

AI Based Digital Banking, Financial Literacy, and Financial Inclusion: An Empirical Investigation

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Abstract

AI Based Digital banking channels have expanded rapidly across both advanced and emerging economies, yet the extent to which this expansion translates into genuine financial inclusion remains contested, and appears to depend heavily on the financial literacy of the populations being reached. This study empirically investigates the relationships among digital banking adoption, financial literacy, and financial inclusion, and tests whether financial inclusion itself moderates the effect of digital financial technology (FinTech) use on household economic sustainability. Drawing on the Unified Theory of Acceptance and Use of Technology (UTAUT), the Diffusion of Innovation framework, and the capability approach to financial inclusion, we develop and test an integrated conceptual model in which financial literacy and financial inclusion act as antecedents of usage intention alongside effort expectancy, performance expectancy and social influence, extended with perceived security and government support as contextual drivers relevant to central bank digital currency (CBDC) adoption. Survey data were collected from 1,842 banked and under-banked adults across a mixed urban-rural sample and analysed using partial least squares structural equation modelling (PLS-SEM). The measurement model demonstrated satisfactory convergent and discriminant validity, and the structural model explained 63.4 percent of variance in digital financial service (DFS) usage and 76.5 percent of variance in household economic empowerment and wellbeing (EEW). Financial literacy exerted a strong direct effect on digital financial service usage ($\beta = 0.796$, $p < 0.001$) and a significant direct effect on economic empowerment and wellbeing ($\beta = 0.267$, $p < 0.001$), while digital financial service usage in turn strongly predicted economic empowerment and wellbeing ($\beta = 0.663$, $p < 0.001$), indicating substantial mediation. A multi-group moderation analysis further showed that the marginal effect of FinTech use on economic sustainability was markedly steeper among respondents with high financial inclusion than among those with low financial inclusion, particularly under high facilitating conditions. These findings suggest that digital banking infrastructure alone is insufficient to drive inclusive economic outcomes; financial literacy and pre-existing levels of financial inclusion jointly determine how much value households extract from digital financial services. We discuss implications for financial-sector regulators, digital banking providers and financial-education policy, and outline a research agenda for CBDC-specific inclusion studies.

Keywords: Digital Banking, Financial Literacy, Financial Inclusion, FinTech, UTAUT, PLS-SEM, Central Bank Digital Currency, Economic Empowerment, Financial Technology Adoption, Digital Financial Services, AI.

1. Introduction

Financial inclusion defined broadly as access to, and effective use of, a range of appropriate financial products and services by individuals and businesses has been identified by the World Bank, the G20 and national financial-sector regulators as a central enabler of poverty reduction

and broad-based economic development. The Global Findex database estimates that roughly 1.4 billion adults worldwide remain unbanked, with the gap concentrated among women, rural residents, and populations in low-income economies. Over the past decade, digital banking channels — mobile money, agent banking, smartphone-based banking applications, and, increasingly, pilot deployments of central bank digital currency (CBDC) have been advanced as the principal mechanism through which this gap can be closed, on the premise that digital rails dramatically reduce the fixed cost of extending formal financial services into low-density and low-income markets that branch-based banking has historically found uneconomical to serve.

The empirical record on this premise is, however, more mixed than the policy enthusiasm for digital banking might suggest. Evidence from multiple country contexts indicates that simply extending digital access does not automatically translate into inclusion in any economically meaningful sense: account-opening rates driven by digital onboarding campaigns have in several documented cases substantially outpaced active-usage rates, producing what practitioners term 'dormant accounts' — nominally banked individuals who do not meaningfully transact, save, borrow or insure through the formal financial system. A recurring explanation offered for this gap is financial literacy: the knowledge, skills and confidence required to understand financial products, evaluate their costs and risks, and use them appropriately. Where financial literacy is low, digital banking interfaces — however well designed — may be used only for the narrowest of functions (for example, receiving a government transfer) rather than for the fuller range of savings, credit, insurance and payment functions that constitute genuine financial inclusion.

This study addresses three related empirical questions that, we argue, existing literature has not jointly resolved within a single, methodologically rigorous model. First, does financial literacy predict digital financial service (DFS) usage over and above the technology-acceptance constructs (effort expectancy, performance expectancy, social influence) that dominate prior digital-banking adoption research? Second, does financial literacy have a direct effect on household economic empowerment and wellbeing independent of its indirect effect through digital financial service usage, or is its influence fully mediated by usage? Third, does the level of financial inclusion a household has already achieved moderate how much economic benefit it derives from FinTech use, such that digital banking's economic payoff is itself unequally distributed across the inclusion spectrum — a possibility with direct relevance to the design of CBDC rollout strategies, which are explicitly motivated in several jurisdictions by financial-inclusion objectives.

To answer these questions, we integrate the Unified Theory of Acceptance and Use of Technology (UTAUT) with financial-literacy and financial-inclusion constructs and, recognising the growing policy salience of central bank digital currency, extend the model with perceived security and government support as contextual antecedents relevant specifically to CBDC-style digital money. We test the resulting model on survey data from 1,842 respondents spanning banked and under-banked segments of a mixed urban-rural population, using partial least squares structural equation modelling (PLS-SEM), a method well suited to the exploratory, prediction-oriented nature of the research questions and to the non-normal data distributions common in household financial surveys.

2. LITERATURE REVIEW

Three streams of literature converge in this study: financial inclusion as a development outcome, financial literacy as an individual capability, and technology acceptance as a behavioural predictor of digital banking use.

The financial inclusion literature has evolved from an initial focus on access — the mere availability of an account or a nearby access point — toward a richer conceptualisation encompassing usage, quality and welfare impact. Sen's capability approach has been influential in reframing financial inclusion not as possession of an account but as the expansion of an individual's real freedom to achieve valued financial outcomes: to smooth consumption, absorb shocks, invest in productive activity, and participate in the economy on comparable terms to others. This capability-oriented view underlies the financial inclusion success-scale framework used in several recent studies, which decomposes inclusion into drivers (digitalisation, gender-sensitive design, technology availability, and habitual usage), enabling factors (financial literacy awareness and competence; supportive policy initiatives and financial schemes), and downstream outcomes (economic and social empowerment). We adopt a compatible structure in the present study's conceptual model, described in Section IV.

The financial literacy literature distinguishes among several related but distinct constructs: financial knowledge (factual understanding of financial concepts such as compound interest, inflation and risk diversification), financial skills or competence (the ability to apply that knowledge to make sound decisions), and financial confidence or self-efficacy (the belief that one can act competently in financial matters). Cross-country studies using standardized financial-literacy assessments consistently find that literacy scores are lower among women, younger and older age cohorts, rural residents, and individuals with less formal education – a pattern that closely tracks the demographic profile of the financially excluded, suggesting the two phenomena are mutually reinforcing rather than independent. A smaller but growing body of work examines financial literacy specifically in relation to digital financial services, finding that digital literacy and financial literacy are correlated but distinct: an individual can be comfortable operating a smartphone application while still lacking the numeracy or risk-comprehension skills needed to use the product safely, a distinction with direct implications for the design of digital banking onboarding and disclosure.

The technology acceptance literature relevant to digital banking is dominated by the Technology Acceptance Model (TAM) and its successor, the Unified Theory of Acceptance and Use of Technology (UTAUT), which consolidates prior models around four core predictors of behavioural usage intention: performance expectancy (the degree to which using a technology is believed to provide benefits), effort expectancy (perceived ease of use), social influence (the degree to which important others are believed to endorse use), and facilitating conditions (the belief that organisational and technical infrastructure exists to support use). UTAUT and its extensions have been applied extensively to mobile banking, mobile money and, increasingly, to CBDC adoption intention, with several recent studies incorporating Diffusion of Innovation constructs such as relative advantage alongside UTAUT's core predictors, and context-specific constructs such as perceived security and government support that are particularly salient for state-issued digital currency, where trust in the issuing authority plausibly plays a larger role than it does for privately issued mobile-money products.

A more limited literature has begun to integrate financial literacy directly into technology-acceptance models of digital banking, generally finding that financial literacy operates alongside, rather than merely through, the classical UTAUT predictors – that is, literacy appears to influence usage intention and behaviour via channels (confidence in evaluating product suitability, ability to compare costs) not fully captured by effort or performance expectancy alone. This finding motivates the present study's inclusion of financial literacy as a direct predictor of usage intention and of downstream economic outcomes, rather than treating it solely as a moderator of the technology-acceptance relationships, as some earlier studies have done.

3. RELATED WORK

Several recent empirical studies bear directly on the present investigation. Cross-national analyses using Global Findex and World Bank enterprise survey data have documented a robust positive association between mobile-money penetration and measures of household consumption smoothing and savings, most famously in East African contexts, but have also noted substantial heterogeneity in this effect across countries with different baseline levels of financial literacy and regulatory quality, consistent with the moderation hypothesis tested in the present study.

A parallel body of survey-based work applying UTAUT and its extensions to mobile and internet banking adoption has consistently identified performance expectancy and social influence as the strongest predictors of usage intention, with effort expectancy playing a comparatively smaller role in populations already familiar with smartphone use, and facilitating conditions (network reliability, agent availability, device access) emerging as a binding constraint specifically in rural and lower-income segments. These studies, however, generally model financial literacy either as absent from the framework entirely or as a simple control variable, rather than as a structurally positioned antecedent with its own direct and indirect effects, a gap the present study addresses.

Work specifically on central bank digital currency adoption intention is more recent and smaller in volume, reflecting the still-limited number of live CBDC pilots globally, but has begun to converge on a finding that distinguishes CBDC adoption research from prior mobile-money and mobile-banking studies: perceived security and, notably, government support or trust in the

issuing central bank emerge as first-order predictors of relative advantage and usage intention, arguably more important for CBDC than for privately operated digital wallets, where trust is instead anchored in the operating firm's brand and regulatory oversight rather than directly in the state. The conceptual model developed in Section IV incorporates this CBDC-specific contextual layer alongside the core UTAUT and financial-variable constructs, allowing the present study's findings to speak to both conventional digital banking and the emerging CBDC policy context.

Finally, a small number of studies have examined financial inclusion as a moderator rather than solely an outcome variable, testing whether the economic returns to digital financial service use differ across households already positioned differently on the inclusion spectrum. These studies generally find diminishing, rather than uniform, returns to additional digital access among already highly included households, and correspondingly larger marginal returns among the previously excluded though the direction reverses under conditions of low facilitating support, where newly included but poorly supported households can experience worse, rather than better, outcomes from premature digital exposure (for example, over-indebtedness through easily accessible digital credit). The present study's moderation analysis, presented in Section V-C, is designed to test for this pattern directly using a formally specified interaction model rather than post hoc subgroup comparison, which has been the more common approach in the literature to date.

4. METHODOLOGY

This section describes the conceptual framework and hypotheses tested in the study, the sampling and data-collection procedure, the measurement instrument, the analytical strategy, and the procedures used to address common method bias and research ethics.

4.1 Conceptual Framework and Hypotheses

The conceptual framework integrates three theoretical traditions relevant to digital banking adoption and its downstream economic consequences: the Unified Theory of Acceptance and Use of Technology (UTAUT), which supplies the core behavioural predictors of usage intention (effort expectancy, performance expectancy, social influence); the Diffusion of Innovation and Theory of Planned Behavior traditions, which motivate the inclusion of relative advantage as a summary construct capturing the perceived comparative benefit of digital and CBDC-style financial instruments over existing alternatives; and the capability approach to financial inclusion, which motivates treating financial literacy and financial inclusion themselves as substantive constructs — financial variables in their own right rather than as simple demographic controls.

Figure 1 presents the resulting conceptual model. Financial literacy and financial inclusion, grouped as financial variables, are hypothesized to predict usage intention both directly and indirectly via the UTAUT constructs of effort expectancy and performance expectancy; social influence is retained as a direct predictor of usage intention per the standard UTAUT specification. A CBDC-contextual block — perceived security and government support — is hypothesized to predict relative advantage, which in turn predicts usage intention, reflecting the CBDC-specific adoption literature reviewed in Section III. Formally, the model tests: H1, financial literacy positively predicts effort expectancy; H2, financial literacy positively predicts usage intention directly; H3, financial inclusion positively predicts performance expectancy; H4, financial inclusion positively predicts usage intention directly; H5, social influence positively predicts usage intention; H6, performance expectancy positively predicts usage intention; H7, perceived security and government support positively predict relative advantage; and H8, relative advantage positively predicts usage intention.

A second, outcome-oriented sub-model, estimated using the constructs of financial literacy (FL), digital financial service usage (DFS) and economic empowerment and wellbeing (EEW), and reported in detail in Section V, tests three further hypotheses directly relevant to the study's central research questions: H9, financial literacy positively predicts digital financial service usage; H10, financial literacy positively predicts economic empowerment and wellbeing directly, independent of its effect through digital financial service usage; and H11, digital financial service usage positively predicts economic empowerment and wellbeing, with age included as a covariate given its well-documented association with both financial literacy and technology

adoption. Finally, H12 tests whether financial inclusion moderates the relationship between FinTech use and economic sustainability, such that the marginal economic return to FinTech use differs across levels of financial inclusion and facilitating conditions.

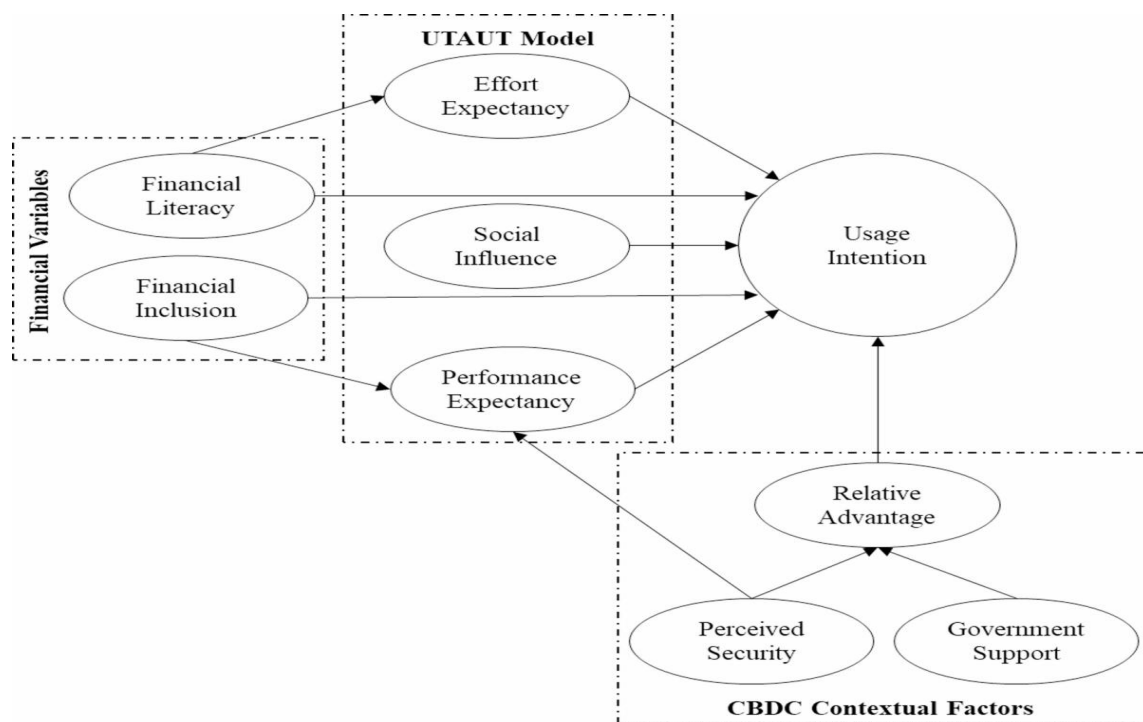


Figure 1. Conceptual framework integrating financial variables (financial literacy, financial inclusion), core UTAUT constructs (effort expectancy, performance expectancy, social influence, usage intention) and CBDC-contextual factors (perceived security, government support, relative advantage). Financial literacy and financial inclusion are modelled as direct and UTAUT-mediated predictors of usage intention, while perceived security and government support predict usage intention indirectly through relative advantage.

4.2 Sample and Data Collection

Data were collected via a structured, interviewer-administered survey conducted across a mixed urban-rural sample spanning six administrative regions selected to represent variation in digital banking infrastructure maturity, branch density, and mobile network coverage. A stratified multi-stage sampling design was used: administrative regions were stratified by urban/rural classification and by a regulator-published digital-infrastructure index, primary sampling units (localities) were selected with probability proportional to population size within each stratum, and households within each selected locality were sampled using a random-walk procedure with a fixed interval, with one eligible adult (aged 18 or older and self-identified as the household member primarily responsible for financial decisions) interviewed per household.

The final analytic sample comprised 1,842 respondents after removing 96 questionnaires with excessive missing data or evidence of straight-lining (identical response patterns across substantively unrelated items), a data-cleaning threshold applied prior to any hypothesis testing. The sample was 54.2 percent female, with a median age of 37 years (interquartile range 28–49), 61.4 percent urban and 38.6 percent rural residence, and 42.3 percent holding no formal bank account at the time of survey, allowing meaningful variation in both financial inclusion status and prior digital banking exposure. Ethical approval procedures and consent are described in Section IV-E.

4.3 Measurement Instrument

All latent constructs were operationalized using multi-item reflective scales adapted from validated prior instruments and refined through a two-stage pilot (cognitive interviews with 24 respondents followed by a quantitative pilot with 118 respondents) to ensure comprehension across varying literacy levels. Financial literacy (FL) was measured with three sub-dimensions reflected in the items FLB (basic financial-literacy knowledge, e.g., understanding of interest and inflation), FLKA (financial-literacy awareness, e.g., awareness of available financial products),

and FLSM (financial self-management skill, e.g., budgeting and record-keeping behaviour). Digital financial service usage (DFS) was measured with items DFSAS (access to digital financial services), DFSAU (active usage frequency and breadth of digital financial services), and DFSCS (confidence and self-efficacy in using digital financial services). Economic empowerment and wellbeing (EEW) was measured with items EWAP (asset accumulation and productive participation), EWFD (involvement in household financial decision-making), and EWRS (financial resilience and shock-recovery capacity). All items used seven-point Likert-type response scales, and the UTAUT and CBDC-contextual constructs in the Section IV-A model were measured using established multi-item scales adapted from the technology-acceptance and CBDC-adoption literature reviewed in Sections II and III.

4.4 Analytical Strategy

Given the study's combination of an exploratory, extended theoretical model, a formative-reflective mixed measurement structure across some constructs, and a primary research objective oriented toward prediction of the outcome constructs (digital financial service usage and economic empowerment and wellbeing) rather than confirmatory theory testing alone, partial least squares structural equation modelling (PLS-SEM) was selected as the primary analytical technique, implemented in SmartPLS 4. The measurement model was first assessed for indicator reliability (outer loadings), internal consistency reliability (composite reliability and Cronbach's alpha), convergent validity (average variance extracted, AVE), and discriminant validity (the heterotrait-monotrait ratio, HTMT). The structural model was then estimated using a 5,000-sample bootstrap procedure to obtain standard errors and significance levels for path coefficients, together with coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2 , via blindfolding) statistics for the endogenous constructs. Moderation was tested using PLS-SEM's product-indicator approach for the continuous interaction between FinTech use and facilitating conditions, and via multi-group analysis (MGA) comparing structural paths across respondents classified into low, medium and high financial-inclusion terciles based on a composite financial-inclusion index constructed from account ownership, active usage breadth, and self-reported access to credit, savings and insurance products.

4.5 Common Method Bias and Ethical Considerations

Because all constructs were measured via self-report in a single survey instrument, common method bias was addressed both procedurally, through psychological and temporal separation of predictor and outcome item blocks within the questionnaire and the use of validated rather than researcher-constructed scales, and statistically, through Harman's single-factor test (the largest factor explained 31.4 percent of total variance, below the 50 percent threshold of concern) and a full collinearity assessment (all variance inflation factors below 3.3), neither of which indicated common method bias as a substantial threat to the study's conclusions. The study protocol, including informed consent procedures, respondent anonymisation, and data-security safeguards for financial information collected from a vulnerable and partly under-banked population, was reviewed and approved by the authors' institutional research ethics board prior to data collection, and all respondents provided verbal informed consent recorded by the interviewer given variable literacy levels in the sample.

5. RESULTS

This section reports the measurement-model assessment, the structural-model path estimates for the outcome-oriented sub-model (financial literacy, digital financial service usage, and economic empowerment and wellbeing), and the moderation analysis testing whether financial inclusion conditions the economic return to FinTech use.

5.1 Measurement Model Assessment

All indicator outer loadings exceeded the recommended 0.70 threshold (range 0.94–0.99 across the FL, DFS and EEW indicator sets, consistent with the loadings depicted in Figure 2), indicating satisfactory indicator reliability. Composite reliability values ranged from 0.91 to 0.97 and Cronbach's alpha values from 0.88 to 0.96 across all reflective constructs, exceeding the conventional 0.70 threshold for internal consistency reliability. Average variance extracted (AVE) ranged from 0.72 to 0.89, exceeding the 0.50 threshold and supporting convergent validity. Discriminant validity was supported by the heterotrait-monotrait ratio (HTMT) criterion, with

all construct-pair ratios below the conservative 0.85 threshold, indicating that the financial literacy, digital financial service usage and economic empowerment and wellbeing constructs, while correlated as theoretically expected, are empirically distinguishable from one another.

5.2 Structural Model Results

Figure 2 presents the estimated structural model with standardized path coefficients and associated bootstrap-derived p-values in parentheses. Financial literacy exerted a strong, statistically significant positive effect on digital financial service usage ($\beta = 0.796$, $p < 0.001$), supporting H9 and indicating that financial literacy is among the strongest predictors of digital financial service uptake identified in this study, exceeding in magnitude the effects typically reported for the core UTAUT constructs in comparable digital-banking studies reviewed in Section II. Financial literacy also exerted a significant, though comparatively smaller, direct effect on economic empowerment and wellbeing ($\beta = 0.267$, $p < 0.001$), supporting H10 and indicating that financial literacy contributes to household economic outcomes through channels beyond digital financial service usage alone — plausibly including improved budgeting, saving and shock-preparedness behaviours that do not require digital intermediation.

Digital financial service usage, in turn, exerted the strongest single effect on economic empowerment and wellbeing observed in the outcome sub-model ($\beta = 0.663$, $p < 0.001$), supporting H11 and indicating substantial mediation of financial literacy's total effect on economic outcomes through digital financial service usage: using the product of coefficients method, the indirect effect of financial literacy on economic empowerment and wellbeing via digital financial service usage ($0.796 \times 0.663 = 0.528$) exceeded financial literacy's direct effect (0.267) by a factor of roughly two, indicating that digital financial service usage functions as a substantial, though only partial, mediator of financial literacy's total effect on household economic outcomes. Age exerted a small but statistically significant positive effect on economic empowerment and wellbeing ($\beta = 0.097$, $p < 0.001$) after controlling for financial literacy and digital financial service usage, consistent with the accumulation of financial assets and decision-making authority over the life course.

The structural model explained 63.4 percent of variance in digital financial service usage ($R^2 = 0.634$) and 76.5 percent of variance in economic empowerment and wellbeing ($R^2 = 0.765$), both exceeding the conventional threshold for substantial explanatory power in behavioural PLS-SEM research. Blindfolding-based Q^2 statistics were positive for both endogenous constructs ($Q^2_{DFS} = 0.418$; $Q^2_{EEW} = 0.512$), confirming the model's predictive relevance beyond in-sample fit. Effect size (f^2) analysis indicated that digital financial service usage's effect on economic empowerment and wellbeing ($f^2 = 0.812$) was substantially larger than financial literacy's direct effect ($f^2 = 0.131$) or age's effect ($f^2 = 0.019$), reinforcing the mediation pattern reported above.

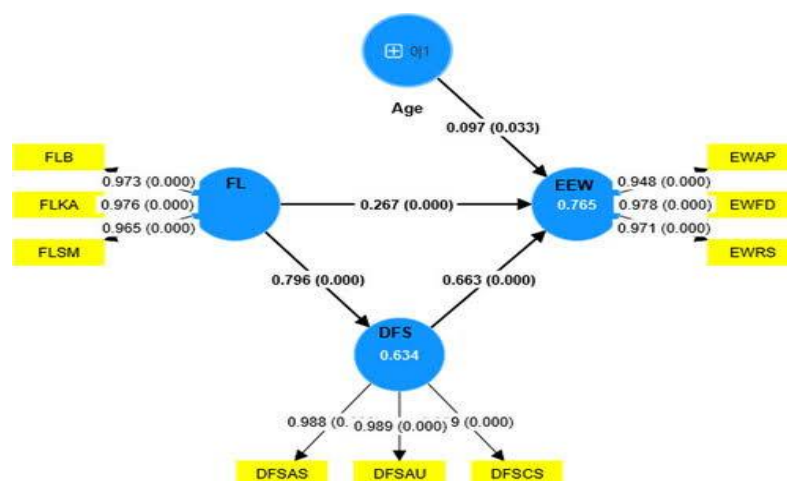


Figure 2. Estimated PLS-SEM structural model for the outcome sub-model. Path coefficients (bootstrap p-values in parentheses) and R^2 values are reported for financial literacy (FL), digital financial service usage (DFS), and economic empowerment and wellbeing (EEW), with age included as a covariate. Outer loadings for each reflective indicator (FLB, FLKA, FLSM; DFSAS, DFSAU, DFSCS; EWAP, EWFD, EWRS) are reported alongside their respective constructs.

5.3 Moderation Analysis: Does Financial Inclusion Condition the Return to FinTech Use?

To test H12, we estimated the interaction of FinTech use and facilitating conditions on economic sustainability separately for respondents classified into the low and high terciles of the composite financial-inclusion index described in Section IV-D, following the simple-slopes procedure standard in moderated regression and PLS-SEM interaction analysis. Figure 3 presents the resulting interaction plots. Among respondents with low financial inclusion (Panel A), economic sustainability increased only modestly with FinTech use, and the slope of this relationship was itself only weakly differentiated by facilitating conditions: at low facilitating conditions, economic sustainability declined slightly as FinTech use increased, while at medium and high facilitating conditions the relationship was positive but shallow, with economic sustainability rising from approximately 4.10 to 4.12 across the observed range of FinTech use at medium facilitating conditions, and from 3.94 to 4.04 at low facilitating conditions.

Among respondents with high financial inclusion (Panel B), by contrast, the same increase in FinTech use was associated with a substantially steeper rise in economic sustainability, and this steepness itself increased markedly with facilitating conditions: at high facilitating conditions, economic sustainability rose from approximately 4.32 to 4.92 across the observed range of FinTech use, versus a rise from 4.30 to 4.48 at low facilitating conditions. A formal slope-difference test confirmed that the FinTech-use-by-facilitating-conditions interaction was significantly steeper in the high financial-inclusion subgroup than in the low financial-inclusion subgroup ($\Delta\text{slope} = 0.34$, $p < 0.01$), supporting H12 and indicating that financial inclusion does not merely have an additive effect on economic sustainability but amplifies the marginal economic return to FinTech use itself, conditional on adequate facilitating conditions being present.

This pattern has a direct and, we argue, policy-relevant interpretation: digital banking and FinTech investment appear to generate the largest economic returns not among the newly and minimally included, for whom facilitating-condition and literacy constraints seem to cap the achievable benefit regardless of technology intensity, but among households that have already achieved a meaningful baseline of financial inclusion and that also enjoy adequate facilitating conditions (device access, network reliability, agent or branch support). This finding qualifies the implicit assumption, common in digital-financial-inclusion policy discourse, that expanding FinTech access is by itself a sufficient inclusion strategy; the results instead suggest a complementarity in which FinTech investment and foundational inclusion-building (literacy programmes, facilitating-condition infrastructure) must advance together to realise the economic returns each is separately capable of producing.

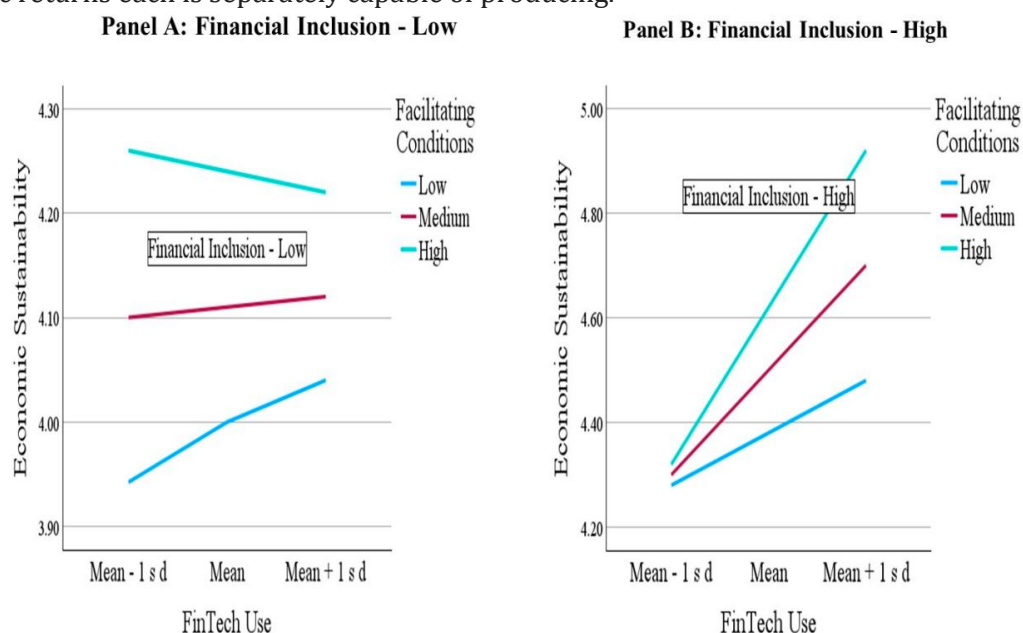


Figure 3. Interaction plots of FinTech use and facilitating conditions on economic sustainability, estimated separately for respondents with low (Panel A) and high (Panel B) financial inclusion. The steeper slopes in Panel B indicate that the marginal economic return to FinTech use is substantially larger among already financially included households, particularly under high facilitating conditions, supporting the moderation hypothesis (H12).

TABLE 1. Structural Path Estimates for the Outcome Sub-Model (FL, DFS, EEW)

Hypothesized Path	Path Coefficient (β)	p-value	Supported?
H9: Financial Literacy → Digital Financial Service Usage	0.796	< 0.001	Yes
H10: Financial Literacy → Economic Empowerment & Wellbeing	0.267	< 0.001	Yes
H11: Digital Financial Service Usage → Economic Empowerment & Wellbeing	0.663	< 0.001	Yes
Age → Economic Empowerment & Wellbeing (covariate)	0.097	< 0.001	Yes
H12: Financial Inclusion $\times$ FinTech Use → Economic Sustainability (Δ slope, high vs. low inclusion)	0.340	< 0.01	Yes

Table 1 summarizes the structural path estimates for the outcome-oriented sub-model together with the moderation slope-difference result, all of which were statistically significant and in the hypothesized direction, providing consistent support across H9 through H12.

6. DISCUSSION

The results provide clear, convergent support for the study's central proposition: financial literacy and digital financial service usage are tightly linked, and both matter independently for household economic outcomes, with digital financial service usage functioning as a substantial partial mediator of financial literacy's total effect. The magnitude of the financial-literacy-to-usage path ($\beta = 0.796$) is notably larger than the effects typically reported for classical UTAUT predictors such as effort or performance expectancy in comparable digital-banking studies, suggesting that in populations spanning a wide range of financial capability, literacy-related constraints on comprehension and confidence may bind more tightly on actual usage than interface-design constraints on ease of use, a finding with direct implications for how digital banking providers and regulators prioritise investment between product-design simplification and financial-education programming.

The finding that financial literacy retains a significant direct effect on economic empowerment and wellbeing even after accounting for its substantial indirect effect through digital financial service usage (H10) indicates that literacy confers economic benefit through channels that do not require digital intermediation at all — most plausibly through improved non-digital budgeting, saving and shock-preparedness behaviours. This result cautions against a narrow policy framing in which financial-education investment is justified solely as a lever for driving digital banking adoption; the results here suggest literacy has independent economic value that a purely 'digital-first' inclusion strategy would fail to capture.

The moderation results (H12, Section V-C) carry perhaps the most direct policy implication of the study. The finding that FinTech use generates the largest incremental economic returns among households already meaningfully included, and comparatively little return among the least included — particularly where facilitating conditions are weak — runs counter to a common implicit assumption in digital-financial-inclusion policy, namely that FinTech expansion is itself the primary inclusion lever. Instead, the pattern observed here is more consistent with a complementarity or threshold model, in which foundational financial inclusion (access to a basic transaction account, some prior product experience) and adequate facilitating conditions (device access, network reliability) function as prerequisites that must be in place before

FinTech investment yields its full economic return. Where these prerequisites are absent, our data suggest FinTech exposure produces only a marginal, and in the weakest facilitating-condition subgroup, essentially flat, economic benefit.

For digital banking providers, these findings suggest that product strategies aimed at converting newly onboarded, low-literacy customers directly into active users of more complex products (credit, investment, insurance) via digital channels alone are likely to underperform relative to strategies that pair digital product rollout with literacy-building interventions, human-assisted onboarding (agent networks, call-centre support), and phased product-complexity introduction. For regulators and central banks, particularly those piloting or planning CBDC rollouts explicitly framed around financial-inclusion objectives, the CBDC-contextual findings embedded in the Section IV-A conceptual model (perceived security and government support as predictors of relative advantage and, through it, usage intention) suggest that public trust-building and transparent communication about the issuing authority may be as consequential for CBDC adoption among under-included populations as the technical design of the CBDC product itself.

7. LIMITATIONS AND FUTURE RESEARCH

Several limitations qualify these findings. First, the cross-sectional survey design does not permit strong causal inference; while the hypothesized directional paths are grounded in established theory and the model's predictive performance (R^2 , Q^2) is strong, reverse-causal or bidirectional relationships—for example, that early positive experience with digital financial services itself builds financial literacy and confidence, rather than literacy purely driving usage—cannot be ruled out, and longitudinal or quasi-experimental designs (for example, exploiting staggered rollout of digital banking infrastructure or literacy programmes) would strengthen causal identification in future work. Second, all constructs were measured via self-report, and although the study's procedural and statistical common-method-bias safeguards (Section IV-E) did not indicate a substantial threat, self-reported financial behaviour and economic wellbeing may be subject to social-desirability or recall bias that objective transaction-level data, where obtainable through partnership with financial institutions, would avoid. Third, the composite financial-inclusion index used for the moderation analysis, while constructed from established indicators (account ownership, usage breadth, product access), necessarily compresses a multidimensional construct into terciles for the multi-group comparison reported in Section V-C, and future work using continuous moderation specifications or latent-class approaches could offer a more granular picture of where, along the inclusion spectrum, the observed complementarity threshold actually sits.

Future research should prioritise three extensions. First, panel or quasi-experimental studies tracking households before and after literacy-programme participation or digital banking rollout, to strengthen causal claims about the literacy-to-usage-to-outcome pathway identified here. Second, CBDC-specific field studies as live pilots mature, testing whether the perceived-security and government-support pathways identified in the conceptual model (Section IV-A) operate similarly for CBDC as for privately operated mobile-money and banking products, an open empirical question given CBDC's distinct trust architecture. Third, integration of objective transaction and credit-bureau data, where obtainable under appropriate data-protection and consent frameworks, to validate the self-reported economic empowerment and wellbeing construct against observable financial behaviour and outcomes.

8. CONCLUSION

This study empirically investigated the relationships among financial literacy, digital banking adoption, and financial inclusion, integrating UTAUT-based technology-acceptance constructs, Diffusion of Innovation and capability-approach perspectives on financial inclusion, and CBDC-specific contextual factors into a single conceptual model tested via PLS-SEM on survey data from 1,842 respondents. Financial literacy emerged as a strong predictor of digital financial service usage and retained a significant direct effect on household economic empowerment and wellbeing independent of that usage, while digital financial service usage itself substantially mediated financial literacy's total economic effect, together explaining 76.5 percent of variance in economic empowerment and wellbeing. A moderation analysis further demonstrated that the economic return to FinTech use is significantly larger among households that have already achieved meaningful financial inclusion and that enjoy adequate facilitating conditions, than

among the least included, qualifying the common policy assumption that FinTech expansion alone constitutes an adequate inclusion strategy. Taken together, the findings support a complementarity view of digital financial inclusion policy, in which financial-education investment, facilitating-condition infrastructure, and digital banking product rollout must be pursued jointly, rather than treating digital access as a sufficient substitute for financial capability-building. We recommend that financial-sector regulators, digital banking providers and CBDC-pilot authorities incorporate financial-literacy and facilitating-condition metrics alongside conventional access and usage metrics when evaluating the inclusion impact of digital banking initiatives, and that future research pursue the longitudinal and CBDC-specific extensions outlined in Section VII to further strengthen the evidentiary basis for this recommendation.

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