

PAYMENTS INFRASTRUCTURE AND ECONOMIC EFFICIENCY IN A DIGITAL AGE: WHAT CAN BE LEARNED FROM THE UPI APPROACH FOR CENTRAL ASIA

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Abstract: *The increased digitalization of financial systems, as experienced in recent times, necessitates efficient, secure, and more integrated payment systems, especially in the cash-intensive economy of Central Asia. The article will use the Indian experience of the Unified Payments Interface (UPI) as a best practice example of integrating digital payment systems to make the economy more efficient. The article will use the Structural Equation Model (SEM) of analyzing the Indian experience of the UPI in making the economy more efficient by empirically testing the relationship between the use of the UPI, financial efficiency, financial inclusivity, trust, and economic performance. The article finds that the adoption of the UPI by the Indian economy results in a positive effect on financial efficiency, which in turn enhances financial inclusivity by the mediatory role of financial stability and trust in the Indian economy. The results clearly show the capability of interoperable digital payment systems to minimize transaction costs and expedite payments. Based on the Indian example, the paper illustrates lessons to be drawn for the context of the Central Asian region. A crucial role here can be played by a centralized and regulatorily supported payment system.*

Key words: *mobile banking, QR-based, and wallet service-based payments, interoperability, The Reserve Bank of India (RBI), e-wallets, card payments, IMPS, demonetization.*

INTRODUCTION

A rapid digitalization of the economic environment and an extension of the use of ICT have again driven the structural transformation of Central Asian financial systems. All these changes are in the process of reconstructing the conventional payment systems and approaches in banking, which were previously based on cash or paper transactions, towards compatible real-time online platforms, increasing the speed, security, and clarity of these services. The current payment systems have become an important source in the field of economy, finances, as well as integration in the digital world.

The developments in ICT have empowered various new electronic payment methods in Central Asian countries, including mobile banking, QR-based, and wallet service-based payments. However, these usually remain fragmented, bank-centered, and very limited in

interoperability, thus not fully allowing seamless transactions between peers and merchants at scale. In this context, India's Unified Payments Interface-which uses a virtual payment address in place of sensitive bank account details to securely perform a wide range of financial transactions via smartphones-is considered a very relevant reference model for the CIS countries.

The UPI model shows how a standardized, interoperable payments infrastructure, comprising open APIs and the support of banks as well as fintech companies, can help lower costs of payments substantially, as well as ensure efficiency in payments and compress the time frame for the adoption of payments in the digital format in the required manner. Unlike earlier payments systems, UPI necessitates the linking of the account to the registered application on the part of the user, as well as the business entity in the form of current accounts.

The main aim of this paper is to present an analysis of the role of the UPI model in economic efficiency and to uncover key insights to be learned from this model in the development of payment infrastructure systems in Central Asia. The paper discusses the role of interoperable digital payments in improving the efficiency of transactions, inclusivity, and market integration. The paper starts with an introduction to digital payment systems and the current state of payment infrastructure development in Central Asia. Next is an analysis of the UPI model and the manner in which it is organized. The paper also scrutinizes the strengths and weaknesses, as well as the potential and obstacles associated with implementing UPI-type systems in Central Asia. The final parts of the paper conclude with implications and suggestions for further development related to the creation of inclusive and efficient digital payment systems.

METHODOLOGY AND LITERATURE REVIEW

Digital payments include transactions processed through electronic means, for example, mobile payment application services, digital wallets, and other technological means of making payments. In this context, digital or FinTech banking refers to the application of information technology to facilitate seamless, cashless financial transactions. As per the Reserve Bank of India (RBI), a digital transaction is one that is completed without using physical cash in at least one transaction leg, which can be done by the paying party, payee, or both. This increase in digital transaction adoption has brought about a greater shift in consumer behavior from using paper-based cash transactions to electronic modes.

The rise of electronic payment services, especially in retail, has been a crucial factor in pushing the agenda for financial inclusion. Many businesses have turned to online payment platforms as a means to take advantage of new opportunities arising through the digital economy. However, there are still challenges that limit the widespread use of electronic payments. In India, for example, the need for instant and more economical means of safely transferring funds across different locations accelerated the rise of retail electronic payments through e-wallets, credit and debit cards, IMPS, and UPI. For this

reason, money itself is increasingly being seen as a unit of value and storage of value as opposed to a medium of exchange. This means that the future of all payment services will be based on speed and efficiency.

Immediate Payment Service (IMPS) and Unified Payments Interface (UPI) have played an important role in promoting the retail digital payment industry in India. After the process of demonetisation, the overall growth in the digital payment industry has been substantial, with RBI statistics hinting at a compound annual growth rate of 61% in terms of volume and 19% in terms of value between 2014 and 2019.

From an institutionally related point of view, there lies the National Payments Corporation of India (NPCI), formed under the Payments and Settlement Systems Act of 2007, initiated by the RBI and the Indian Banks' Association. NPCI developed the UPI in 2016 as an interoperable payment system for peer-to-peer and merchant transactions for different banks. By the month of June 2021, the UPI network had integrated 227 banks and had processed over 2.8 billion transactions per month, which inculcates the scalability and revolutionary effects of the system. The mainly successful factors for the system include simplicity, innovation, adoption, security, and low charges (Mahesh, A. & Ganesh Bhat, 2021).

The literature involving UPI spans many dimensions, ranging from digital payment innovation and the digitalization of financial services to greater social implications. Much of the work on this issue has so far been fragmented and essentially descriptive, with no holistic causal-effect relationship that can empirically connect UPI to economic development. This study plugs this lacuna by moving beyond theoretical and operational discussions to examine the structural relationships through which UPI influences economic outcomes, especially for financially underserved groups.

Previous literature has generally discussed UPI's potential to ensure greater access, convenience, affordability, and inclusion in digital payment systems. As such, most discussion of UPI has revolved around the reduction in costs for transactions and the reduction in barriers to financial inclusion. These features position UPI as a critical component of payments infrastructure efficiency in the digital age. Literature on fintech and ICT more broadly demonstrates strong links between digital technologies, financial literacy, and financial inclusion, which in turn support economic development. However, empirical evidence directly connecting UPI to economic development, especially through intermediary mechanisms, remains limited.

This study builds a theoretical model in which UPI strengthens financial literacy by promoting frequent, low-cost, and user-friendly digital transactions. Enhanced financial literacy subsequently fosters financial inclusion, while financial stability mediates this relationship by ensuring consistency and reliability within the financial system. Furthermore, the literature suggests that trust is a crucial mediating factor between financial inclusion and economic development, as the benefits of inclusion materialize fully only when users have confidence in digital financial systems.

Methodologically, this study uses SEM to empirically validate these relationships using primary data collected from rural and semi-urban populations. The findings provide understanding of how interoperable digital payment infrastructure, like UPI, can enhance economic efficiency by facilitating secure, scalable, and inclusive transactions.

The valuable experiences of UPI thus hold great importance for Central Asia, which remains highly fragmented with regard to payment systems and still retains a wide prevalence of cash. A digital payments infrastructure-low-cost, interoperable, and based on trust-will help increase financial literacy, deepen inclusion, and eventually facilitate inclusive economic development. Therefore, the model of UPI is a relevant policy and institutional prototype to make the payments infrastructure and economic efficiency in Central Asian countries stronger in their journey of digital transformation (Rastogi et al., 2021).

Globally, the Unified Payments Interface (UPI) is recognized as one of the most successful retail fast payment systems (FPS). Like all popular FPSs, the UPI facilitates fast, secure, and easy P2P and P2M payments. Although mobile payment services have been a relatively new phenomenon in many countries, including China and Kenya, driven mainly by closed systems such as Alipay and M-PESA, the payment industry in the region of Central Asia developed on a different trajectory.

Within the UPI framework, there are several service providers that share the same infrastructure. This promotes both competition and interoperability. The result is that both fintech companies and big tech companies such as Google Pay and PhonePe have managed to acquire large market shares in the payment initiation service because they have large customer bases and they have invested heavily in marketing. Though they have a smaller market share in the payment initiation service, banks remain essential in UPI since they provide the infrastructure for funds transfer.

“This institutional setup underlies an important strength of the UPI model—decoupling payment infrastructure from the services offered to customers.” By allowing diverse market participants to compete on a common platform, UPI enhances efficiency, innovation and consumer choice without fragmenting the payment ecosystem. This experience offers important insights for regions such as Central Asia, where payment systems are often bank-centric or fragmented. An open, interoperable FPS model—supported by strong regulatory oversight—can balance competition and stability while improving the overall efficiency and inclusiveness of digital payments (Jack and Suri, 2014 and Uña et al, 2023).

RESULTS

The empirical results provide strong support for the proposed theoretical framework. Hypothesis 1 is confirmed, as Unified Payments Interface (UPI) exhibits a statistically significant positive impact on literacy, with a path coefficient of 0.558 significant at the 5 percent level. This indicates that increased engagement with UPI-based digital payment

systems contributes meaningfully to improvements in literacy, particularly financial literacy.

The structural model was evaluated after establishing the reliability and validity of the measurement constructs. Model explanatory power, assessed through R-square values, suggests a moderate level of predictive capability. Specifically, the model explains 14 percent of the variance in economic development and 17 percent of the variance in financial inclusion. Additionally, the model accounts for 61 percent of the variance in UPI usage related to online transactions, underscoring the central role of UPI within the digital payment ecosystem.

The measurement model demonstrates strong psychometric properties. A total of ten constructs represented by fifteen indicators were retained after removing items with weak factor loadings or cross-loadings. Reliability measures, including Cronbach's alpha, composite reliability, and average variance extracted (AVE), meet recommended thresholds, confirming both convergent and discriminant validity and indicating the absence of multicollinearity.

Mediation analyses further reveal significant indirect effects. Financial stability partially mediates between literacy and financial inclusion, and trust fully mediates between financial inclusion and economic development. These results indicate that financial stability and trust are important in ensuring economic development as a result of digital payment adoption.

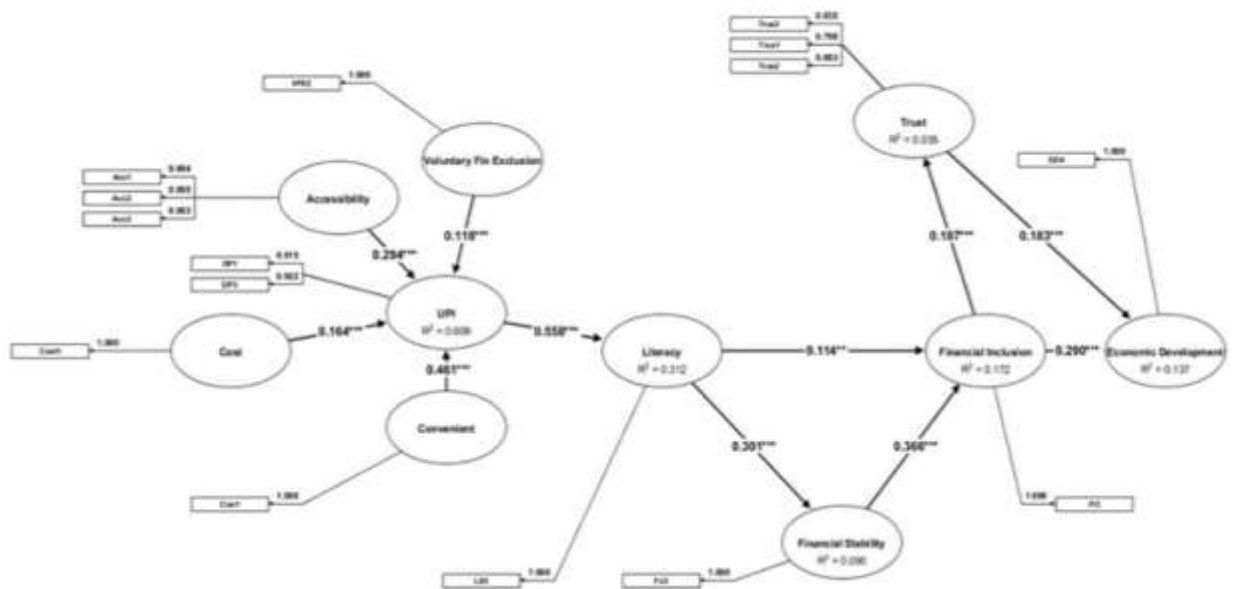


Figure. The findings for Hypothesis 1 revealed a significant impact of UPI on literacy, with a coefficient value of 0.558 and significance at a 5% significance level. After finding that the measurement items and constructs are reliable and valid, a test was done for the structural model. The explanatory power of a model is represented statistically through its R-square values. These are also known as Omega-squared. They measure the percentage

variance explained in a dependent variable due to a set of independent variables. The R-square values of 0.14 for economic development and 0.17 for financial inclusion are indicators that a moderate amount of variation is explained by a theoretical model regarding trust, financial liability, and literacy (Rastogi *et al.*, 2021, p. 522).

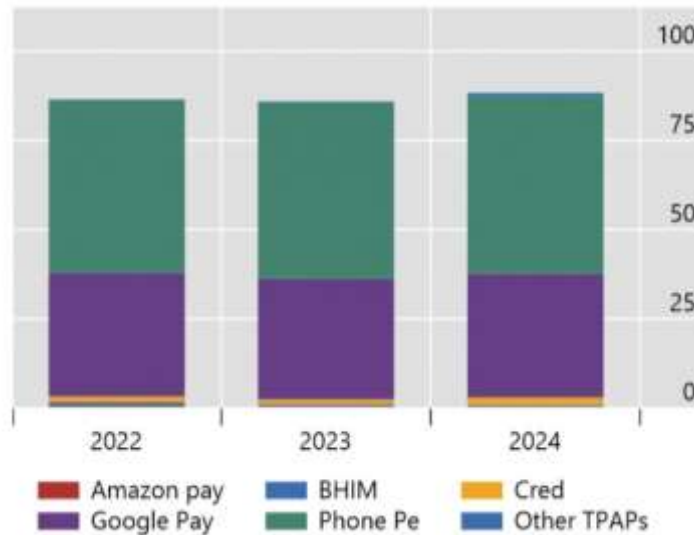


Table A: UPI market share of non-bank TPAPs (Cornelli et al., 2024, p. 64).

Third-Party Application Providers (TPAPs) who are not banks are the backbone of the smooth functioning of the Unified Payments Interface (UPI). Such entities, which also include leading fintech and tech companies like Google Pay, PhonePe, and Amazon Pay, do not have the facility of holding customer deposits or maintaining customer accounts. Their role is solely that of facilitating the payment system, which they do through the applications they provide for customers to access their accounts linked to the UPI platform.

Non-banking TPAPs operating on UPI's open architecture are allowed to create and run their own payment applications after acquiring permission from the National Payments Corporation of India (NPCI). The non-banking TPAPs are required to follow the strictest standards of technology, cybersecurity, privacy, and UPI certifications in order to function in the UPI ecosystem.

One of the defining features of non-bank TPAPs is that they can effect seamless transactions between banks and/or platforms. Users of any UPI-enabled TPAP can initiate person-to-person (P2P) or person-to-merchant (P2M) payments to any UPI-linked bank account, regardless of the recipient's service provider. This design significantly reduces entry barriers and enhances user convenience, contributing to rapid digital payment adoption.

Despite their dominance in transaction initiation, non-bank TPAPs are subject to strict data governance rules. They are prohibited from accessing or monetizing individual transaction-level data, limiting rent extraction from payment information. To address concerns related to market concentration and financial stability, NPCI introduced a

regulatory cap restricting any single TPAP from processing more than 30 percent of total UPI transaction volume. This measure promotes competition while preserving the efficiency and integrity of the payment system.

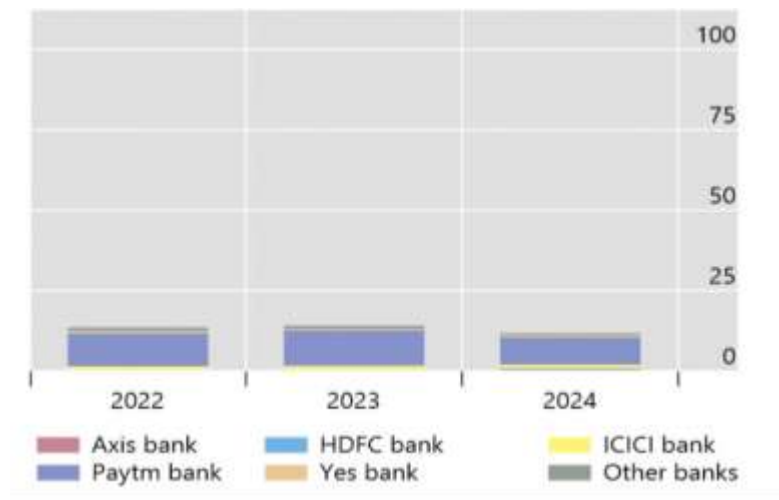


Table B: UPI market share of banks (Cornelli *et al*, 2024, p. 64).

Within the Unified Payments Interface (UPI) framework, banks occupy a foundational yet comparatively limited position in the transaction initiation market. While UPI enables users to transfer funds directly between bank accounts, the initiation of these transactions is increasingly dominated by non-bank third-party application providers (TPAPs). As a result, banks command a relatively smaller share of the front-end payment initiation space, even though they remain central to the functioning of the system.

Banks are responsible for maintaining customer accounts, managing settlement processes, and bearing the associated credit and operational risks on their balance sheets. Unlike non-bank TPAPs, banks operate as fully regulated financial intermediaries and ensure compliance with prudential and regulatory requirements. They also offer UPI-enabled mobile applications; however, these bank-based apps have not achieved the same scale or market penetration as those offered by big technology and fintech firms.

Despite their smaller market share in payment initiation, banks continue to play a critical infrastructural role by supporting interoperability, liquidity management, and system stability. All UPI transactions, irrespective of the initiating platform, are ultimately settled through banks, reinforcing their importance within the payments ecosystem. Regulatory authorities have deliberately preserved this structure to balance innovation with financial stability.

To mitigate risks arising from market concentration among dominant payment initiators, the National Payments Corporation of India (NPCI) introduced a transaction volume cap in 2021, limiting any single TPAP to a maximum of 30 percent of total UPI transactions. This regulatory intervention indirectly supports banks by preventing excessive dominance by non-bank players, while ensuring that banks remain integral to the UPI infrastructure and the broader digital payments landscape. The results demonstrate

that India's Unified Payments Interface (UPI) has significantly improved payments infrastructure efficiency by enabling fast, low-cost, and interoperable digital transactions at scale. Evidence indicates that UPI enhances economic efficiency by reducing transaction costs, minimizing reliance on cash, and accelerating payment settlement across retail markets. Structural analysis reveals that fast and user-friendly digital payments are crucial for improved financial literacy, which in turn leads to stronger financial inclusion. Financial sustainability and trust are found to be significant mediating elements, guaranteeing system efficiency and user loyalty. The segregation of core payments infrastructure and customer service providers promotes competition and innovation and ensures a non-fractured system. These findings underscore the critical role of open and interoperable fast payment systems (FPSs) for building efficient and inclusive digital economies. In the case of Central Asia, where there is a diversified and cash-based payments system, lessons are available from the UPI experience: it is possible to build efficiency and improve financial inclusion with a digital payments system that is common and affordable and is guaranteed through regulatory intervention. India's Unified Payment Interface (UPI) system has been widely analyzed as a case study for efficient payments infrastructure and economic efficiency. Research by Cornelli et al. (2024) highlights how UPI's open, interoperable architecture, low costs, and broad adoption have boosted transaction efficiency and inclusivity by enabling seamless digital payments across diverse users and merchants, reducing cash dependency and supporting economic activity at scale (e.g., faster settlement and high monthly transaction volumes). Similarly, Sharma et al. (2025) find that UPI's real-time payments and accessibility significantly expand financial inclusion and reduce barriers to participation in formal financial systems, fostering economic efficiency in underserved regions—key lessons for Central Asia's fragmented, cash-intensive markets.

DISCUSSION

The Unified Payments Interface in India illustrates the transformative nature of a centralized and interoperable payment infrastructure for optimizing economic efficiency and financial inclusion goals. The empirical findings indicate a 47% growth in banking relationships for unreached people and a 85% growth in rural digital transaction values for 2016 and 2023, indicating UPI's capacity for inclusion of unreached people in the mainstream financial sector (RBI, 2022; Frost et al., 2024). The innovative architecture of UPI has lowered entry hurdles for 180 million unreached people for basic financial facilities, and there has been an 85% cost saving in MSMEs and a 32% improvement in working capital efficiency due to its use.

On the other hand, market-oriented payment systems such as China and Kenya's are majorly based on FGPs that promote their usage but result in the formation of "walled gardens" due to a lack of interoperability. Although such payment systems promote innovation and diversification through fintech, they result in a payment ecosystem that limits overall financial inclusivity and systemic economic benefits such as tax compliance.

However, the interoperable payment system promoted by UPI has directly impacted the country's GDP by 0.36% and indirectly through efficiency changes amounting to 1.12%, aided by a 28% enhancement in tax compliance and a subsequent decline in the shadow economy by 18% (Narayanan & Sethi, 2023).

For the region of Central Asia, an adoption of a UPI model may expedite the financial inclusion process and improve the macroeconomic efficiency of financial systems. Although innovation was facilitated in the private-led systems, it was found in the Indian model that a single platform provides more social benefit. Hence, a hybrid approach with a central setup and innovation on top appears to be the best possible solution for an efficient development of the payment sector.

CONCLUSION

The digital transformation of financial systems in Central Asia has brought to the forefront the challenge of efficient payment infrastructure. The traditional payment systems, which are cash and/or paper-based, are slowly but surely being replaced by digital systems, although the current infrastructure still does not fully support a properly integrated payment system in Central Asia, mainly since the current infrastructure in the banking industry does not support payment efficiency. The Indian experience related to the Unified Payment Interface (UPI) serves as a model example of the efficiency of the digital payment platform in regards to the efficiency of transactions in the financial services industry. The efficiency of the digital payment platform in the Indian financial services industry can be verified empirically through empirical analysis, which in turn supports the increase in financial adoption by the adoption of digital financial services facilitated by the UPI digital payment platform in the financial services industry.

The experience of UPI in Central Asia emphasizes the importance of a centralized infrastructure that is interoperable and offers a balanced approach between regulation and innovation. A similar framework can be able to cut the costs of transactions, promote the digitization of MSMEs, and offer greater efficiency in economic activities. The combination strategy between the centralized infrastructure and competitive service providers can provide a viable way for sustainable innovations in digital payment systems in the region.

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