Available Online: 29 October 2026 DOI: 10.54254/3049-5768/2026.38536

The inclusive effects and evolutionary path of payment infrastructure: an analysis of Cambodia's Bakong–KHQR system

Peixuan Li

College of International Studies, National University of Defense Technology, Nanjing, China

244691061@qq.com

Abstract. In October 2020, the National Bank of Cambodia launched Bakong, a retail payment system, followed by the introduction of KHQR, a unified national QR code standard, in 2022. By the end of 2024, the system had reached 30 million registered users and 4.5 million merchant acceptance points. In 2025, it processed 1.326 billion transactions, of which 771 million were denominated in the local currency, the Cambodian riel, surpassing US dollar-denominated transactions for the first time. This paper examines the mechanisms underlying the inclusive effects of payment infrastructure and its evolutionary path, dividing the transmission process into four layers: access, scale, data, and denomination. At the access layer, the key change is that credit assessment shifts from being a prerequisite for account opening to becoming an outcome of account usage. At the scale layer, a unified QR code standard and clearing neutrality jointly enable the system to overcome the critical-mass threshold characteristic of two-sided markets. At the data layer, progress remains constrained by three complementary institutional arrangements: data ownership, credit reporting coverage, and risk-based pricing. At the denomination layer, reduced transaction frictions in retail payments marginally alter the inertia of domestic currency use. On this basis, the paper proposes an evolutionary path progressing from the clearing layer to the standards layer, the use-case layer, and finally the credit layer. It also discusses four boundary conditions: coverage does not necessarily translate into usage, fraud risks, the costs of cross-border interoperability, and the limits of retail-level de-dollarization.

Keywords: payment infrastructure, financial inclusion, two-sided markets, currency substitution, Cambodia

1. Introduction

In October 2020, the National Bank of Cambodia launched a retail payment system called Bakong. The project's technical development was undertaken by Soramitsu, a Japanese blockchain company, and its underlying ledger is based on Hyperledger Iroha. By the end of 2024, the system had reached 30 million registered users, with 63 commercial banks, microfinance institutions, and payment service providers connected and another seven in the process of integration. Acceptance points for the unified QR code standard, KHQR, had expanded to 4.5 million. In 2025, the system processed 1.326 billion transactions, including 771 million denominated in the local currency, the Cambodian riel, and 555 million denominated in US dollars.

Copyright: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Cambodia did not start from favorable conditions for the development of financial inclusion. According to the World Bank's figures, only 22% of adults held a bank or mobile money account in 2017, rising to 33% in 2021. By 2024, this proportion had reached 39%, with the figure for urban areas standing at 65%. Access to financial services had long been concentrated in urban areas and the formal sector, while rural residents and self-employed individuals relied primarily on cash and informal lending.

Research on the inclusive effects of mobile money has reached relatively consistent conclusions. Evidence from M-PESA shows that the widespread adoption of mobile money can improve risk-sharing among households, smooth consumption, and significantly reduce poverty incidence over the long term [1]. Replacing cash-based transfers with digital disbursements has also reduced both the costs incurred by recipients and payment leakage [2]. Most of these studies treat payment as a service that can be provided by the private sector, focusing on agent networks, fee structures, and user adoption behavior. The direct construction of retail payment systems by central banks, with interfaces made available to participating institutions, emerged relatively recently. Related discussions have focused largely on technical architecture and cross-border connectivity, while analyses of the underlying mechanisms remain comparatively limited.

This paper asks why an infrastructure that performs only a clearing function and does not extend loans can simultaneously expand merchant acceptance, alter transaction structures, and increase the proportion of transactions denominated in the domestic currency, even as improvements in individual account coverage remain relatively slow. Answering this question requires distinguishing between two different thresholds. Opening a traditional bank account requires verifiable identity, assessable repayment capacity, and the ability to maintain a minimum balance. All three conditions must be satisfied simultaneously; failure to meet any one of them results in exclusion. Payment infrastructure does not change these requirements themselves, but rather the order in which they arise.

The analysis proceeds in four layers. Section 2 establishes the theoretical framework, explains the public good characteristics and two-sided market features of payment infrastructure, and presents the analytical approach and research methodology for examining the four-layer transmission process. Section 3 describes Cambodia's initial conditions, including the structure of financial service provision, telecommunications infrastructure, degree of dollarization, and institutional preparedness. Section 4 examines the mechanisms operating at each of the four layers—access, scale, data, and denomination—with each layer corresponding to a proposition that can be challenged empirically. Section 5 proposes an evolutionary path progressing from the clearing layer to the standards layer, the use-case layer, and finally the credit layer, and examines the risks associated with transitions between these stages. Section 6 discusses the boundary conditions under which the aforementioned effects hold. Section 7 presents the conclusions.

This paper makes three main contributions. First, it decomposes the inclusive effects of payment infrastructure into four mechanisms, each with its own distinct conditions for failure, thereby avoiding the assumption that transaction growth is equivalent to financial inclusion. Second, it identifies three complementary institutional arrangements that constrain the conversion of payment data into credit capital, distinguishing payment inclusion from credit inclusion. Third, it provides a comparable sequence of development stages for small, open economies characterized by high levels of dollarization and low banking penetration.

2. Theoretical framework and research methods

2.1. The public good characteristics of payment infrastructure

Payment clearing exhibits the typical characteristics of network infrastructure. The value of a network increases with the number of participating nodes, while its marginal cost declines as its scale expands. Together, these two properties give rise to natural monopoly [3]. Under purely private provision, operators may exclude unprofitable groups through pricing, with small and micro-sized merchants and low-income households often being the first affected. Retail payments also constitute a two-sided market in which merchants and consumers generate utility for each other. An insufficient scale on either side discourages participation on the other [4]. Taken together, these two theories explain a common phenomenon: fragmented wallet systems remain trapped in a low-level equilibrium in small markets over extended periods. Each institution operates its own QR codes and merchant network, while the duplication of QR code deployment raises social costs.

Central bank intervention changes the structure of provision. The public sector provides the clearing layer, while licensed institutions continue to compete in the provision of front-end services. In their discussion of central bank digital currencies, Bech and Garratt distinguish between the wholesale and retail segments. The value of the wholesale segment lies in improving clearing efficiency and reducing settlement costs, whereas the value of the retail segment depends on whether the public can actually open and use accounts. These two benefits do not automatically follow from one another [5]. This distinction is central to the present study. Making the clearing layer a public service eliminates the root cause of network fragmentation, but end-user coverage continues to depend on the commercial incentives of participating institutions.

2.2. An analytical framework for the four-layer transmission mechanism

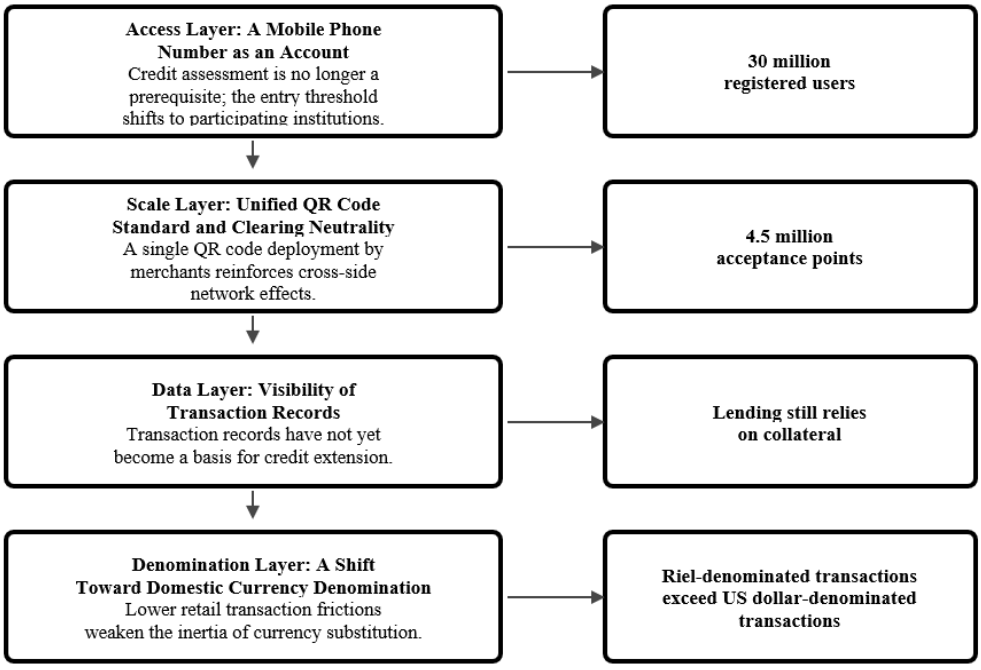


Figure 1. Four-layer transmission mechanism of payment infrastructure

This paper divides the operation of payment infrastructure into four layers: access, scale, data, and denomination. These layers are sequentially related: the completion of each preceding layer is a prerequisite for the next to take effect, although the conditions under which each layer may fail differ. The access layer determines who can hold an account; the scale layer determines whether the network can reach a viable scale; the data layer determines whether payment records can be converted into credit information; and the denomination layer determines the persistence of domestic currency use in retail transactions. Figure 1 illustrates the sequence of transmission across the four layers and their corresponding observable outcomes.

The advantage of this layered approach is that it makes it possible to identify points of failure. If acceptance points expand while credit conditions remain unchanged, the problem lies at the data layer rather than the access layer. If account numbers increase while merchant acceptance stagnates, the problem lies at the scale layer. Discussing all four layers together risks mistaking a temporary expansion in coverage for the realization of financial inclusion. Table 1 summarizes the mechanisms, theoretical foundations, observable implications, and current status of each layer in Cambodia.

Table 1. Four-layer mechanisms of payment infrastructure

Layer	Core Mechanism	Theoretical Foundation	Observable Implication	Current Status
Access	Credit assessment shifts from a prerequisite to an ex post outcome	Supply-side explanations of financial exclusion	Account growth becomes decoupled from credit growth	Operational
Scale	A unified QR code standard reduces the number of QR code deployment relationships, while clearing neutrality constrains rent extraction	Two-sided markets and network externalities	Acceptance points increase with the total number of participating institutions	Operational
Data	Transaction records generate credit information as an alternative to collateral	Information asymmetry and relationship lending	Lending continues to rely primarily on collateral	Not yet established
Denomination	Reduced retail transaction frictions alter the inertia of domestic currency use	Currency substitution and network externalities	Domestic currency transaction count exceeds that of foreign currency transactions	Emerging

2.3. Research methods and data sources

This paper combines theoretical deduction with process tracing. Theoretical deduction draws on four established strands of theory—financial exclusion, two-sided markets, information asymmetry, and currency substitution—to derive the causal chain underlying each of the four mechanisms and formulate four corresponding falsifiable propositions. Process tracing covers the period from 2020 to 2025, focusing on four milestones: the launch of Bakong, the unification of KHQR, cross-border QR code interoperability, and the introduction of tourist wallets. At each milestone, the analysis examines whether the links among causes, mechanisms, and outcomes are complete.

The analysis draws primarily on three categories of publicly available documents. Annual reports published by the National Bank of Cambodia provide data on transaction volumes, the number of participating institutions, and account scale. Policy documents issued by the Royal Government of Cambodia reveal the institutional objectives underlying policy design. World Bank account surveys provide internationally comparable measures, while its assessments of the business environment offer benchmarks for institutional quality. Cross-validation across these three categories of sources helps reduce the biases associated with reliance on any single source.

Other policies implemented during the study period must also be distinguished in the analysis. Cambodia simultaneously introduced tax incentives, expanded its special economic zones, and pursued policies supporting the recovery of tourism. These factors may have contributed independently to the expansion of merchant acceptance. This paper addresses the issue by distinguishing effects at different layers: for mechanisms directly attributable to payment infrastructure, observable intermediate outcomes are identified; where the effects of other policies cannot be separated, they are explicitly classified as not independently distinguished.

3. Initial conditions

Cross-country evidence indicates that access to financial services contributes more to improving income distribution than the size of the financial system, and that relaxing credit constraints has the greatest marginal effect on low-income groups [6]. Cambodia's financial service provision structure, however, restricts access primarily to urban areas. Commercial bank branches are concentrated in medium-sized and large cities, while microfinance institutions provide most financial services in rural areas. Over the past two decades, microfinance institutions have extended credit into rural communities, but their deposit-taking activities have remained restricted, leaving most rural residents without transaction accounts. This structure indicates that rural areas do not lack access to financial services in general; rather, they lack accounts that can be used to make and receive payments.

Telecommunications conditions present the opposite picture. The number of mobile phone subscriptions in Cambodia has long exceeded its population. Competition among multiple operators has kept tariffs relatively low by regional standards, and mobile networks cover the vast majority of administrative villages. The physical means of accessing accounts is already in place; what is missing is an institutional arrangement that converts mobile phone numbers into payment accounts. In this respect, Cambodia's initial conditions resemble those of mobile money systems in East Africa. The difference is that Cambodia's initiative was driven not by telecommunications operators but by the central bank.

The third constraint is dollarization. The US dollar has long accounted for the vast majority of domestic deposits and credit, while the local currency, the Cambodian riel, has primarily been used for small change. The self-reinforcing mechanism of dollarization lies in pricing habits. When most goods are priced in US dollars, holding the domestic currency becomes less convenient, users bear the costs of currency conversion, and the price system converges further toward dollar denomination. Under these conditions, monetary policy transmission is impeded, weakening the central bank's influence over interest rates and liquidity.

Institutional preparations intensified after 2021. The Royal Government of Cambodia issued its Policy Framework on Digital Economy and Digital Society, identifying digital payments as a priority area. Subsequent digital government policies and the Pentagonal Strategy introduced in 2023 continued in the same direction. The policy objectives were clear, but two elements were missing at the implementation level: a

unified QR code standard and a cross-institutional clearing arrangement. Bakong and KHQR supplied precisely these two elements.

4. The four-layer transmission of financial inclusion effects

4.1. The access layer

The barriers to opening a traditional account consist of three elements. Applicants need verifiable identity documents, credit records that enable their repayment capacity to be assessed, and a minimum balance that can be maintained without incurring account maintenance fees. These three requirements can be met simultaneously in large cities, but rural residents often lack all three. Under conditions of information asymmetry, lenders cannot screen out low-risk borrowers simply by raising interest rates. Instead, they must restrict supply through credit rationing, systematically excluding customers with low net worth [7]. Account opening linked to credit provision is subject to the same constraints.

Bakong's design replaces bank account numbers with mobile phone numbers as account identifiers and shifts responsibility for identity verification from bank branches to licensed member institutions. Users register through the mobile application of any member institution and receive a payment address linked to their mobile phone number. Interinstitutional transfers no longer require knowledge of the recipient's bank. A payment account does not itself confer an overdraft facility, so assessing repayment capacity is unnecessary at the account-opening stage. The account incurs no maintenance fee, thereby eliminating the minimum-balance requirement. Of the three barriers, two are removed and the third is shifted to a lower level.

This leads to the first proposition: once the opening of payment accounts is decoupled from credit assessment, the constraints on account growth shift from credit reporting coverage to network coverage and the capacity to verify identity. Cambodia's mobile network conditions were already in place by 2019; what was lacking was the institutional arrangement. Experience in East Africa supports this argument. The expansion of M-PESA was built on mobile phone penetration and agent networks, rather than on the development of a comprehensive credit reporting system [8].

This shift in constraints yields an observable implication. Since account opening no longer depends on credit reporting, growth in registered accounts should become decoupled from credit growth, creating a gap between the two. This gap does not indicate policy failure; rather, it is an inevitable consequence of the mechanism's design. Whether it can be closed depends on the data layer discussed below.

4.2. The scale layer

The difficulty of launching a two-sided market lies in the mutual waiting between its two sides. Merchants are reluctant to display QR codes because too few customers use scan-to-pay services, while consumers are reluctant to use such services because acceptance points are insufficient. Before Bakong was introduced, Cambodia already had multiple electronic wallets, each operating its own QR codes and merchant network. Merchant counters often displayed several QR code placards side by side. Merchants bore the costs of deploying duplicate codes, fragmenting the economies of scale associated with merchant acquiring.

KHQR reduces the many-to-many relationships involved in QR code deployment to a one-to-many arrangement. A merchant needs to display only one standardized QR code, which can be scanned by users of any member institution to complete a payment, with funds cleared through Bakong. The merchant's marginal cost of joining the network therefore approaches zero. Network value no longer depends on the user base of an individual institution but on the combined user base of all participating institutions. This arrangement

circumvents the subsidy races commonly seen during the launch phase of two-sided markets, eliminating the need for any single institution to bear the cost of developing the market on its own.

Clearing neutrality constitutes the second necessary condition. Bakong is operated by the central bank and does not compete for front-end customers. Services offered by member institutions on the platform are therefore substitutable. If the clearing layer were controlled by a commercial bank or technology company, that institution would have both the incentive and the ability to favor its own services in pricing, interfaces, and data access, thereby reducing other institutions' willingness to participate. Rochet and Tirole have shown that a platform's ownership structure and pricing structure jointly determine participation levels [4]. Cambodia's approach separates the infrastructure owner from the market competitors: the central bank owns the infrastructure, while commercial institutions compete on top of it.

The second proposition follows: a unified QR code standard and clearing neutrality jointly determine whether a network can cross the critical-mass threshold. In the absence of either condition, the market will remain characterized by multiple small networks operating alongside one another. Several countries in the region also experienced a phase in which the number of wallets expanded while merchant acceptance stagnated before introducing unified QR code standards. Acquiring scale increased significantly only after the unified standards were implemented. This comparison provides indirect support for the proposition.

4.3. The data layer

The conversion of payment data into credit information is the point of connection between payment infrastructure and the credit market. A unified ledger allows transaction records to accumulate in a centralized system, theoretically making it possible to generate credit information independent of collateral. Cambodia's credit infrastructure, however, remains centered on collateral. In the World Bank's Business Ready 2025 assessment, Cambodia received a score of 84.45 for financial services, ranking first among the ASEAN economies assessed and ahead of Vietnam at 80.32 and Singapore at 78.74. The report identified the efficiency of secured transactions registration and management, the timeliness of credit data updates, and the adoption of electronic customer identification as key strengths. All three relate to collateral and identity verification rather than transaction records. The capabilities recognized by the assessment lie precisely outside the scope of transaction-data-based credit assessment.

The first break occurs in data ownership and sharing rules. Transaction records are generated between member institutions and the clearing system. Clear rules are needed to determine who can access these records, for what purposes they may be accessed, and how they must be stored after retrieval. In the absence of such rules, institutions may be reluctant to use data for credit decisions even when they possess the data, because the associated compliance risks cannot be priced.

The second break concerns credit reporting coverage. Cambodia's credit reporting system relies primarily on formal credit records. Borrowers' previous borrowing and repayment histories can be incorporated into credit reports, but payment transaction records have not yet become a standard input. When credit reports exclude payment behavior, banks have little incentive to use payment data beyond cross-selling to existing customers, limiting its potential reach.

The third break lies in risk-pricing capabilities. Micro-merchants experience volatile and highly seasonal cash flows and often lack financial statements. Converting transaction records into probabilities of default requires appropriate models and credit personnel. Microfinance institutions have long relied on relationship-based lending assessments, with loan officers familiar with borrowers' business operations and household circumstances. This capability cannot readily be replaced by data models [9]. For micro-merchants,

information asymmetry does not manifest itself as a lack of data, but rather as instability in the relationship between observed data and default risk.

These three breaks are complementary in nature. The absence of any one of them substantially diminishes the benefits of the other two. If data can be accessed but no credit reporting interface exists, transaction records remain confined to individual institutions. If a credit reporting interface exists but risk-pricing capabilities are lacking, incorporating data into a model still does not produce usable credit limits. If risk-pricing capabilities are available but the data cannot be accessed, the model has no inputs. This complementarity means that advancing any single component independently is unlikely to yield significant results.

The third proposition follows: the conversion of payment data into credit capital depends on the simultaneous establishment of three institutional arrangements—data ownership, credit reporting coverage, and risk pricing. An expansion in transaction volume cannot automatically accomplish this conversion. Cambodia's current position can be summarized as follows: the first two layers of the mechanism are already operational, while the third has yet to be activated. This assessment does not conflict with external evaluations. The Business Ready assessment measures the quality of the regulatory framework and credit infrastructure, whereas this paper examines the actual use of transaction records in credit decisions. The two assessments therefore address different objects.

4.4. The denomination layer

Dollarized economies face a distinctive constraint. Domestic currency use exhibits network externalities: when most transactions are priced in US dollars, the convenience of holding and using the domestic currency declines, while users bear the costs of currency conversion and making change. As a result, the pricing system gradually converges toward dollar denomination. Conventional approaches to de-dollarization include raising reserve requirements on domestic currency deposits, issuing domestic currency bonds, and requiring the public sector to denominate transactions in domestic currency. These measures operate on the asset and liability sides of the financial system and have limited effects on retail transactions. When cash accounts for a high proportion of transactions, opportunities to use domestic currency in everyday life remain scarce. Even when domestic currency offers interest rate advantages, residents still lack sufficient incentives to hold it.

Payment infrastructure changes the frictions associated with retail transactions. When all acceptance points use a common QR code standard, transactions denominated in domestic currency no longer require users to prepare additional cash or make change. The differences in payment experience between the domestic currency and the US dollar are thereby reduced. Data for 2025 reveal a directional shift: riel-denominated transactions reached 771 million, compared with 555 million US dollar-denominated transactions, marking the first time that the domestic currency had surpassed the US dollar. Transaction counts are not equivalent to transaction values, and the US dollar remains dominant in high-value payments. Nevertheless, the change in retail transaction frequency indicates that usage habits are shifting.

The fourth proposition is that the domestic-currency effect of payment infrastructure depends on the density of retail use cases rather than the intensity of monetary policy instruments. Use-case density encompasses the number of acceptance points, the scope of cross-border connectivity, and the extent to which mandatory or routine use cases, such as government payments, are integrated into the system. Cambodia has already established the first two elements, while the third remains under development. The policy implication of this proposition runs counter to conventional recommendations: the breakthrough for de-dollarization at the retail level lies in payment convenience rather than interest rate instruments.

5. The evolutionary path from clearing to credit

5.1. The two layers already completed

The construction of the clearing and standards layers was largely completed between 2020 and 2022. Bakong provides real-time interinstitutional clearing, while KHQR provides a unified QR code standard. Together, they form the technological foundation for all subsequent use cases. The degree of completion of these two layers can be assessed by the number of participating institutions and the scale of merchant acceptance. The 63 participating institutions cover three categories: commercial banks, microfinance institutions, and payment service providers. The number of acceptance points has reached 4.5 million, covering major payment scenarios such as retail, dining, and transportation.

The way in which these two layers were established also has distinctive features. Cambodia did not follow a sequence in which rules were established before the system was built. Instead, it built the system first and then used problems arising during operation to drive the development of rules. This approach is relatively common in countries with limited regulatory capacity. Its cost is reduced predictability in the regulatory framework, while its benefit is that infrastructure can be deployed more quickly than the legislative process would otherwise allow.

5.2. Three expansion paths at the use-case layer

The first path for expanding use cases is tourism. Launched in 2024, Bakong Tourist allows inbound visitors to top up their wallets using foreign bank cards and make QR code payments at acceptance points nationwide. In 2025, it had 22,138 registered accounts. Tourist payments typically involve small transaction amounts, high transaction frequency, and substantial reliance on cash, making tourism an appropriate setting in which to test the density of acceptance points. The second path is cross-border connectivity. Cambodia has established cross-border QR code interoperability with Thailand, Laos, Vietnam, Malaysia, and South Korea. Through partnerships with international card networks and wallet providers, it has also enabled acceptance of major Chinese payment wallets, while connectivity with India remains under development. Following the launch of the first phase of connectivity with Laos in 2023, the second phase was completed in December 2025, establishing a two-way channel. The significance of cross-border connectivity extends beyond making payments more convenient for tourists: it expands the use cases for domestic currency denomination from the domestic market to cross-border trade.

The third path is the integration of government payments and wage disbursements. Once public-sector fees, social security payments, utility bills, and telecommunications bills are integrated into the unified QR code standard, one-time users can be converted into frequent users. The distinctive feature of this path is that demand is relatively inelastic, meaning users do not need to be persuaded to participate. The three paths jointly increase usage frequency. Once the number of accounts approaches saturation, the next stage of financial inclusion lies in the depth of usage, which is determined by the range of available use cases.

5.3. Prerequisites and sequencing at the credit layer

Activating the credit layer requires three developments to occur simultaneously. First, the credit reporting system must incorporate payment transaction records as a standard input. Second, an open finance framework must allow users to provide payment data to credit institutions with their authorization. Third, consumer protection rules must establish boundaries for data use. Among these three requirements, the second entails the highest institutional cost because it requires participating institutions to relinquish exclusive control over

customer data. Exclusive access to data is a basis of competition in the payment market, and opening up data means surrendering part of that competitive advantage to other institutions.

A feasible sequence would be to begin with pilot programs at microfinance institutions, using transaction records to adjust credit limits and determine renewal terms for existing customers. After sufficient default data have been accumulated, the approach could then be extended to commercial banks. This path carries relatively low risks, although its effects may take longer to emerge. An alternative is to establish a public credit data exchange platform, with the central bank acting as an intermediary and maintaining the interfaces through which institutions access data with appropriate authorization. This path could advance more quickly but places greater demands on the central bank's technical and governance capabilities. The two paths are not mutually exclusive and can often proceed in parallel in practice.

5.4. Risks associated with transitions between stages

The most likely problem when transitioning from the use-case layer to the credit layer is data misuse. Payment data are more sensitive than ordinary transaction data. If they are used for improper debt collection or discriminatory pricing, public trust in the system may deteriorate rapidly. Trust requires long-term accumulation, yet a single incident may be sufficient to destroy it. Cambodia's payment system operates on the credibility of the central bank, meaning that any loss of public trust can directly undermine confidence in the system itself. This distinguishes it from commercial platforms.

Another risk is a change in the form of exclusion. At the access layer, exclusion manifests as the absence of an account; at the data layer, it manifests as having an account but being unable to obtain credit. The latter is more difficult to identify and more easily obscured by growth in transaction volumes. If the credit layer remains disconnected for an extended period, the benefits of financial inclusion will remain confined to payments, leaving the financing constraints faced by microenterprises largely unaddressed.

6. Boundary conditions of financial inclusion effects

The first boundary condition is that coverage does not necessarily translate into usage. According to the World Bank's Global Findex 2025 data, only 39% of adults in Cambodia held an account in 2024, with coverage reaching 65% in urban areas and being considerably lower in rural areas. During the same period, Bakong had already reached 30 million registered users. The gap between registered accounts and individual coverage indicates that the system contains substantial numbers of duplicate registrations and low-frequency accounts. Account numbers alone cannot be treated as evidence that financial inclusion has been achieved. The density of agent locations in rural areas, older adults' ability to operate digital services, and differences in access to smartphones and feature phones can all create a divergence between nominal coverage and actual usage.

The second boundary condition concerns fraud and consumer protection. Cross-border connectivity expands the acceptance network but also creates more opportunities for fraud. The anonymity of tourist wallets, QR code substitution, and the difficulty of pursuing claims involving cross-border transactions are all issues that require proactive design. The more efficient a payment system becomes, the more rapidly losses from individual fraudulent transactions can propagate. The development of risk management capabilities must therefore keep pace with the expansion of use cases.

The third boundary condition is the cost of cross-border interoperability. Each cross-border connection requires alignment with the other party's standards, clearing arrangements, and regulatory rules. As the number of connections increases, so does system complexity. A more fundamental issue concerns control over standards. When interoperability is established with a much larger payment system, differences in the scale of

acceptance networks can translate into differences in bargaining power, creating the possibility that local standards may be displaced. In Cambodia's interoperability arrangements with India, the number of acceptance points covered by the Indian side far exceeds that of the Cambodian side. This asymmetry is likely to be reflected in subsequent negotiations over the rules governing interoperability.

The fourth boundary condition concerns the other side of dollarization. An increase in domestic currency use represents a positive development for monetary policy, but for residents and businesses holding US dollar-denominated assets, it also brings exchange rate risk back into consideration. De-dollarization that proceeds too rapidly may trigger portfolio reallocation, whereas a pace that is too slow will leave monetary policy transmission constrained. Payment infrastructure can change currency usage habits at the retail level, but it cannot substitute for decisions concerning the exchange rate regime and the macroprudential framework.

7. Conclusion

The Cambodian case demonstrates that the inclusive effects of payment infrastructure stem from a change in the sequence of barriers, rather than from the technological sophistication of the infrastructure itself. By shifting credit assessment from a prerequisite for account opening to an outcome of account usage, the system changes the constraints on account growth from credit reporting coverage to network coverage and identity verification capacity. A unified QR code standard and clearing neutrality jointly address the initial coordination problem of two-sided markets, and neither is sufficient on its own. These two mechanisms are already operational, as evidenced by the scale of merchant acceptance and the structure of transactions.

The data layer leads to a further conclusion: payment inclusion is not equivalent to credit inclusion. Converting transaction records into credit capital requires the simultaneous establishment of three institutional arrangements: data ownership, credit reporting coverage, and risk pricing. These arrangements are complementary, and progress in any one of them alone is unlikely to produce significant results. In its 2025 assessment, the World Bank ranked Cambodia first in the region for financial services, based on factors including the registration of security interests and the quality of credit data. This assessment itself indicates that the focus of credit infrastructure remains on collateral rather than payment transaction records. Treating growth in transaction volumes as evidence that financial inclusion has been achieved would obscure the persistent financing constraints faced by microenterprises.

The findings at the denomination layer point to a policy path that differs from conventional approaches. In highly dollarized economies, the key to de-dollarization at the retail level lies in payment convenience rather than interest rate instruments. Reduced transaction frictions can alter the inertia of domestic currency use, but this mechanism is confined to everyday payments and cannot be extended to the functions of asset denomination and store of value.

For economies facing similar conditions, the sequence that merits consideration is to advance progressively through the clearing layer, the standards layer, the use-case layer, and the credit layer, moving to each subsequent layer only after the preceding one has been established. The risk of skipping stages is that the credit layer may be activated before adequate data governance arrangements are in place, potentially resulting in data misuse and a loss of public trust. For external partners engaged in cross-border digital payment cooperation, the Cambodian case suggests that supporting standards and clearing interfaces is more effective than promoting front-end wallet applications. The former preserves institutional space for local adaptation, whereas the latter may encounter resistance from domestic institutions.

The validity of the four propositions is limited to small, open economies characterized by high levels of dollarization, low banking penetration, and extensive mobile network coverage. Countries with larger

populations or more complex financial structures face different constraints, and the strength of these mechanisms requires separate empirical examination. A comparative analysis of the QR code standardization processes in Cambodia, Thailand, and Vietnam within the same analytical framework could further establish whether clearing neutrality constitutes a necessary condition.

References

[1] Suri, T., & Jack, W. (2016). The long-run poverty and gender impacts of mobile money. *Science, 354*(6317), 1288–1292. https://doi.org/10.1126/science.aah5309

[2] Aker, J. C., Boumnijel, R., McClelland, A., & Tierney, N. (2016). Payment mechanisms and antipoverty programs: Evidence from a mobile money cash transfer experiment in Niger. *Economic Development and Cultural Change, 65*(1), 1–37. https://doi.org/10.1086/687578

[3] Katz, M. L., & Shapiro, C. (1985). Network externalities, competition, and compatibility. *The American Economic Review, 75*(3), 424–440.

[4] Rochet, J.-C., & Tirole, J. (2003). Platform competition in two-sided markets. *Journal of the European Economic Association, 1*(4), 990–1029. https://doi.org/10.1162/154247603322493212

[5] Bech, M. L., & Garratt, R. (2017). Central bank cryptocurrencies. *BIS Quarterly Review*, September, 55–70.

[6] Beck, T., Demirgüç-Kunt, A., & Levine, R. (2007). Finance, inequality and the poor. *Journal of Economic Growth, 12*(1), 27–49. https://doi.org/10.1007/s10887-007-9010-6

[7] Stiglitz, J. E., & Weiss, A. (1981). Credit rationing in markets with imperfect information. *The American Economic Review, 71*(3), 393–410.

[8] Jack, W., & Suri, T. (2011). Mobile money: The economics of M-PESA. *NBER Working Paper No. 16721*. National Bureau of Economic Research. https://doi.org/10.3386/w16721

[9] Petersen, M. A., & Rajan, R. G. (1994). The benefits of lending relationships: Evidence from small business data. *The Journal of Finance, 49*(1), 3–37. https://doi.org/10.1111/j.1540-6261.1994.tb04418.x