

Uneven Pathways to Financial Inclusion: Physical and Digital Infrastructure in Cambodia, 2008–2023

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Abstract:

Cambodia expanded both conventional and digital financial channels between 2008 and 2023, but the extent to which these developments corresponded with different forms of financial participation remained unclear. This study examines the development of branches, automated teller machines, point-of-sale terminals, mobile-money agent outlets and internet usage and assesses their relationships with deposit accounts, loan accounts and active mobile-money accounts. Annual national data were analysed descriptively in levels for 2008–2023. Six ordinary least squares models used 15 annual changes for 2009–2023, with coefficient inference based on one-lag Newey–West heteroskedasticity- and autocorrelation-consistent standard errors. All infrastructure and inclusion indicators ended the period above their 2008 values, although their paths differed. In the physical models, branch and ATM growth were positively associated with deposit-account changes, while only branch growth was associated with loan-account changes. In the digital models, POS growth was positively associated with deposit-account changes. No selected digital indicator was significantly associated with loan-account changes. Internet growth had a negative coefficient for active mobile-money accounts, but the joint model evidence was marginal and requires caution. Mobile-money agent growth was not individually significant in any model. The findings provide partial support for both hypotheses and show that infrastructure–inclusion relationships differ across delivery channels and participation measures. Cambodia’s financial-inclusion policies should therefore combine complementary physical and digital infrastructure with measures addressing affordability, documentation, user capability, service reliability and effective adoption. The estimates represent associations rather than causal effects.

Keywords: Cambodia, Digital Finance, Financial Inclusion, Financial Infrastructure.

1. INTRODUCTION

Financial inclusion depends not only on the presence of financial institutions but also on whether households and businesses can open accounts, obtain credit, make payments and use other formal services. Branches and automated teller machines (ATMs) have traditionally connected customers with financial

institutions, while point-of-sale (POS) terminals, mobile-money agents, internet access and electronic payment systems have broadened the available channels. Global Findex surveys document growth in account ownership and in the use of accounts for payments, saving and borrowing across developing economies [1], [2]. Infrastructure expansion, however, does not imply that every dimension of financial inclusion develops in the same way.

Conventional and technology-based channels perform different functions. The channels do not offer equivalent forms of access. The choice of channel often depends on the task: paperwork and staff consultation are generally handled at branches, whereas an ATM is sufficient for withdrawing cash or carrying out a basic transaction. Some services can be accessed remotely through digital channels, although availability does not necessarily lead to adoption. Mobile-money systems are also influenced by pricing, regulation and market structure [3]. Evidence from lower-middle-income ASEAN economies connects digitalisation with financial inclusion [4], but regional findings cannot determine whether physical and digital infrastructure correspond differently with deposit, credit and mobile-money participation within an individual country.

Cambodia provides a relevant setting for this comparison. Between 2008 and 2023, branches and ATMs remained part of the financial network while POS terminals, mobile-money agents and internet connectivity expanded [5]–[8]. Financial inclusion also became a national policy priority. Cambodia formalized this priority through the National Financial Inclusion Strategy 2019–2025, which set national directions for broader participation in formal financial services [9]. In 2020, Bakong added an interoperable payment arrangement intended to improve interconnectivity, efficiency, speed and security among participating institutions and payment-service providers [10]. Cambodia's development therefore reflects the coexistence of physical and digital channels rather than the complete replacement of one by the other.

Previous Cambodian studies provide important but incomplete evidence. Sam [11] identifies distance, service costs, documentation, trust and financial literacy as barriers to formal saving and credit. Using Cambodian institutional evidence, Khok et al. [12] explore how information technology relates to financial inclusion and financial-sector outcomes. However, limited longitudinal evidence separates physical from digital infrastructure and relates each group to deposit, credit and mobile-money participation over a common period.

This study addresses that gap using Cambodian data for 2008–2023. The physical-infrastructure group contains branch and ATM density, with both indicators expressed for every 100,000 adults. The digital group consists of POS-terminal density per 1,000 adults, mobile-money agent density per 100,000 adults and the share of the population using the internet. Three account-based outcomes are examined separately: deposits, loans and active mobile-money accounts, each reported for every 1,000 adults. The level series describe developments across the complete period, whereas regressions in first differences assess contemporaneous movements from 2009 to 2023. As the analysis uses observational annual data, the estimated relationships should not be read as evidence of causation.

By retaining separate infrastructure and participation indicators within one national setting, the study identifies which relationships are supported and whether their patterns vary across conventional and digital

channels. Three objectives guide the analysis: (1) to trace the development of physical and digital financial infrastructure and financial inclusion in Cambodia during 2008–2023; (2) to examine the relationship between changes in physical financial infrastructure and changes in financial inclusion; and (3) to examine the relationship between changes in digital financial infrastructure and changes in financial inclusion.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Theoretical Foundation: Financial Intermediation, Access and Use

2.1.1 Financial Intermediation and Infrastructure

Financial institutions mobilize deposits, allocate credit and facilitate payments and transfers. Access to these functions partly depends on the channels through which services are delivered. Branches provide direct assistance, documentation and consultation; automated teller machines support cash withdrawals and routine account services; POS terminals enable merchant payments; mobile-money agents facilitate registration and cash-based transactions; and internet connectivity provides access to online platforms.

Infrastructure availability, however, does not ensure financial participation. Beck et al. [13] distinguish the outreach of banking facilities from the use of deposit and credit services. Beck and de la Torre [14] relate financial access to supply- and demand-side constraints, including geographic reach, service costs, product design and user characteristics. Honohan and King [15] examine household saving and borrowing, while Allen et al. [16] identify individual- and country-level differences in formal-account ownership and use. These studies show that delivery channels provide opportunities for participation without determining whether available services are used.

2.1.2 Access versus Actual Use

Availability refers to the presence of service channels, access concerns whether potential users can obtain suitable services, and use involves participation through accounts, saving, borrowing or payments. Financial services may be available but remain inaccessible because of costs, eligibility requirements or institutional conditions [17].

Movement from access to use may also depend on documentation, income, trust, financial capability and digital skills. Allen et al. [16] show that account participation varies with individual circumstances and national conditions. Global Findex distinguishes account ownership from saving, borrowing and payment activity [1], [2], while Pesqué-Cela et al. [18] treat financial inclusion as multidimensional. These distinctions justify using infrastructure as the explanatory concept while retaining deposit, credit and mobile-money participation as separate outcomes.

2.1.3 Transaction Costs and Proximity

Physical and digital channels address different barriers. Branches can reduce the distance involved in obtaining assistance, completing documentation and applying for credit, while ATMs make cash and routine services more convenient. Digital channels allow some payments and transfers to occur without visiting a conventional service point.

Evidence from Kenya shows that M-PESA reduced transaction costs and strengthened household risk sharing across distance [19]. Such outcomes should not be generalized automatically to every service or national context. Aron [20] finds that the consequences of mobile money depend on adoption and local

financial conditions, while Ahmad et al. [3] identify pricing, regulation, market structure and interaction with established institutions as additional influences. Reduced proximity constraints may improve access, but digital availability alone does not establish sustained use.

2.1.4 Uneven Pathways to Financial Inclusion

Taken together, the literature indicates that the relationship between infrastructure and financial inclusion depends on the delivery channel and the form of participation examined. Financial inclusion is multidimensional [18], while the outcomes associated with conventional and digital access vary across services and institutional settings [3], [13], [20]. The study therefore does not assume that infrastructure growth corresponds uniformly with deposit accounts, loan accounts and active mobile-money accounts. This uneven-pathways proposition provides the conceptual basis for evaluating the infrastructure–inclusion relationships separately.

2.2 Physical Financial Infrastructure and Financial Inclusion

Branches and ATMs provide distinct forms of physical access. Branches allow customers to obtain staff assistance, submit documents, open accounts and apply for credit. They are particularly relevant when identification, eligibility checks or borrower assessment is required. Branch coverage forms part of the banking-outreach measures used by Beck et al. [13], while geographic reach and service costs appear among the access constraints discussed by Beck and de la Torre [14]. Allen et al. [16] also connects provider proximity with formal-account participation. In Cambodia, the importance of location must be considered alongside documentation and other barriers affecting formal saving and credit [11]

An ATM gives customers access to cash, account balances and certain basic transactions without requiring the branch to be open. They can make existing accounts more convenient to use but generally cannot provide consultation or process credit applications. An increase in ATM availability is therefore unlikely to have the same relationship with every financial product. Moreover, users may still face costs, documentation and eligibility requirements even when a physical access point is available [17].

These functional differences suggest that the relationship with financial inclusion will depend on the outcome examined. Deposit participation may correspond with easier routine account access, while lending continues to involve documentation and assessment. Active mobile-money accounts rely more directly on mobile devices and agent networks [3]. Global Findex similarly distinguishes account ownership, saving, borrowing and digital payment activity [1]. Physical infrastructure may consequently remain relevant during digital expansion, but its relationship with participation is expected to vary across deposit, credit and mobile-money accounts.

2.3 Digital Financial Infrastructure and Financial Inclusion

2.3.1 Mobile-Money Agent Outlets

Mobile-money agents provide registration, cash-in, cash-out, transfer and payment services beyond conventional branches, extending transaction access to areas with limited institutional coverage. Kenyan evidence links mobile money with lower transaction costs and improved household risk sharing [19], while longer-term access is associated with reduced extreme poverty and changes in women's occupations [21].

These outcomes cannot be attributed to outlet numbers alone. Mobile-money development is also shaped by pricing, regulation, market structure and its interaction with conventional finance [3]. Participation varies with user characteristics and available services [22], and social networks may influence how mobile money relates to financial inclusion [23]. Agent density therefore indicates service reach rather than sustained account use.

2.3.2 POS Terminals

POS terminals allow transaction accounts to be used for merchant payments and may reduce dependence on cash. In the framework presented in [24], payment inclusion involves both access to a transaction account and meaningful use of that account. Global Findex similarly reports account ownership separately from digital merchant payments [2], while Khera et al. [25] distinguish digital access from usage. A wider POS network may therefore increase payment opportunities without producing corresponding growth in deposit or loan accounts. In this study, POS density represents Cambodia's national payment-acceptance environment.

2.3.3 Internet Connectivity

Internet connectivity makes online financial platforms accessible but is not itself a financial service. Use also requires a suitable device, identification, digital capability and confidence in service security. Ozili [26] identifies both the inclusion potential and practical limitations of digital finance. Lenka and Barik [27] find a positive relationship between telecommunications expansion and financial inclusion in SAARC countries, while Ong et al. [4] examine digitalisation and business access to domestic bank credit in lower-middle-income ASEAN economies. These findings establish the relevance of connectivity without implying that internet expansion increases every form of account participation.

Mobile-money agents, POS terminals and internet usage are retained separately because they represent service points, payment acceptance and general connectivity, respectively. Combining them could conceal which part of the digital environment corresponds with each financial-inclusion outcome.

2.4 Coexistence of Physical and Digital Channels

Physical and digital channels operate within the same financial system and may relate through complementarity, partial substitution and functional differentiation. Branches and ATMs represent conventional outreach [13], while agents, POS terminals and internet-enabled services extend where and how transactions can occur.

Complementarity arises when customers use several channels within one financial relationship. An institutionally maintained account may support ATM withdrawals, agent transactions, POS payments and online transfers. The Committee on Payments and Market Infrastructures and World Bank Group [24] similarly place transaction accounts within a wider arrangement of access points, acceptance infrastructure and supporting technology.

Partial substitution occurs when routine payments, transfers or inquiries move away from branches. Ahmad et al. [3] consider the relationship between mobile money and conventional finance, while Aron [20] explains how mobile services can bypass some costs and weaknesses of traditional delivery. Such substitution is more likely to affect particular transactions than the entire financial relationship. Other

activities, including documentation, verification and credit assessment, may continue to require institutional contact.

Because the channels coexist without serving identical purposes, their relationships with deposit accounts, loan accounts and active mobile-money accounts may differ. The empirical analysis therefore estimates physical and digital infrastructure separately rather than combining them into a single delivery system.

2.5 Cambodian Context and Research Gap

Cambodia's physical and digital financial channels developed concurrently during 2008–2023. Branches and ATMs remained part of the service network while POS terminals, mobile-money agents and internet connectivity expanded [5]–[8]. The National Financial Inclusion Strategy 2019–2025 established priorities for widening access to and use of formal services [9], while Bakong introduced an interoperable payment arrangement intended to improve connectivity, efficiency, speed and security among participating providers [10].

Cambodian research has examined particular elements of this transition. Drawing on Cambodia's FinScope survey, Sam [11] reports that formal saving and borrowing are constrained by geographic access, service charges, paperwork requirements, confidence in providers and financial knowledge. Khek et al. [12] consider information technology in relation to financial inclusion and institutional profitability. These studies establish the relevance of user constraints and technological development but do not compare multiple physical and digital infrastructure indicators with separate measures of financial participation over time.

This study addresses that gap by retaining branches, ATMs, POS terminals, mobile-money agents and internet usage as individual indicators and examining their relationships with deposit, loan and active mobile-money accounts. Trends are described for 2008–2023, while associations among annual changes are estimated for 2009–2023. This design permits comparison across channels and participation measures without treating the estimates as causal effects.

2.6 Hypothesis Development

2.6.1 Physical Infrastructure Hypothesis

Branches and ATMs address different access constraints, so their relationships with deposit, loan and active mobile-money accounts may not follow the same pattern. Previous evidence likewise provides no uniform directional expectation across these forms of participation [11], [13], [16].

H1: Changes in physical financial infrastructure are significantly associated with changes in selected indicators of financial inclusion in Cambodia.

2.6.2 Digital Infrastructure Hypothesis

POS terminals, mobile-money agents and internet connectivity represent distinct elements of the digital financial environment. Their relationships with participation may vary with adoption, affordability, trust, regulation and channel function [3], [20], [22]. Evidence from Asian economies also differs across measures and settings [4], [27]. A common directional relationship is therefore not assumed.

H2: Changes in digital financial infrastructure are significantly associated with changes in selected indicators of financial inclusion in Cambodia.

H1 and H2 are evaluated through the individual coefficients, their joint significance and the inclusion outcomes for which evidence is observed. Comparisons between the physical and digital models remain descriptive. Without a formal coefficient-equality test, differences in signs or significance levels are not treated as evidence that the corresponding coefficients are statistically unequal.

3. RESEARCH METHODOLOGY

3.1 Research Design

This study uses a quantitative longitudinal design based on annual national data for Cambodia. Level observations for 2008–2023 describe the development of physical and digital financial infrastructure and the three financial-inclusion indicators. The regression analysis examines annual changes during 2009–2023, providing 15 observations for each model. The country-year is the unit of analysis. Because the data are observational and the models estimate contemporaneous relationships, the coefficients are interpreted as associations rather than causal effects.

3.2 Data Sources and Preparation

Annual series were compiled from NBC sector reports, the IMF Financial Access Survey and the World Bank's Global Financial Inclusion and World Development Indicators databases [5], [6], [7], [8], [28]. The series were aligned by calendar year and retained in their published units. A consistent source was used for each variable throughout the study period wherever coverage permitted.

The level dataset contains 16 annual observations. For the regression analysis, each variable is transformed into its annual first difference:

$$\Delta X_t = X_t - X_{t-1},$$

where X_t is the value in year t and X_{t-1} is its value in the preceding year. The transformation measures annual change in the original unit rather than percentage growth. The 2008 observations provide the baselines for calculating the first annual changes in 2009.

3.3 Variables and Measurement

Physical infrastructure comprises formal financial institution branches (BR) and automated teller machines (ATM), both measured per 100,000 adults. Digital infrastructure comprises point-of-sale terminals (POS) per 1,000 adults, mobile-money agent outlets (MMA) per 100,000 adults and internet usage (INT) as a percentage of the population. These variables describe Cambodia's national infrastructure rather than facilities belonging to a particular institution.

Financial inclusion is measured by deposit accounts (DEP), loan accounts (LOAN) and active mobile-money accounts (AMA), each per 1,000 adults. The outcomes are retained separately to distinguish deposit, credit and mobile-money participation.

3.4 Model Specification

Physical and digital infrastructure are estimated in separate model groups so that their relationships with financial inclusion can vary. The physical-infrastructure specification is:

$$\Delta FI_{j,t} = \alpha_j + \beta_{1j} \Delta BR_t + \beta_{2j} \Delta ATM_t + \varepsilon_{j,t} \quad (1)$$

The digital-infrastructure specification is:

$$\Delta FI_{j,t} = \alpha_j + \beta_{1j} \Delta POS_t + \beta_{2j} \Delta MMA_t + \beta_{3j} \Delta INT_t + \varepsilon_{j,t} \quad (2)$$

In both equations, $\Delta FI_{j,t}$ denotes the annual change in financial-inclusion outcome j in year t , where $j \in \{\text{DEP}, \text{LOAN}, \text{AMA}\}$. BR denotes formal financial institution branches, ATM denotes automated teller machines, POS denotes point-of-sale terminals, MMA denotes mobile-money agent outlets, and INT denotes internet usage. The parameter α_j is the intercept, the β_{kj} terms represent the slope coefficients, and $\varepsilon_{j,t}$ is the error term. H1 is assessed by fitting specification (1) once for each of the three financial-inclusion outcomes. The same procedure is followed for specification (2) and H2, resulting in six regressions altogether.

3.5 Estimation and Diagnostic Procedures

Descriptive statistics, trend figures and level-series Pearson correlations are reported first. Because expanding level series may share common trends, H1 and H2 are tested using ordinary least squares regressions in annual first differences. Variance inflation factors assess multicollinearity, while the Breusch–Godfrey, Breusch–Pagan, Shapiro–Wilk and Ramsey RESET tests examine serial correlation, heteroskedasticity, residual normality and functional form. Cook’s distance is used to screen for influential observations.

Coefficient inference uses one-lag Newey–West heteroskedasticity- and autocorrelation-consistent standard errors with a finite-sample correction. Corresponding HAC Wald tests evaluate the infrastructure coefficients jointly. Results are evaluated at the 1% and 5% levels, with p-values between 0.05 and 0.10 treated as marginal. Given the 15 observations in each model, estimates and descriptive comparisons between model groups are interpreted cautiously. No formal coefficient-equality test is conducted.

4. RESULTS

4.1 Descriptive Development of Financial Infrastructure and Inclusion

Table 1 reports descriptive statistics for Cambodia’s physical infrastructure, digital infrastructure and financial-inclusion indicators from 2008 to 2023. Figures 1–3 show their annual movements over the same period.

Table 1: Descriptive Statistics of Financial Infrastructure and Financial Inclusion, 2008–2023

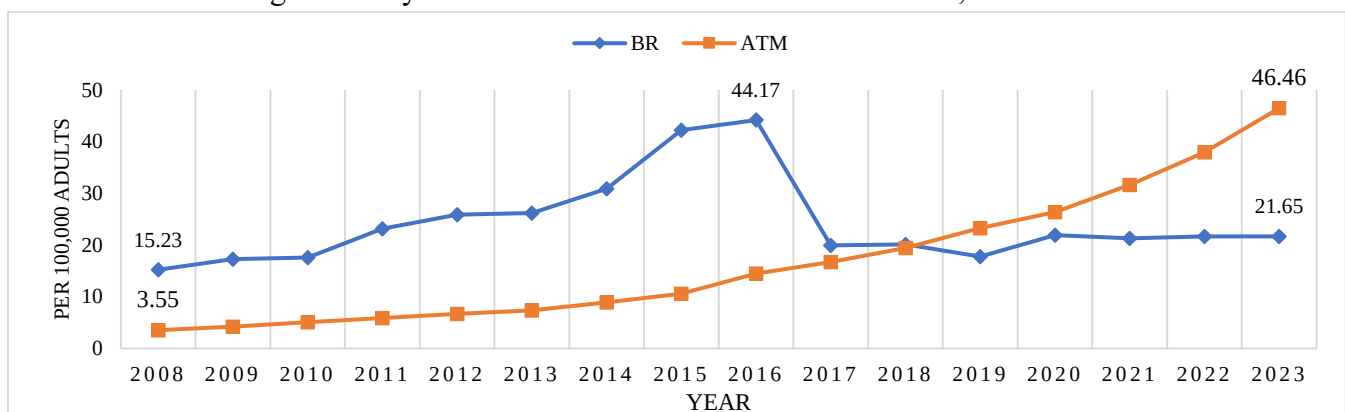
Variable	Code	Unit	2008	2023	Mean	SD
Formal financial institution branches	BR	Per 100,000 adults	15.23	21.65	24.18	8.37
Automated teller machines	ATM	Per 100,000 adults	3.55	46.46	16.80	13.10

Point-of-sale terminals	POS	Per 1,000 adults	0.35	3.04	1.18	0.87
Mobile-money agent outlets	MMA	Per 100,000 adults	0.00	499.60	179.68	190.29
Internet usage	INT	% of population	0.51	60.70	26.91	23.77
Deposit accounts	DEP	Per 1,000 adults	91.72	1,586.32	536.97	448.51
Loan accounts	LOAN	Per 1,000 adults	48.60	311.89	206.76	86.11
Active mobile-money accounts	AMA	Per 1,000 adults	0.00	915.26	219.52	310.31

Note: Values are annual level observations for 2008–2023 (N = 16) for each variable. SD = standard deviation.

The two measures of physical infrastructure followed different paths. Branch density increased from 15.23 per 100,000 adults in 2008 to a peak of 44.17 in 2016. It fell markedly in 2017 and subsequently remained within a narrower range, ending at 21.65 in 2023. By contrast, ATM density followed a more sustained upward course, rising from 3.55 to 46.46 per 100,000 adults. As shown in Figure 1, branches were more prevalent during most of the earlier years, whereas ATM density surpassed branch density from 2019 onward.

Figure 1: Physical Financial Infrastructure in Cambodia, 2008–2023

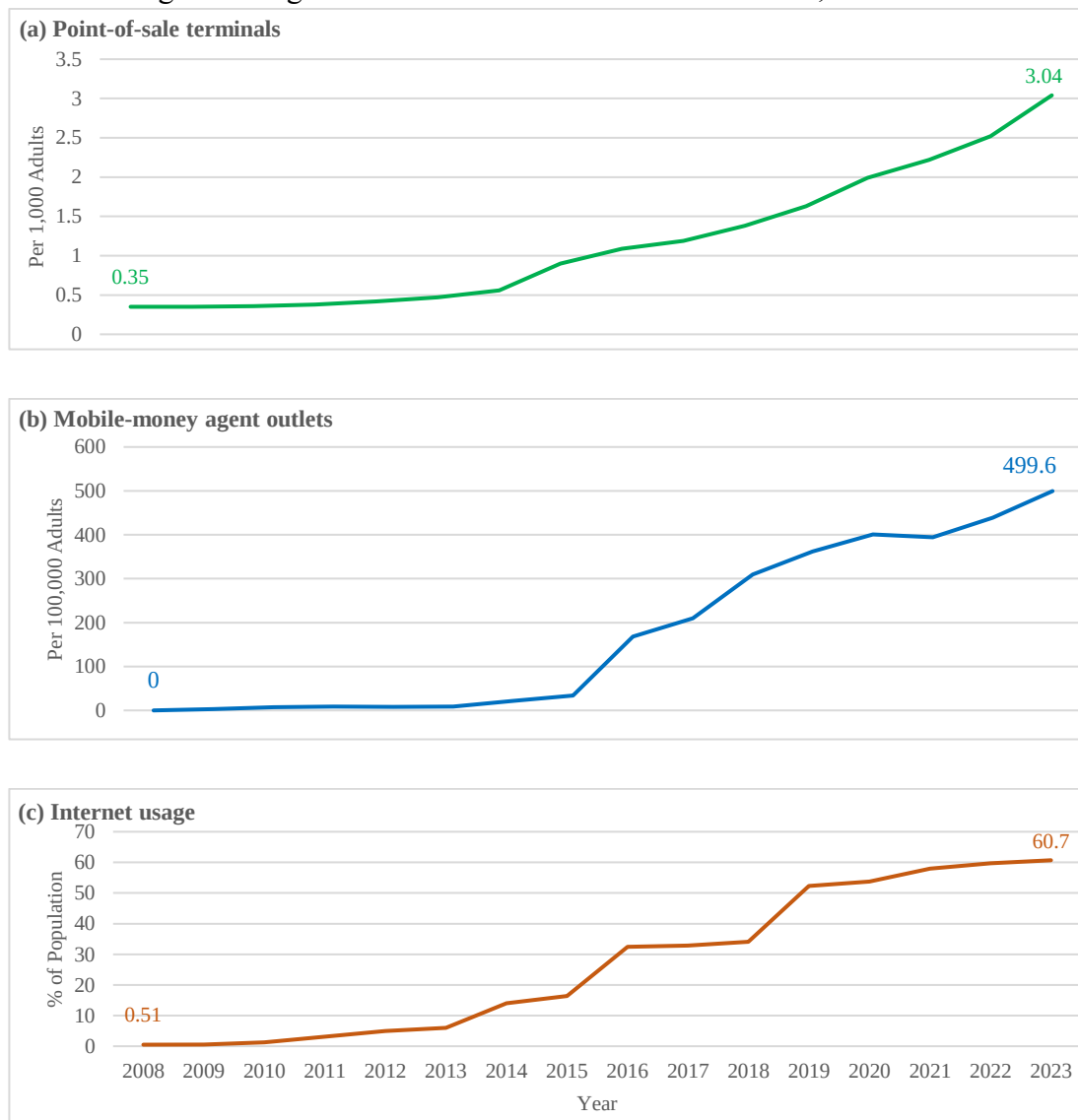


Digital infrastructure also expanded, but the timing and magnitude of the changes differed across indicators. POS-terminal density rose comparatively gradually, from 0.35 to 3.04 terminals per 1,000 adults. Mobile-money agent coverage changed more sharply. After remaining limited during the early years, it expanded visibly after 2014 and reached 499.60 outlets per 100,000 adults in 2023. The dispersion in this series is mainly attributable to the low values recorded initially and the much higher values observed toward the end of the period.

Internet access also changed substantially across the study period. Internet users accounted for 0.51% of Cambodia's population at the beginning of the period, compared with 60.70% in the final year. As illustrated in Figure 2, the largest year-to-year movements occurred in 2013–2014, 2015–2016 and 2018–2019. Growth persisted thereafter, but the yearly increments became smaller. These patterns show that

Cambodia's digital environment expanded through merchant-payment infrastructure, agent networks and internet connectivity, but not at a uniform rate.

Figure 2: Digital Financial Infrastructure in Cambodia, 2008–2023

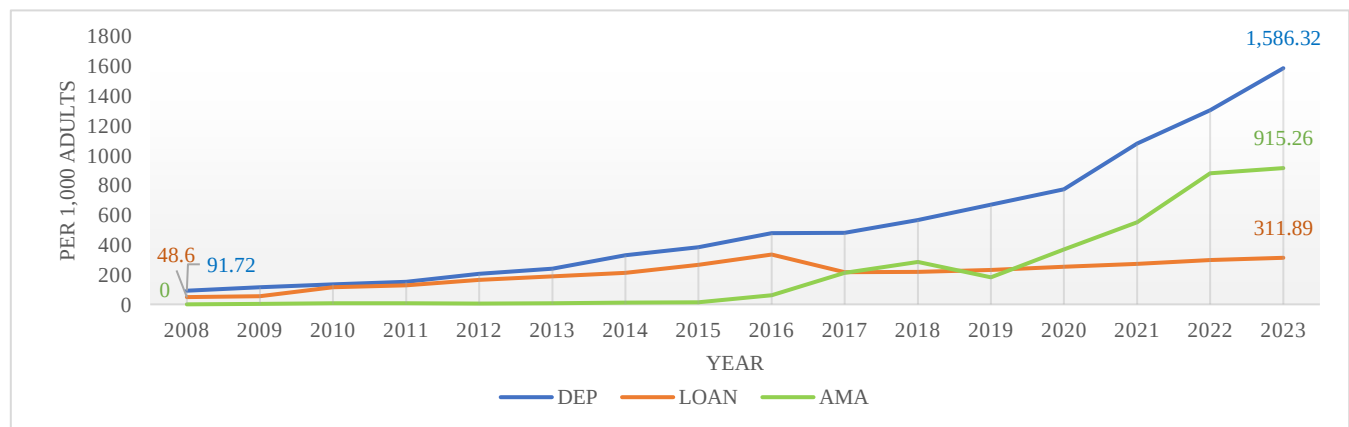


The financial-inclusion indicators likewise followed distinct trajectories. Deposit accounts recorded the largest numerical increase, rising from 91.72 to 1,586.32 accounts per 1,000 adults. Growth occurred through most of the period and became especially pronounced after 2019. Loan accounts increased more moderately, from 48.60 to 311.89 per 1,000 adults. The series reached a mid-period high in 2016, declined in 2017 and subsequently resumed a gradual upward movement.

Active mobile-money accounts remained limited during the first part of the period but grew more visibly after 2015. Following some variation between 2017 and 2019, the series rose sharply from 2020 and

reached 915.26 accounts per 1,000 adults in 2023. By the final year, active mobile-money accounts exceeded loan accounts but remained below deposit accounts.

Figure 3: Financial-Inclusion Indicators in Cambodia, 2008–2023



Overall, all eight indicators ended the period above their 2008 levels, but their development was uneven. ATM density increased more consistently than branch density, while mobile-money agent outlets and internet usage expanded more sharply than POS-terminal coverage. Among the inclusion measures, deposit accounts showed the greatest numerical increase, active mobile-money accounts grew mainly during the later years, and loan accounts followed a more moderate and less continuous path. These descriptive patterns establish the historical context for the regression analysis but do not demonstrate that infrastructure expansion caused changes in financial participation.

4.2 Preliminary Analysis and Diagnostic Results

Table 2 presents the Pearson correlations among the variables in levels. Strong positive correlations appear among ATM density, POS terminals, mobile-money agent outlets, internet usage, deposit accounts and active mobile-money accounts. The largest coefficients are observed between ATM and POS ($r = 0.995$), ATM and deposit accounts ($r = 0.994$), mobile-money agent outlets and internet usage ($r = 0.979$), and deposit and active mobile-money accounts ($r = 0.969$). Loan accounts are also positively correlated with the other infrastructure and inclusion measures. Branch density follows a different pattern, with weak negative correlations with most variables and a moderate positive correlation with loan accounts ($r = 0.522$).

Because many of the variables increased over the study period, these correlations may partly capture common time trends rather than underlying relationships between the series. The level correlations are therefore reported descriptively and are not used to test the hypotheses. The regression models instead use annual first differences.

Table 2: Pearson Correlations among Level Variables, 2008–2023

Correlations								
	BR	ATM	POS	MMA	INT	DEP	LOAN	AMA
BR	1	-0.120	-0.100	-0.201	-0.056	-0.071	0.522*	-0.224
ATM	-0.120	1	0.995**	0.957**	0.944**	0.994**	0.740**	0.963**
POS	-0.100	0.995**	1	0.969**	0.960**	0.985**	0.751**	0.948**
MMA	-0.201	0.957**	0.969**	1	0.979**	0.924**	0.701**	0.889**
INT	-0.056	0.944**	0.960**	0.979**	1	0.919**	0.793**	0.850**
DEP	-0.071	0.994**	0.985**	0.924**	0.919**	1	0.750**	0.969**
LOAN	0.522*	0.740**	0.751**	0.701**	0.793**	0.750**	1	0.613*
AMA	-0.224	0.963**	0.948**	0.889**	0.850**	0.969**	0.613*	1

*Note: Pearson correlations are based on annual level observations for 2008–2023 (N = 16). Variable definitions are provided in Table 1. The correlations are descriptive; strong values may partly reflect common trends and are not used to test H1 or H2. **p < 0.01; *p < 0.05.*

Table 3 reports the diagnostic results for the six first-difference models. Maximum VIF values are 1.012 in the physical models and 1.533 in the digital models, indicating no material multicollinearity among the transformed predictors. The Breusch–Godfrey test detects serial correlation only in the Physical–LOAN model (p = 0.018), while the Breusch–Pagan test detects heteroskedasticity only in the Physical–AMA model (p = 0.038).

The Shapiro–Wilk results indicate departures from residual normality in the Physical–DEP (p = 0.002), Physical–LOAN (p = 0.015) and Digital–LOAN (p = 0.003) models. None of the Ramsey RESET tests is statistically significant at the 5% level, providing no evidence of functional-form misspecification under the specification tested.

Table 3: Regression Diagnostic Results

Model	Maximum VIF	BG p-value	BP p-value	SW p-value	RESET p-value
Physical–DEP	1.012	0.979	0.481	0.002	0.300
Physical–LOAN	1.012	0.018	0.692	0.015	0.214
Physical–AMA	1.012	0.149	0.038	0.107	0.282
Digital–DEP	1.533	0.948	0.135	0.420	0.512
Digital–LOAN	1.533	0.337	0.727	0.003	0.356
Digital–AMA	1.533	0.619	0.172	0.198	0.150

Note: Diagnostics use annual first differences for 2009–2023 ($N = 15$). BG = one-lag Breusch–Godfrey LM test; BP = classical Breusch–Pagan LM test; SW = Shapiro–Wilk test; RESET = Ramsey RESET test using squared and cubed fitted values. Bold values indicate $p < 0.05$.

Cook’s-distance screening identifies potentially influential observations, particularly the 2017 observation in the physical models. These observations are retained because they form part of the national annual series, but their potential influence warrants caution. Coefficient inference is based on one-lag Newey–West HAC standard errors with a finite-sample correction, which make the estimated covariance matrix robust to heteroskedasticity and autocorrelation. This procedure does not resolve residual non-normality, influential observations or possible model misspecification. Leave-one-year-out checks indicated that some supported coefficients were sensitive to individual annual observations; the full-sample estimates are therefore treated as exploratory evidence for the study period.

4.3 Physical Infrastructure and Financial Inclusion

Table 4 reports the estimated relationships between annual changes in physical infrastructure and the three financial-inclusion indicators. Each model contains 15 observations for 2009–2023. Individual coefficient tests use one-lag Newey–West HAC standard errors, while the HAC Wald test evaluates the branch and ATM coefficients jointly.

Table 4: Physical Financial Infrastructure and Financial Inclusion

Variable	Δ DEP	Δ LOAN	Δ AMA
Δ BR	2.337*** (0.644)	4.899*** (0.680)	–2.906 (1.679)
Δ ATM	37.474*** (4.867)	1.696 (1.682)	20.248 (12.578)
Constant	–8.562 (10.225)	10.605 (6.754)	4.338 (23.098)
Adjusted R^2	0.808	0.699	0.133
HAC Wald p -value	<0.001	<0.001	0.068
Observations	15	15	15

*Note: Entries are unstandardized OLS coefficients, with one-lag Newey–West HAC standard errors in parentheses. The HAC covariance estimates include a finite-sample correction. The Wald test evaluates the joint null hypothesis that the coefficients on Δ BR and Δ ATM are both zero. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$. All coefficient tests are two-sided.*

The deposit-account model provides the clearest evidence of a relationship with physical infrastructure. It has an adjusted R^2 of 0.808, and the two infrastructure coefficients are jointly significant ($p < 0.001$). Branch growth is positively associated with changes in deposit accounts ($B = 2.337$, $p = 0.003$). Holding ATM growth constant, an annual increase of one branch per 100,000 adults corresponds to an estimated increase of 2.337 deposit accounts per 1,000 adults. ATM growth also has a positive coefficient ($B = 37.474$, $p < 0.001$), indicating that an additional ATM per 100,000 adults corresponds to an estimated increase of 37.474 deposit accounts per 1,000 adults, holding branch growth constant.

For loan accounts, the model has an adjusted R^2 of 0.699, and the infrastructure coefficients are jointly significant ($p < 0.001$). Branch growth is positively associated with changes in loan accounts ($B = 4.899$, $p < 0.001$), whereas the ATM coefficient is not statistically significant ($B = 1.696$, $p = 0.333$). The evidence for this outcome is therefore concentrated in branch growth.

The active mobile-money-account model provides weaker evidence. Its adjusted R^2 is 0.133, and the joint Wald result is marginal at the 10% level ($p = 0.068$). Neither branch growth ($B = -2.906$, $p = 0.109$) nor ATM growth ($B = 20.248$, $p = 0.133$) is significant at the 5% level. The model therefore provides no firm evidence of an individual relationship between either physical-infrastructure measure and active mobile-money accounts.

Overall, H1 receives partial support. Both physical-infrastructure measures are associated with deposit-account changes, while only branch growth is associated with loan-account changes. No individual physical-infrastructure coefficient is supported for active mobile-money accounts. These findings concern specific associations during the study period and do not establish a general or causal effect of physical infrastructure on financial inclusion.

4.4 Digital Infrastructure and Financial Inclusion

Table 5 reports the estimated relationships between annual changes in digital infrastructure and the three financial-inclusion indicators. Each model contains 15 observations for 2009–2023. Individual coefficient tests use one-lag Newey–West HAC standard errors with a finite-sample correction, while the HAC Wald test evaluates the three digital-infrastructure coefficients jointly.

Table 5: Digital Financial Infrastructure and Financial Inclusion

Variable	ΔDEP	$\Delta LOAN$	ΔAMA
ΔPOS	478.795** (160.100)	37.292 (56.525)	200.881 (214.477)
ΔMMA	−0.493 (0.661)	−0.200 (0.224)	0.588 (0.609)
ΔINT	1.810 (2.974)	2.608 (2.877)	−9.174*** (2.880)
Constant	22.928 (14.542)	7.076 (22.951)	42.214 (30.301)
Adjusted R^2	0.385	−0.145	0.090
HAC Wald p -value	0.009	0.800	0.0503
Observations	15	15	15

*Note: Entries are unstandardized OLS coefficients, with one-lag Newey–West HAC standard errors in parentheses. The HAC covariance estimates include a finite-sample correction. The Wald test evaluates the joint null hypothesis that the coefficients on ΔPOS , ΔMMA and ΔINT are all zero. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$. All coefficient tests are two-sided.*

The deposit-account model has an adjusted R^2 of 0.385, and the digital-infrastructure coefficients are jointly significant ($p = 0.009$). POS growth is positively associated with changes in deposit accounts ($B = 478.795$, $p = 0.012$). Holding changes in mobile-money agent outlets and internet usage constant, an annual increase of one POS terminal per 1,000 adults corresponds to an estimated increase of 478.795

deposit accounts per 1,000 adults. This coefficient should be viewed in relation to the relatively small annual changes in POS density. Mobile-money agent growth ($p = 0.471$) and internet-usage growth ($p = 0.555$) are not significant in this model.

The loan-account model provides no statistical support for a relationship with the selected digital indicators. Its adjusted R^2 is -0.145 , and the joint Wald test is insignificant ($p = 0.800$). None of the three individual coefficients reaches the 5% significance threshold: POS terminals ($p = 0.523$), mobile-money agent outlets ($p = 0.389$) or internet usage ($p = 0.384$).

For active mobile-money accounts, the model has an adjusted R^2 of 0.090. The joint Wald result falls narrowly above the 5% threshold ($p = 0.0503$) and is therefore treated as marginal. Internet-usage growth has a negative coefficient ($B = -9.174$, $p = 0.009$). Conditional on the other digital indicators, a one-percentage-point annual increase in internet usage corresponds to an estimated decrease of 9.174 active mobile-money accounts per 1,000 adults. Neither POS growth ($p = 0.369$) nor agent growth ($p = 0.355$) is significant. Given the marginal joint result, limited sample and associative research design, the internet coefficient should not be interpreted as evidence that greater connectivity causes mobile-money participation to decline.

Overall, H2 receives partial support. The evidence for deposit accounts is concentrated in POS growth, while no supported relationship is observed for loan accounts. The active mobile-money-account model provides qualified evidence involving internet usage, but the digital indicators are only marginally significant when evaluated jointly. The results therefore do not support a uniform relationship between digital infrastructure and all dimensions of financial inclusion.

4.5 Summary of Hypothesis Evidence

Table 6 summarizes the evidence for H1 and H2 across the three financial-inclusion outcomes. The assessments consider both the individual HAC coefficient tests and the joint HAC Wald tests.

Table 6: Summary of Hypothesis Results

Hypothesis	Outcome	Relevant relationships	Evidence
H1	ΔDEP	Positive ΔBR and ΔATM relationships; joint test significant	Supported
H1	ΔLOAN	Positive ΔBR relationship; ΔATM insignificant; joint test significant	Partially supported
H1	ΔAMA	No significant individual relationship; joint test marginal	Not supported
H2	ΔDEP	Positive ΔPOS relationship; ΔMMA and ΔINT insignificant; joint test significant	Partially supported
H2	ΔLOAN	No significant individual or joint relationship	Not supported
H2	ΔAMA	Negative ΔINT relationship; ΔPOS and ΔMMA insignificant; joint test marginal	Partially supported, with qualification

H1 is supported for deposit accounts, partially supported for loan accounts and not supported for active mobile-money accounts. H2 is partially supported for deposit accounts and receives qualified partial support for active mobile-money accounts because the significant internet coefficient is accompanied by only marginal joint evidence. H2 is not supported for loan accounts. Overall, the evidence varies across infrastructure indicators and inclusion outcomes rather than indicating a uniform relationship between infrastructure development and financial inclusion.

5. DISCUSSION

5.1 Physical Infrastructure and Conventional Financial Participation

The physical-infrastructure findings vary across the three forms of participation. Branch and ATM growth are positively associated with deposit-account changes, whereas only branch growth is associated with loan-account changes. Neither physical indicator has a significant individual relationship with active mobile-money accounts. This pattern reinforces the distinction between financial-service outreach and actual use [13] and is consistent with evidence that account participation depends on provider proximity as well as user and country conditions [16].

The different results for branches and ATMs are also consistent with their functions. In practical terms, an ATM mainly gives existing account holders another place to withdraw cash or complete a basic transaction, rather than access the broader services available at a branch. Branches additionally support identification, documentation, consultation and credit assessment, making them more relevant to lending relationships. Cambodian evidence identifies both distance and documentation as barriers to formal saving and credit [11]. The present findings do not show that branch expansion causes account growth, but they indicate that changes in branch coverage moved with both deposit and loan participation during the study period.

5.2 Digital Infrastructure and Mobile-Money Participation

The digital indicators do not exhibit a common relationship across the three outcomes. POS growth is positively associated with deposit-account changes but not with loan or active mobile-money accounts. A wider acceptance network may increase the practical value of transaction accounts by providing more opportunities for electronic payment. This interpretation accords with the distinction between access to digital services and their effective use [25]. Because POS terminals support merchant payments rather than credit assessment, their lack of a supported relationship with loan accounts is also understandable.

Mobile-money agent growth is not individually significant in any model. This does not demonstrate that agents are unimportant; rather, annual increases in national agent density did not move consistently with same-year changes in the selected account measures after the other digital indicators were considered. Mobile-money participation also depends on adoption, pricing, regulation, market structure and interaction with conventional institutions [3], [20]. Individual characteristics and available services create further variation in use [22].

Internet growth has a negative coefficient for active mobile-money accounts, but the digital indicators are only marginally significant jointly in that model. Internet usage measures general connectivity rather than

adoption of a particular financial service. The coefficient could reflect shifts toward other online services, differences between registered and active accounts, or omitted developments occurring during the same period. It should not be interpreted as evidence that greater connectivity reduces financial inclusion. Its direction differs from the broader positive relationships reported in SAARC and lower-middle-income ASEAN economies [4], [27], possibly because the studies use different indicators, samples and methods. Evidence from Kenya connects mobile money with lower transaction costs, improved risk sharing and longer-term welfare outcomes [19], [21]. Those results concern different outcomes and an institutional setting that cannot be transferred directly to Cambodia's annual account data. As Aron [20] observes, the evidence on mobile money varies across outcomes and empirical contexts.

5.3 Coexistence and Uneven Pathways

Taken together, the findings support an uneven-pathways interpretation of financial inclusion. Deposit-account changes are associated with branches, ATMs and POS terminals, while loan-account changes are associated only with branches. Neither infrastructure group provides firm model-level evidence for active mobile-money accounts at the 5% threshold.

The results do not support a simple substitution argument in which digital development makes conventional infrastructure unimportant. Instead, the evidence suggests that channel relevance depends on the financial activity examined. This pattern is consistent with the multidimensional treatment of financial inclusion in Global Findex [2] and in the work of Pesqué-Cela et al. [18]. Expansion in one delivery channel should therefore not be expected to correspond equally with deposit, credit and mobile-money participation.

5.4 Contribution to Cambodian and International Evidence

This study extends Cambodian evidence by examining physical and digital infrastructure over the same period and relating them to three distinct forms of financial participation. Sam [11] focuses on barriers to formal inclusion, while Khok et al. [12] consider technology in relation to inclusion and institutional profitability. The present analysis adds a longitudinal comparison of annual changes, showing that the supported relationships vary by both delivery channel and inclusion outcome.

The findings also qualify broader international evidence on digital finance. Although digital infrastructure can widen service availability, greater availability does not necessarily lead to sustained use—a distinction reflected in previous research [13], [25], [26]. The Cambodian results similarly indicate that infrastructure should be considered alongside affordability, documentation, trust, financial capability, service reliability and interoperability. This interpretation is consistent with the National Financial Inclusion Strategy and the interoperable-payment framework represented by Bakong [9], [10].

The contribution remains bounded by the short national annual series and the absence of additional control variables. The results identify contemporaneous associations and may conceal variation across provinces, institutions and customer groups. Research using institution-level, household-level or higher-frequency data could determine whether these relationships persist after accounting for economic conditions, regulation, service quality and platform-specific adoption.

6. CONCLUSION AND IMPLICATIONS

6.1 Conclusion

This study examined the development of physical and digital financial infrastructure in Cambodia during 2008–2023 and assessed how annual changes in these indicators were associated with changes in financial inclusion during 2009–2023.

For the first objective, the descriptive evidence shows that conventional and technology-based channels developed concurrently. Branches and ATMs remained part of the national financial network, while POS terminals, mobile-money agent outlets and internet connectivity expanded. Deposit, loan and active mobile-money accounts also ended the period above their initial levels, although their development followed different paths. Cambodia's experience therefore reflects the coexistence of physical and digital infrastructure rather than the complete replacement of conventional channels.

For the second objective, physical infrastructure has clearer relationships with conventional participation. Branch and ATM growth are positively associated with deposit-account changes, while the supported relationship for loan accounts is limited to branch growth. Neither physical indicator has a significant individual relationship with active mobile-money accounts. H1 is therefore supported for deposit accounts, partially supported for loan accounts and not supported for active mobile-money accounts.

For the third objective, the digital findings are less uniform. POS growth is positively associated with deposit-account changes, but no selected digital indicator has a supported relationship with loan-account changes. Internet growth has a negative coefficient for active mobile-money accounts, although the marginal joint evidence requires caution. H2 consequently receives partial support for deposit accounts, qualified partial support for active mobile-money accounts and no support for loan accounts.

The article contributes by examining physical and digital infrastructure separately within the same national period and retaining distinct measures of deposit, credit and mobile-money participation. The findings show that infrastructure–inclusion relationships depend on the delivery channel and the form of participation examined. Infrastructure expansion should therefore be evaluated against particular financial services rather than treated as uniform progress across all dimensions of financial inclusion.

6.2 Policy Implications

Cambodia should continue developing physical and digital channels as complementary elements of its financial system. Branches remain relevant for services involving documentation, assistance and credit assessment. ATMs facilitate routine account use, while POS terminals widen opportunities for account-based payments. No single channel should therefore be expected to perform every access function.

Expansion should also be accompanied by measures that support effective use. Increasing the number of agents, terminals or digital connections may not be sufficient without affordable services, accessible identification procedures, financial and digital capability, consumer trust, cybersecurity, operational reliability and effective complaint resolution. Interoperability matters because customers can transact more easily when different providers' systems work together.

In the loan-account model, none of the digital indicators was statistically significant. This result indicates that expanding digital channels, by itself, may not address the conditions that restrict access to formal

credit. Responsible credit expansion requires attention to documentation, eligibility, borrower assessment, consumer protection, transparent lending requirements and access to reliable financial information.

6.3 Limitations and Future Research

Several limitations qualify the findings. The regressions contain only 15 annual changes, limiting statistical power and the number of variables that can be included. Because the specifications omit other covariates and relate changes occurring within the same year, the coefficients describe co-movement but cannot establish cause and effect. National indicators also prevent analysis of variation across provinces, institutions and population groups. Some estimated relationships are sensitive to influential annual observations and should therefore be interpreted as exploratory evidence within the study period. Moreover, infrastructure availability does not directly measure service quality, affordability or individual adoption.

Future studies could use longer or higher-frequency series and institution-level or provincial panel data. Household-level research could examine infrastructure alongside income, education, gender, documentation, trust and digital capability. A useful next step would be to separate registered accounts from accounts that record actual activity. Data on transaction numbers, transaction values and the use of individual platforms would also provide a more detailed view of how available infrastructure relates to continued participation.

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