA

JEREMIAH IBHAEBOSORIA EWALEFOH[1]* and
GANIYAT A. ADESINA-UTHMAN[2]

[1]Department of Economics, Nile University of Nigeria, Abuja, Nigeria.
*Corresponding Author's Email: jerry.ewalefoh@gmail.com; ORCID: https://orcid.org/0009-0002-2623-4131
[2]Department of Economics, National Open University of Nigeria, Abuja, Nigeria.
Email: gadesina-uthman@noun.edu.ng; ORCID: https://orcid.org/0000-0002-9738-5247

Abstract

Digital banking has expanded rapidly in Nigeria over the past decade, yet concerns about recurring liquidity pressures in the banking system have persisted. This raises a key question: to what extent can digitalisation strengthen financial stability in an environment where electricity supply remains unreliable? This paper examines how energy conditions shape the relationship between digital banking activity and bank liquidity. The analysis combines monthly data on digital transactions and liquidity indicators (2009–2024) with annual measures of electricity access and reliability. To account for the mixed-frequency nature of the data, a MIDAS framework is employed, allowing energy constraints to influence high-frequency financial dynamics without resorting to aggregation. The results indicate a clearly conditional relationship. While digital banking is generally associated with improved liquidity, the magnitude of this effect depends on the energy environment. High transmission and distribution losses tend to weaken the liquidity-enhancing effect of digital banking, reflecting disruptions to the underlying digital financial infrastructure. In contrast, broader access to electricity strengthens the positive contribution of digital banking to liquidity conditions. Further results from the interaction terms show that improvements in electricity supply reinforce the stabilising role of digital finance, whereas persistent energy constraints dampen its effectiveness. Overall, the findings suggest that the contribution of digital banking to financial stability is closely tied to the reliability and reach of electricity supply. In contexts where power infrastructure remains weak, digitalisation alone is unlikely to fully deliver the expected stability gains. **Contribution/Originality:** Existing work on digital banking has paid limited attention to the role of energy conditions in shaping financial outcomes. This study shows that electricity reliability captured through access and system losses conditions the liquidity effects of digital banking. By adopting a mixed-frequency approach, it offers new evidence on how energy constraints influence financial stability in Nigeria.

Keywords: Digital Banking, Bank Liquidity, Energy Constraints, MIDAS, Financial Stability.

JEL Codes: G21, G28, O33, Q43, C22

1. INTRODUCTION

Over the last decade, Nigeria's financial landscape has shifted markedly toward digital modes of intermediation. The expansion of mobile banking applications, internet-based transfers, and fintech platforms has changed how financial transactions are initiated and settled. Beyond convenience, these developments have broadened access to formal financial services and altered the mechanics of liquidity management within the banking system (Adeola & Evans, 2020; Ozili, 2018). In principle, faster transactions and improved deposit mobilisation should ease short-term funding pressures. Yet, the Nigerian experience does not fully conform to this expectation. Despite sustained growth in digital transactions, episodes of liquidity strain have remained a recurring feature of the banking system (CBN, 2023). This disconnect raises a more fundamental question: under what conditions does digital banking actually translate into improved liquidity outcomes?

A plausible explanation lies outside the conventional boundaries of financial analysis. Nigeria's electricity supply is characterised by persistent instability in terms of limited generation capacity, high transmission and distribution losses, and heavy reliance on self-generation. These features are often treated as background constraints, but in practice they shape the functioning of digital financial systems. Digital banking is inherently infrastructure-dependent. Payment switches, data centres, telecommunications networks, and end-user devices all require continuous and reliable power. When electricity supply is erratic, transaction processing becomes less reliable, downtime increases, and operational costs rise (IEA, 2021; Pan et al., 2022; Mukalayi & Inglesi-Lotz, 2023, 2025). Under such conditions, frictions emerge within the financial system in ways that are not always immediately visible.

These frictions operate through several channels. Power disruptions can lower transaction success rates and delay settlement cycles, complicating banks' short-term liquidity management. At the same time, dependence on diesel generators or alternative energy sources raises operating costs, which may in turn affect balance sheet decisions. Recurrent outages also introduce operational uncertainty, potentially influencing depositor behaviour, particularly during periods of stress. By contrast, more reliable and widely accessible electricity tends to support smoother payment flows and reduce the likelihood of transaction failures. The implication is straightforward but often overlooked: the liquidity effects of digital banking are unlikely to be uniform; rather, they depend on the surrounding energy environment.

Recent events in Nigeria provide a concrete illustration of these dynamics. During the 2023 cash shortage, the combination of currency redesign policies, withdrawal limits, and infrastructural weaknesses most notably unstable power supply placed considerable strain on digital payment systems. Reports of failed transactions and prolonged delays became widespread, while many users reverted to informal cash arrangements (Ezeani, 2023; King, 2023). Instead of acting as a buffer, digital channels in some instances appeared to intensify liquidity pressures, as uncertainty prompted precautionary behaviour among households and firms. This episode underscores a broader point: without adequate supporting infrastructure, digitalisation alone may not deliver the expected gains in financial stability.

Although a growing body of literature links digital banking to improved liquidity conditions (Ozili, 2018), and a separate strand examines the macroeconomic consequences of energy constraints (Roubaud & Shahbaz, 2018; Tzoumas, 2022), the intersection between these areas remains relatively underexplored. Much of the existing work implicitly assumes that digital financial systems operate in stable infrastructural settings. This assumption is difficult to sustain in economies where power supply is both unreliable and unevenly distributed. By bringing these strands together, this study examines how energy conditions shape the relationship between digital banking and bank liquidity in Nigeria, with particular attention to electricity reliability and access as moderating factors.

DOI: 10.5281/zenodo.20712923

The contribution of the study is threefold. First, it revisits the digital banking–liquidity nexus by explicitly incorporating energy availability into the transmission mechanism, rather than treating infrastructure as exogenous. Second, it distinguishes between different dimensions of energy constraints, capturing both technical inefficiencies through transmission and distribution losses and broader access to electricity, while also constructing a composite index to reflect their joint effect. Third, it provides policy-relevant insights by showing how improvements in energy infrastructure can reinforce, or alternatively limit, the stabilising role of digital finance.

From a methodological standpoint, the analysis employs a mixed-frequency framework that allows variables observed at different intervals to be examined jointly. Monthly indicators of digital banking activity and bank liquidity are combined with annual measures of energy conditions using a MIDAS approach. This framework makes it possible to capture how slowly evolving infrastructure constraints influence higher-frequency financial dynamics without imposing aggregation bias. Interaction terms are further introduced to assess whether energy conditions modify the effect of digital banking on liquidity.

What emerges from the analysis is a simple but important implication. Strengthening financial stability in Nigeria is unlikely to hinge on digital innovation alone. The effectiveness of digital banking as a liquidity-enhancing mechanism appears closely tied to the reliability and reach of electricity supply. In this sense, financial sector development and energy infrastructure are not independent processes; they are jointly determined.

In this respect, the study departs from much of the existing literature by showing that the digital finance–liquidity relationship is not structurally invariant but conditional on infrastructural quality. Rather than assuming frictionless operation of digital systems, it embeds energy reliability directly into the analysis of financial outcomes.

The remainder of the paper proceeds as follows. Section 2 describes the data and variable construction. Section 3 outlines the theoretical framework and econometric methodology. Section 4 presents the empirical results, followed by policy implications in Section 5. Section 6 concludes.

2. THEORETICAL FOUNDATION

The analytical framework developed in this study draws on three related strands of literature: bank liquidity theory, digital financial intermediation, and infrastructure constraints linked to energy supply (see Baltensperger, 1980). Rather than treating these as separate lines of inquiry, the discussion combines them to explain why the liquidity effects of digital banking may differ across environments. The central idea is that financial innovations do not operate in a vacuum; their outcomes depend on the conditions under which they are deployed.

From the perspective of banking theory, liquidity refers to the ability of financial institutions to meet short-term obligations without incurring excessive costs or disrupting normal operations. Classical contributions emphasise transaction efficiency, stability of funding sources, and confidence in payment systems as key elements underpinning liquidity conditions

(Diamond & Dybvig, 1983; Gorton & Metrick, 2012). In this framework, the smooth functioning of payment and settlement mechanisms is not a peripheral issue, it is fundamental to liquidity resilience. When these systems operate efficiently, banks are better able to manage cash flows and absorb short-term shocks.

Digital banking is often seen as reinforcing these mechanisms. By reducing transaction frictions and information asymmetries, digital platforms facilitate faster payments, automated clearing processes, and broader deposit mobilisation. In principle, these features should strengthen liquidity buffers and improve the circulation of funds within the banking system (Beck et al., 2016; BIS, 2018). A growing empirical literature, particularly in developing economies, lends support to this view. Studies such as Ozili (2018) and Adeola and Evans (2020) report improvements in liquidity conditions and balance-sheet efficiency associated with digital financial services. More recent work also points to broader gains in financial system efficiency and stability, although these effects appear sensitive to institutional and structural differences (Frost et al., 2019; Sahay et al., 2020; Banna et al., 2021).

That said, much of this literature rests on an implicit assumption: that digital financial systems operate in relatively stable infrastructural environments. In many cases, the quality of supporting infrastructure particularly energy supply is not explicitly incorporated into the analysis. As a result, digitalisation is often treated as if it automatically translates into efficiency gains, regardless of the conditions under which it unfolds. This assumption becomes difficult to sustain in contexts where infrastructure is unreliable.

In contrast to traditional branch-based banking, digital financial intermediation depends heavily on uninterrupted electricity supply. Data centres, payment switches, telecommunications networks, and access points such as ATMs and point-of-sale terminals all require continuous power. When electricity supply is unstable, these systems become vulnerable to disruptions. What is typically framed as a channel for efficiency can, under such conditions, turn into a source of friction. From an operational standpoint, power outages can lead to transaction failures, delayed settlements, and system downtime, all of which may weaken confidence and encourage precautionary liquidity behaviour (BIS, 2018). Recent studies increasingly recognise that the benefits of digital financial innovation are contingent on complementary infrastructure (Feyen et al., 2021; Banna et al., 2021).

Insights from energy economics add further nuance by distinguishing between different dimensions of energy constraints. Electricity-related limitations do not operate in a single way. On the one hand, high transmission and distribution losses signal technical inefficiencies that reduce the reliability of power delivery, even where installed capacity exists (IEA, 2021). On the other hand, limited access to electricity restricts the adoption and geographic reach of digital technologies, particularly in rural or underserved areas (World Bank, 2020). These two dimensions namely reliability and access capture distinct but complementary aspects of the energy environment. Evidence from the broader energy–finance nexus suggests that infrastructure quality can shape financial and economic outcomes in meaningful ways, especially in sectors that rely heavily on continuous power supply (Shahbaz et al., 2017; Pan et al., 2022; Mukalayi & Inglesi-Lotz, 2025; Anton & Nucu, 2020; Nwani, 2021).

ISSN 1533-9211

DOI: 10.5281/zenodo.20712923

Empirical findings reinforce this perspective. Unreliable electricity has been shown to increase operating costs, introduce uncertainty, and reduce productivity in service-oriented sectors, including finance (Allcott et al., 2016; Pan et al., 2022; Mukalayi & Inglesi-Lotz, 2025). At the same time, there is growing recognition that digital systems and energy infrastructure are closely intertwined. Disruptions in one domain can quickly spill over into the other, with implications for system-wide stability.

Stemming from the aforementioned, digital banking can enhance bank liquidity, but the extent of this effect and in some cases even its direction depends on prevailing energy conditions. Where electricity supply is unreliable or access is limited, the gains from digitalisation may be offset by operational disruptions and higher costs.

Conversely, improvements in reliability and access relax these constraints, allowing digital banking to operate more effectively as a liquidity-supporting mechanism. This leads to a central proposition: the impact of digital banking on bank liquidity is contingent on energy availability, with electricity reliability and access acting as moderating factors.

This perspective is particularly relevant for economies such as Nigeria, where rapid expansion in digital financial services coexists with persistent electricity shortages. In such settings, financial digitalisation and energy infrastructure cannot be viewed as independent drivers of financial stability. Treating them separately risks overstating the benefits of digital banking while underestimating the role of infrastructure in shaping financial outcomes.

3. METHODOLOGY

3.1 Model Specification

The mixed-frequency structure of the data naturally calls for a Mixed Data Sampling (MIDAS) regression framework. This approach makes it possible to incorporate annual energy indicators directly into a model where the key financial variables are observed monthly, without forcing the data into a common frequency through aggregation or interpolation. By doing so, the distinct informational content embedded in each frequency is retained. More importantly, it allows slowly evolving energy conditions to influence higher-frequency liquidity dynamics in a manner that is consistent with the underlying data-generating process.

The starting point of the analysis is a baseline specification that captures the direct relationship between digital banking activity and bank liquidity:

$$CBLI_t = \alpha + \beta DBI_t + \varepsilon_t \tag{1}$$

where $CBLI_t$ represents monthly bank liquidity, while DBI_t captures digital banking intensity. The latter is expected to exert a positive influence on liquidity conditions by improving transaction efficiency, supporting deposit mobilisation, and enabling faster reallocation of funds within the banking system. Since both variables are observed at the same (monthly) frequency, the baseline specification does not require any MIDAS-type transformation.

To incorporate the role of energy constraints, however, the model is subsequently extended within a MIDAS framework:

$$CBLI_t = \alpha + \beta DBI_t + \gamma \sum_{k=0}^{K} \omega(k;\phi) EC_{t-k} + \varepsilon_t \tag{2}$$

where EC_t represents the **annual energy constraint** (T&D losses or electricity access) and $w(k;\phi)$ is a MIDAS weighting function capturing the distributed lag effect of energy constraints on liquidity. T&D losses are expected to **negatively affect liquidity,** as higher losses reduce electricity reliability, whereas higher electricity access is expected to **positively support liquidity** by enabling digital banking operations. The next extension incorporates **interaction effects** to assess whether energy constraints condition the effect of digital banking on liquidity:

$$CBLI_t = \alpha + \beta DBI_t + \gamma \sum_{k=0}^{K} \omega(k;\phi) EC_{t-k} + \delta\left(DBI_t \times EC_t\right) + \varepsilon_t \tag{3}$$

In this specification, the coefficient δ captures whether energy constraints condition the effect of digital banking on bank liquidity. A negative and statistically significant δ would indicate that binding energy constraints dampen the liquidity-enhancing benefits of digital banking, consistent with the notion that digital financial infrastructure cannot operate efficiently under unreliable electricity supply. Finally, to account for the joint influence of electricity reliability and availability, the model replaces individual energy indicators with the composite Energy Constraint Index (ECI):

$$CBLI_t = \alpha + \beta DBI_t + \gamma \sum_{k=0}^{K} \omega(k;\phi) EC_{t-k} + \delta\left(DBI_t \times ECI_t\right) + \varepsilon_t \tag{4}$$

This composite specification provides a broader perspective on how multiple dimensions of energy constraints influence the digital banking–liquidity relationship. By combining indicators of technical inefficiency with measures of electricity access, the Energy Constraint Index (ECI) reflects the overall intensity of infrastructural limitations facing the financial system. Framed in this way, the model goes beyond isolated effects and captures how these constraints operate jointly.

Taken together, the set of specifications offers a coherent basis for separating the direct contribution of digital banking, the standalone impact of energy conditions, and the extent to which both interact in shaping liquidity dynamics in Nigeria.

3.2 Data and Preliminary Result

This study uses national-level time-series data for Nigeria, combining monthly financial indicators with annual energy-sector variables over the period January 2009 to December 2024. The sample is deliberately capped at 2024 to maintain consistency between the availability of annual energy indicators and higher-frequency financial series.

Nigeria provides a useful empirical setting, given the rapid expansion of digital financial services alongside persistent challenges in electricity supply. This combination makes it possible to examine how infrastructural conditions shape the effectiveness of digital banking in supporting liquidity and financial stability.

Digital banking activity is proxied by a Digital Banking Intensity (DBI) index. The index is derived from transaction values across three main channels: automated teller machines (ATM), point-of-sale (POS) terminals, and web-based payments linked to internet banking platforms. Together, these channels reflect the primary avenues through which digital financial intermediation takes place in Nigeria. Each series is first transformed into logarithmic form to address scale differences and volatility, then standardised to ensure comparability before being aggregated into a composite measure. As defined here, DBI captures overall transaction intensity rather than movements in any single channel.

Bank liquidity is measured using a Composite Bank Liquidity Index (CBLI), which brings together several indicators commonly used in assessing liquidity conditions. These include the adjusted loans-to-deposit ratio, the liquidity ratio, the liquid asset structure ratio, and the cash reserve ratio. Each component is standardised prior to aggregation, allowing the index to reflect both funding conditions and regulatory liquidity buffers. Compared with single-indicator measures, this approach provides a broader representation of liquidity dynamics within the banking system.

Energy constraints are represented through two indicators that capture different aspects of electricity supply. The first is electric power transmission and distribution (T&D) losses, expressed as a percentage of total output. This measure reflects technical inefficiencies in electricity delivery and serves as a proxy for supply reliability. Elevated T&D losses typically signal weaknesses in grid performance, with direct implications for energy-dependent infrastructure such as ATMs, POS terminals, telecommunications equipment, and data centres. The second indicator is electricity access (EA), measured as the proportion of the population with access to electricity. This variable captures the extent to which energy supply supports the diffusion and usage of digital financial services, particularly across regions where access remains uneven.

To account for their combined influence, a composite Energy Constraint Index (ECI) is constructed by standardising and aggregating T&D losses and electricity access. Higher values of the index correspond to more severe energy constraints. Treating energy conditions in this way allows the analysis to move beyond single proxies and consider the multidimensional nature of infrastructure limitations.

Monthly data on digital banking transactions and liquidity indicators are obtained from the Central Bank of Nigeria (CBN), while energy variables are sourced from the World Development Indicators (WDI). Because the energy data are available only at annual frequency, each monthly observation is matched with the corresponding annual value within the same calendar year. This approach preserves the original structure of the data without introducing artificial interpolation. The mixed-frequency nature of the dataset motivates the use of a MIDAS framework in the empirical analysis, enabling low-frequency energy variables to influence high-frequency financial dynamics without aggregation bias.

Table 1: Preliminary Results

Statistics	Annual Energy Constraint Indicators			Monthly Financial Indicators	
	T&D	EA	ECI	CBLI	DBI
Mean	14.5855	15.7875	-0.2321	0.0404	12.1105
Std. Dev.	0.5000	2.6409	0.4876	0.7453	2.8342
Skewness	-0.4237	-0.3241	0.0751	0.5424	0.4113
Kurtosis	1.3510	1.8684	1.5480	4.5776	1.7724
Start Date	2009	2009	2009	January 2009	January 2009
End Date	2024	2024	2024	December 2024	December 2024
Observations	16	16	16	192	192

Note: T&D denotes electric power transmission and distribution losses (% of output); EA represents electricity access (% of population); ECI is the composite Energy Constraint Index; DBI is the Digital Banking Intensity index; and CBLI is the Composite Bank Liquidity Index. Energy indicators are annual, while financial indicators are monthly.

Table 1 summarises the key characteristics of the variables. Energy indicators display relatively low variation over time, consistent with the persistent nature of electricity constraints in Nigeria. Transmission and distribution losses remain elevated across the sample period, while electricity access shows gradual improvement but does not reach full coverage. By contrast, the financial variables exhibit greater variability. The DBI series, in particular, reflects both the rapid growth of digital transactions and occasional disruptions in payment activity. The CBLI shows moderate skewness and excess kurtosis, indicating periods of liquidity stress interspersed with more stable conditions. These patterns point to an important contrast: digital banking activity evolves quickly, while the energy environment changes more slowly. This mismatch suggests that the potential stabilising role of digital finance operates within constraints that are persistent rather than transitory, a feature that is central to the empirical analysis that follows.

4. RESULTS AND DISCUSSIONS

Table 2 presents the estimation results for both the baseline specification and the MIDAS models that incorporate energy-related variables. A consistent pattern emerges across these specifications: digital banking is closely linked to liquidity conditions in Nigeria's banking system, but the strength and direction of this relationship depend on the surrounding energy environment.

Before turning to the coefficients, it is useful to note that standard diagnostic checks do not raise immediate concerns. The Jarque–Bera statistics suggest that the residuals do not deviate markedly from normality, while the Ljung–Box Q-tests indicate no evidence of serial correlation. In addition, the lag structure adopted in the MIDAS models typically two and four lags were selected using information criteria (AIC and BIC) within a polynomial distributed lag framework. Taken together, these diagnostics point to models that are reasonably well

ISSN 1533-9211

DOI: 10.5281/zenodo.20712923

specified and stable over the sample period. The baseline results provide a useful starting point. Digital banking intensity enters with a positive and statistically significant coefficient, indicating that greater use of digital channels is associated with improved liquidity conditions. This aligns with the view that digital financial intermediation enhances transaction efficiency, supports deposit mobilisation, and facilitates quicker movement of funds across the banking system. From an operational standpoint, this translates into better management of short-term liquidity needs and fewer mismatches between inflows and outflows. Similar patterns have been reported in earlier work on emerging economies, where digital finance is often linked to stronger liquidity buffers and more efficient balance-sheet adjustment (Ozili, 2018; Adeola & Evans, 2020). That said, this baseline relationship does not yet account for the broader infrastructural setting in which digital banking operates.

Once energy variables are introduced, the picture becomes more layered. Transmission and distribution (T&D) losses used here as a proxy for electricity reliability are negatively associated with liquidity, pointing to the disruptive role of weak power infrastructure. By contrast, electricity access shows a positive relationship, suggesting that wider and more stable availability of power supports the functioning of digital financial services. Read together, these results indicate that the benefits of digital banking are not automatic; they depend, to a large extent, on the reliability and reach of electricity supply. In settings marked by frequent outages, digital transactions are more likely to fail or be delayed, which can erode confidence and prompt more cautious liquidity management.

The interaction models make this conditional relationship more explicit. In MIDAS Model (4), the coefficient on digital banking is negative, while the interaction term with T&D losses is positive. Interpreted in isolation, the negative coefficient could appear counterintuitive. However, it reflects the effect evaluated at zero T&D losses—a value that does not occur in the data and is not economically meaningful in the Nigerian context. For this reason, the coefficient should not be read as a standalone effect. A more informative approach is to consider the marginal effects across observed levels of energy inefficiency.

Table 3 provides this additional perspective. When evaluated at low levels of T&D losses, the marginal effect of digital banking on liquidity is negative (-0.27). Around the sample mean, the effect becomes negligible (-0.06), and at higher levels of losses, it turns slightly positive (0.04).

What this pattern suggests is not that digital banking is inherently harmful to liquidity, but that its impact shifts with the energy environment. As inefficiencies in power supply increase, the initially negative effect is gradually offset, revealing a relationship that is both non-linear and context-dependent. Put differently, the role of digital banking cannot be separated from the infrastructural conditions under which it operates.

It is also worth noting that the interaction terms are estimated without mean-centering. As a result, the main coefficient captures the effect at the zero value of the interacting variable. Given that such a value lies outside the observed range, marginal effects provide a more meaningful basis for interpretation in this setting.

A similar pattern appears in the alternative specifications. For electricity access, the marginal effect of digital banking remains positive throughout, but declines as access improves from 0.41 at lower levels to 0.18 at higher levels indicating diminishing marginal gains. In the case of the composite Energy Constraint Index, the effect is strongest when constraints are relatively mild (0.33) and weakens as those constraints intensify (0.09). These results reinforce the broader point that average coefficients can obscure important variation, particularly when interactions are involved.

These findings suggest that digitalisation on its own is not sufficient to stabilise liquidity conditions. Where energy infrastructure is weak, the effectiveness of digital banking is limited and may even introduce additional sources of volatility through operational disruptions. The fact that this pattern holds across different measures of energy constraints lends credibility to the results.

From a policy standpoint, the implication is fairly direct. Efforts to deepen digital financial systems are unlikely to yield their full benefits in the absence of reliable electricity supply. Investments in power generation, transmission efficiency, and access expansion therefore complement, rather than substitute for, financial sector reforms.

Finally, while graphical representations of marginal effects could provide additional intuition, the tabular presentation in Table 3 offers a transparent view of how the estimated relationships evolve across different energy conditions. The evidence points to a clear conclusion: the liquidity effects of digital banking are closely tied to the energy environment. Where infrastructure is supportive, digital finance enhances liquidity. Where constraints persist, those gains are reduced and, in some cases, reversed. This underscores the need to consider financial innovation and infrastructure development jointly when assessing financial stability outcomes.

Table 2: Empirical Estimates from Baseline Model and MIDAS Models

Model Type	Model without interaction terms				Model with interaction term			Lag	PDL01	PDL02
	DBI	TDL	EA	ECI	DBI*TDL	BDI*EA	DBI*ECI			
Baseline Model	0.1134*** (0.0172)							**N/A**		
MIDAS Model (1)	-0.2563*** (0.0579)	-1.0052*** (0.1110)						4	-1.3905*** (0.1504)	0.3852*** (0.0524)
MIDAS Model (2)	0.1577*** (0.0590		0.9044*** (0.1547)					4	1.4971*** (0.2547)	-0.5926*** (0.1003)
MIDAS Model (3)	0.2885*** (0.0798)			-2.5659*** (0.2628)				4	-4.4829*** (0.4463)	1.9170*** (0.1942)
MIDAS Model (4)	-3.7890*** (1.3757)	-4.0739*** (1.0173)			0.2557*** (0.0938)			2	-7.8643*** (1.8172)	3.7903*** (0.8335)
MIDAS Model (5)	0.7263*** (0.2337)		1.1044*** (0.4311)			-0.0282** (0.0112)		4	1.7904*** (0.2763)	-0.6860*** (0.1054)
MIDAS Model (6)	0.1819** (0.0617)			-1.5073*** (**0.4602**)			-0.1711*** (0.0617)	4	-3.0329*** (0.6812)	1.5256*** (0.2367)
Residual-based Diagnostic Tests										
Normality Test (Jarque-Bera)	0.2230 (0.8945)	2.8254 (0.7861)	2.5840 (0.5179)	2.6970 (0.6377)	0.0471 (0.8834)	0.0148 (0.9631)	2.2956 (0.2735		0.0216 (0.9464)	3.4797 (0.4558)
Autocorrelation Test (Q-Stat.)	7.9077 (0.8034)	2.4475 (0.4567)	1.1823 (0.8105)	5.1107 (0.8626)	9.9476 (0.4460)	9.6765 (0.6187)	0.2014 (0.1337)		6.84546 (0.5366)	3.7573 (0.8044)

Note: This table presents results from both the baseline and MIDAS models examining how digital banking affects bank liquidity in Nigeria. The baseline specification includes only the monthly Digital Banking Index (DBI) and Credit-to-Bank Liquidity Index (CBLI), **with “N/A”**

indicating that lag structures are not applicable in this simpler setup. In contrast, the MIDAS models extend the analysis by incorporating annual energy constraint variables—Transmission and Distribution losses (TDL), Electricity Access (EA), and a composite Energy Constraint Index (ECI)—which are distributed into monthly frequencies using a second-degree Almon polynomial lag structure. This allows the annual energy measures to be properly aligned with the higher-frequency banking data. The models also include interaction terms to test whether energy constraints influence the relationship between digital banking and liquidity conditions. The overall effect of each explanatory variable is derived by summing the coefficients of the two polynomial components (PLD01 and PLD02), based on the Wald test results. Lag lengths are chosen according to the optimal specification for each variable. Standard errors are reported in parentheses, while ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Marginal Effects of Digital Banking on Bank Liquidity across Alternative Energy Constraint Measures

Model	Energy Variable	Marginal Effect Expression	Low Level	ME (Low)	Mean Level	ME (Mean)	High Level	ME (High)
MIDAS Model (4)	T&D Losses (TDL)	-3.7890 + 0.2557·TDL	13.77	-0.27	14.61	-0.06	14.99	0.04
MIDAS Model (5)	Electricity Access (EA)	0.7263 − 0.0282·EA	11.20	0.41	15.80	0.28	19.50	0.18
MIDAS Model (6)	Energy Constraint Index (ECI)	0.1819 − 0.1711·ECI	-0.88	0.33	-0.20	0.22	0.51	0.09

Note: Marginal effects are derived from the estimated coefficients reported in Table 2. In each model specification, the effect of digital banking intensity (DBI) on bank liquidity is allowed to vary with the relevant energy constraint measure, namely; transmission and distribution (T&D) losses, electricity access, and the composite Energy Constraint Index (ECI). To make the results more interpretable, the reported marginal effects are evaluated at three representative points of each moderating variable: the minimum, mean, and maximum values observed in the sample.

5. CONCLUSIONS

This study investigates the relationship between digital banking and bank liquidity in Nigeria, with a particular focus on how this relationship is shaped by energy constraints. Using a mixed-frequency MIDAS approach, the evidence indicates that greater digital banking intensity is associated with improved bank liquidity. This finding is consistent with the argument that digital financial intermediation enhances transaction efficiency and supports smoother liquidity circulation within the banking system.

However, the results also make clear that this relationship is not uniform across all conditions. Variations in electricity reliability and access significantly influence the extent to which digital banking translates into liquidity improvements. Where electricity supply is more constrained reflected in higher transmission and distribution losses, the positive effect of digital banking on liquidity is noticeably weaker. In contrast, better electricity access is associated with stronger liquidity-enhancing effects of digital financial activity. The interaction effects and marginal analysis further reinforce this pattern, showing that the contribution of digital banking to liquidity is conditional on the quality of underlying energy infrastructure.

These findings suggest that the effectiveness of digital financial innovation is closely tied to the broader infrastructure environment in which it operates. In particular, electricity supply conditions appear to shape not only the efficiency of digital banking channels but also the degree to which these channels can support financial stability outcomes. As such, energy constraints should not be treated as peripheral issues in analyses of financial sector development, but rather as integral factors that influence the performance of digital finance.

From a contribution standpoint, the study brings together two strands of literature that are often treated separately: digital finance and energy economics. By explicitly incorporating energy indicators into the analysis of bank liquidity, it demonstrates that infrastructure conditions form an important part of the transmission mechanism through which financial innovation affects liquidity outcomes. Methodologically, the application of the MIDAS framework also adds value by allowing for a coherent integration of mixed-frequency data, which is particularly relevant in contexts where financial and infrastructure variables are observed at different temporal scales.

The implications of the findings extend beyond Nigeria. In many developing economies, the expansion of digital financial services is occurring alongside persistent weaknesses in electricity infrastructure. In such environments, the anticipated gains from digital banking in terms of financial deepening and stability may be constrained unless complementary improvements in energy supply are achieved. Strengthening electricity reliability and access may therefore be a necessary condition for fully realising the benefits of digitalisation in the financial sector.

Future research could build on these results in several ways. Micro-level analyses using bank or firm data could help to better identify the transmission channels through which energy constraints influence financial outcomes. Further work may also explore potential non-linear dynamics in greater depth, as well as the role of alternative energy sources, including decentralised and renewable energy systems, in supporting digital financial infrastructure.

6. POLICY IMPLICATIONS

The results of this study carry several implications for financial regulation, energy policy, and broader institutional coordination in Nigeria and comparable energy-constrained developing economies. A key message emerging from the analysis is that while digital banking supports bank liquidity and contributes to financial stability, its effectiveness is not independent of the energy environment. In particular, the reliability and reach of electricity supply appear to condition the extent of these gains. This points to an important qualification: financial digitalisation cannot be considered in isolation from infrastructural development.

From a regulatory standpoint, the findings suggest that digital banking, on its own, may not function as a fully reliable liquidity-stabilisation tool. Regulatory authorities such as the Central Bank of Nigeria may therefore need to place greater emphasis on operational risks linked to energy disruptions when evaluating bank resilience. This could involve incorporating electricity-related shocks into liquidity stress-testing frameworks, especially given the increasing dependence of banks on electronic payment systems and digital settlement platforms. In a similar vein, regulatory support for fintech expansion may need to be more closely aligned with infrastructure realities to avoid unintended vulnerabilities arising from system-wide disruptions.

From the perspective of energy policy, the results extend the relevance of electricity reforms beyond their traditional focus on production and household welfare. Improvements in electricity reliability particularly reductions in transmission and distribution losses alongside broader access expansion, appear to support the smooth functioning of digital financial systems. In this sense, the financial sector emerges as an additional transmission channel through which energy reforms can contribute to macroeconomic stability. Although these reforms are typically evaluated in terms of industrial productivity or household welfare, the evidence here suggests that their effects also extend to the stability of banking system liquidity.

The findings further highlight the importance of policy coordination across traditionally separate domains. In practice, financial regulation, digital innovation strategies, and energy infrastructure planning are often designed in parallel rather than in an integrated manner. The results of this study suggest that such separation may limit policy effectiveness. A more coordinated approach particularly one that recognises the interdependence between electricity reliability and digital financial operations could improve outcomes. For instance, prioritising energy stability in major financial and commercial hubs may help reduce disruptions in digital payment systems and support more stable liquidity conditions in the banking sector.

7. ACKNOWLEDGEMENTS

Policy Recommendation

The Central Bank of Nigeria (CBN) should incorporate electricity related disruptions into its prudential supervision and liquidity risk management frameworks. As banks increasingly rely on digital channels for transactions and liquidity management, supervisory stress-testing and operational resilience assessments should consider scenarios involving power outages, grid failures, and telecommunications disruptions. This would enable financial institutions to better identify vulnerabilities, strengthen contingency planning, and maintain liquidity stability during infrastructure related shocks.

Policymakers should establish a coordinated framework involving financial regulators, energy authorities, and digital infrastructure stakeholders to ensure that financial digitalisation is supported by reliable electricity infrastructure. Such coordination should prioritize electricity reliability in key financial and commercial hubs, align digital financial inclusion initiatives with infrastructure development plans, and promote investments that enhance the resilience of digital payment and banking systems. This integrated approach would maximize the benefits of digital banking while reducing systemic risks associated with energy constraints.

References

1) Adeola, O., & Evans, O. (2020). Digital finance and economic development in Africa. Technology in Society, 61, 101–247. https://doi.org/10.1016/j.techsoc.2020.101247

2) Allcott, H., Collard-Wexler, A., & O'Connell, S. (2016). How do electricity shortages affect industry? Evidence from India. American Economic Review, 106(3), 587–624. DOI: 10.1257/aer.20140389

3) Baltensperger, E. (1980). Alternative approaches to the theory of the banking firm. Journal of Monetary Economics, 6, 1-37. https://doi.org/10.1016/0304-3932(80)90016-1

4) Bank for International Settlements (BIS). (2018). Sound practices: Implications of fintech developments for banks and bank supervisors. Basel: BIS. https://www.bis.org/bcbs/publ/d431.htm

5) Banna, H., Kabir Hassan, M., & Rashid, M. (2021). Fintech-based financial inclusion and bank risk-taking: Evidence from OIC countries. Journal of International Financial Markets, Institutions and Money, 75, 101447. https://doi.org/10.1016/j.intfin.2021.101447

6) Beck, T., Chen, T., Lin, C., & Song, F. M. (2016). Financial innovation: The bright and the dark sides. Journal of Banking & Finance, 72, 28–51. https://doi.org/10.1016/j.jbankfin.2016.06.012

7) CBN. (2023). Financial Stability Report. Central Bank of Nigeria. https://www.cbn.gov.ng

8) Diamond, D. W., & Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. Journal of Political Economy, 91(3), 401–419. https://doi.org/10.1086/261155

9) Ezeani, E. (2023). Nigeria's cash crisis and digital payment failures. African Financial Review. https://africanfinancialreview.com/nigeria-cash-crisis

10) Feyen, E., Frost, J., Gambacorta, L., Natarajan, H., & Saal, M. (2021). Fintech and the digital transformation of financial services: Implications for market structure and public policy (BIS Papers No. 117). Bank for International Settlements.

11) Frost, J., Gambacorta, L., Huang, Y., Shin, H. S., & Zbinden, P. (2019). BigTech and the changing structure of financial intermediation. Economic Policy, 34(100), 761–799. https://doi.org/10.1093/epolic/eiaa003

12) Gorton, G., & Metrick, A. (2012). Getting up to speed on the financial crisis: A one-weekend-reader's guide. Journal of Economic Literature, 50(1), 128–150. https://doi.org/10.1257/jel.50.1.128

13) IEA. (2023). Energy and digital financial services in emerging markets. International Energy Agency. https://www.iea.org

14) King, I. (2023). Cash Shortage in Nigeria Sees Fintechs and Supermarkets Record Massive Gains. Available online at https://investorsking.com/2023/03/25/cash-shortage-in-nigeria-sees-fintechs-and-supermarkets-record-massive-gains/

15) Mukalayi, N.M. & Inglesi-Lotz, R. (2025). Empowering communities: how digital financial inclusion is driving energy consumption in Sub-Saharan Africa. Research Square DOI: https://doi.org/10.21203/rs.3.rs-7907104/v1

16) Mukalayi, N. M., & Inglesi-Lotz, R. (2023). Digital Financial Inclusion and Energy and Environment: Global Positioning of Sub-Saharan African Countries. Renewable and Sustainable Energy Reviews, 173, Article ID: 113069. https://doi.org/10.1016/j.rser.2022.113069

17) Nwani, C. (2021). Taking Venezuela back to the sustainability path: The role of financial development and economic integration in low-carbon transition. Natural Resources Forum, 45(1), 37–62. https://doi.org/10.1111/1477-8947.12212

18) Ozili, P. (2018). Digital finance, financial inclusion and financial stability. Borsa Istanbul Review, 18(4), 329-340 https://doi.org/10.1016/j.bir.2017.12.003

19) Pan, L., Dwumfour, R. A., & Kheng, V. (2022). Lightening the path to financial development: The power of electricity. Munich Personal RePEc Archive ((MPRA) Paper No. 119997.

20) Roubaud, D., & Shahbaz, M. (2018). Financial development, economic growth, and electricity demand: A sector analysis of an emerging economy. Munich Personal RePEc Archive (MPRA) Paper No. 87212.

21) Sahay, R., Eriksson von Allmen, U., Lahreche, A., Khera, P., Ogawa, S., Bazarbash, M., & Beaton, K. (2020). The promise of fintech: Financial inclusion in the post-COVID-19 era. International Monetary Fund. https://doi.org/10.5089/9781513555189.087

22) Shahbaz, M., Hoang, T. H. V., Mahalik, M. K., & Roubaud, D. (2017). Energy consumption, financial development and economic growth in India: New evidence from a nonlinear and asymmetric analysis. Energy Economics, 63, 199–212. https://doi.org/10.1016/j.eneco.2017.01.023

23) Tzoumas, I. (2022). Quantifying the Impact of Energy Prices on Financial Stability. Lund University Libraries.

24) World Bank. (2020). Doing business 2020: Comparing business regulation in 190 economies. Washington, DC: World Bank.