

Building Public Digital Infrastructure for the Next Century:

The Case of India's
Unified Payments
Interface

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Key Takeaways

- India is expected to clock the fastest growth in the digital payments sector between 2019 and 2023, with a compounded annual growth of 20.2%. India's Unified Payments Interface (UPI) is a real-time payments system that allows users to instantly transfer funds between bank accounts through a mobile application. With 200 banks live on a single platform, and multiple private service providers, it has fostered a diverse and innovative fintech ecosystem.
- The UPI can be seen as a case of a GovTech innovation that puts the user at the centre, designs for safety in transactions, and allows multiple private players to build on top of a public, regulated platform. The UPI is a part of the larger "India Stack", a family of APIs, open standards, and infrastructure components. The digital payments architecture of the NPCI is designed to include users without internet access, coupling the *99# mobile SMS system with the UPI to make payments. The UPI has helped bridge a critical internet access gap and helped increase the ambit of financial services to rural India.
- In 2019, UPI went global, launching in Singapore, and is ready to expand across Asia and Africa. At the same time, UPI poses policy challenges given its mandate. Issues such as the government's Zero-Merchant Discount Rate Policy, lack of public accountability of its key governing body (the NPCI), and fintech companies' access to financial data in the absence of a legal framework for data protection in India are causes for concern.
- UPI's overwhelming popularity, owing to apps developed by tech giants like Google and Facebook, also raises concerns about an emerging Google-Facebook duopoly, lack of risk management processes and resilience of financial ecosystems dependent on big private entities.

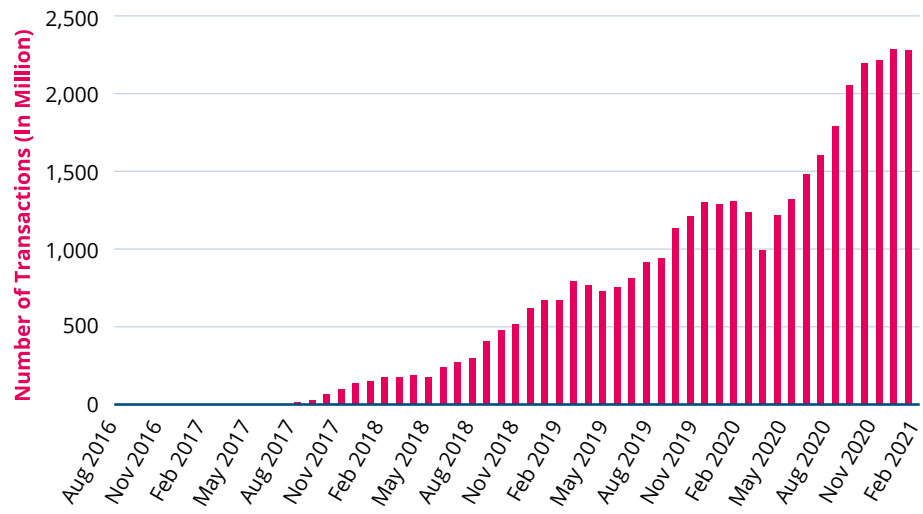
1 Introduction

India's Unified Payments Interface (UPI) is a digital payments infrastructure that has been making headlines since its launch in 2016. Developed indigenously, UPI is part of a broader agenda of achieving financial inclusion through developing an open and publicly held national payments system. UPI is an interoperable, real-time payment platform that provides cheap and instantaneous financial services to citizens. From 21 banks that were part of the infrastructure at the time of its inception to 200 live member banks at present, UPI has grown rapidly in its four-year journey.¹ It crossed a milestone of 1 billion transactions in November 2019, with transaction volumes having risen from \$4.13 million in August 2016 to \$26.02 billion in October 2019 (Figure 1). In July 2020, UPI hit 1.5 billion transactions, worth \$39.93 billion, its highest ever in a single month.² UPI's governing body, the National Payments Corporation of India (NPCI), forecasts that by 2023 the annual number of UPI transactions would reach a massive 60 billion.³

India's public digital infrastructure model is a novel approach that involves building platforms that onboard stakeholders and serve as the foundational infrastructure to support financial growth and boost innovation. The UPI is a state-of-the-art innovation, pivotal in fostering a government-tech ecosystem in India. The "public goods" model seeks to challenge the standalone private payment systems that have been the dominant walled-gardens in the finance sector so far. This paper makes a case for a public digital infrastructure, built through public-private sector collaborations, which can be crucial for economic empowerment, information access, and financial inclusion.

- 1 "UPI Live Members." NPCI, 2020. (<https://www.npci.org.in/what-we-do/upi/live-members>).
- 2 Manikandan, Ashwin. 2020. "Record volumes as digital payments thrive in time of pandemic." *Economic Times*, 3 August. (<https://tech.economictimes.indiatimes.com/news/internet/upi-clocks-highest-monthly-volume-with-1-5-billion-transactions-in-july/77306734>).
- 3 Ramsey, Craig. 2019. "How far UPI can reach in India: After 1 billion transactions, this is next." *Financial Express*, 20 December. (<https://www.financialexpress.com/industry/banking-finance/how-far-upi-can-reach-in-india-after-1-billion-transactions-this-is-next/1799529/>).

Figure 1: UPI transactions by volume since launch (2016–2021). Source: NPCI Data.



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2 Background: Creating an Inclusive Cashless Economy

C Access to finance is critical for growth for emerging markets as well as developed economies in the 21st century. India's approach to digital finance includes providing digital infrastructure as a public good. Unlike private financial infrastructure that involves tolls to make innovations pay off, public goods are systems which allow multiple players to build on top of a financial public road. Towards this end, the National Payments Corporation of India (NPCI) was set up in 2008 to create a robust payments and settlement infrastructure. RBI's vision was to "encourage electronic payment systems for ushering in a less-cash society in India and to ensure payment and settlement systems in the country are safe, efficient, interoperable, authorised, accessible, inclusive and compliant with international standards".⁴ Before developing the UPI, the NPCI developed the Immediate Payment Service (IMPS), which operates 24/7. IMPS was channel-independent and could be accessed through mobile phones, internet, ATM, and Unstructured Supplementary Service Data (USSD) on basic phones with low-speed mobile internet access. IMPS provided a mobile-based interoperable fund transfer service using India's National Finance Switch (NFS), which laid down a standard for all banks in the country to facilitate interop-

⁴ Reserve Bank of India. 2012. "Payment Systems In India Vision 2012-15." Department of Payment and Settlement Systems, Reserve Bank of India.

erable payments. Transfers could now involve various stakeholders such as banks, merchants, and telecom service providers.⁵ UPI is built using IMPS technology with the added advantage of instant transfers at zero transaction costs for consumers. It was the first instant, peer-to-peer, round-the-clock payments system that allowed transfers between users, banks, and merchants, all on a single platform.

The vision of UPI catered to broadening access to the banking system using the national digital biometric identity for all citizens – the *Aadhaar* – to facilitate the move towards a cashless economy. India has taken long strides in its march towards this goal. The Global Findex Database, released by the World Bank in 2011, stated that only 40% of adult Indians had a bank account.⁶ The prime reasons were the financial weakness of the rural poor and their exclusion from the formal economy. Seven years later, the Findex in 2018 reported that almost 80% of adult Indians held bank accounts. UPI and India's digital payments ecosystem have leveraged this growth to leapfrog the debit-and-credit-card generation to financially empower the poor, non-urban, and marginalised populations in the country. The development of UPI as a real-time payments system platform has created ease of transactions for both retail customers as well as small-scale users. However, despite this leap, India remains the second-largest economy with an unbanked population of 191 million, after China.⁷ India has 504 million active internet users, with rapidly rising rural internet penetration. This is only about 40% of the Indian population.⁸ The digital payments architecture of the NPCI is designed to include users without internet access, coupling the *99# mobile SMS system with the UPI to make payments. The UPI has helped bridge a critical access gap between those who have access to the internet and those who do not. Since its introduction in 2016 to 2020, the *99# system has clocked transactions worth 10 billion through its USSD service.⁹ The UPI went international in 2019, launching at the Singapore FinTech Festival. UPI will now allow cross-border transactions between the two countries using a QR code-based system and a UPI application.¹⁰

5 Gochhwal. 2017. "Unified Payment Interface – An Advancement in Payment Systems." *American Journal of Industrial and Business Management*. (https://www.scirp.org/pdf/AJIBM_2017102515484308.pdf).

6 World Bank. 2020. "Global Financial Inclusion – Database." (<https://databank.worldbank.org/reports.aspx?source=1228>).

7 World Bank. 2020. "Global Findex Database." (<https://globalfindex.worldbank.org/>).

8 Digital in India 2019 – Round 2 Report". IAMAI and Nielsen, 2019. (<https://cms.iamai.in/Content/ResearchPapers/2286f4d7-424f-4bde-be88-6415fe5021d5.pdf>).

9 "*99# Product Statistics." NPCI, 2020. (<https://www.npci.org.in/what-we-do/99/product-statistics>).

10 "BHIM UPI goes international, launches at Singapore FinTech Festival". *Business Standard*, 2019. (https://www.business-standard.com/article/pti-stories/bhim-upi-goes-international-qr-code-based-payments-demonstrated-at-singapore-fintech-festival-119111300380_1.html).

3 What is the Unified Payments Interface?

The UPI was conceptualised as a paperless and cashless mode of fund transfer that would offer financial and non-financial services. The UPI is a payments architecture built on the IMPS and allows users to perform bank transfers directly from their mobile devices. UPI merges banking features, seamless fund routing, and merchant payments onto a single system.¹¹ UPI is a real-time payments system which is built mobile-first and does not require any additional hardware, and currently provides connectivity to 200 banks across India.¹² Its architecture aims to take advantage of increasing mobile penetration and internet adoption to provide financial services. It allows all bank account holders in India to send and receive money instantly from their smartphones without the need to enter bank account information or net banking user id/password.¹³ UPI was inaugurated on 11 April 2016¹⁴ and launched for public use on 25 August 2016.¹⁵

3.1 How does UPI work?

The uniqueness of UPI lies in its four-party integrated framework. In the UPI framework, a consumer uses an app called a PSP (Payments Service Provider). Enabled by the UPI switch, the PSP can communicate with the user's bank account. UPI is the first platform to enable

¹¹ "UPI Product Overview." NPCI, 2020. (<https://www.npci.org.in/what-we-do/upi/product-overview>).

¹² Abraham, Sunil. 2020. "Unified Payment Interface: Towards greater cyber sovereignty". Observer Research Foundation Issue Brief. (<https://www.orfonline.org/research/unified-payment-interface/>).

¹³ "UPI API Overview." India Stack, 2020. (<https://www.indiastack.org/upi/#:-:text=%E2%80%9CUnified%20Payment%20Interface%E2%80%9D%20>).

¹⁴ "NPCI Presents Unified Payments Interface (UPI) System." NewsVoir, 11 April 2016. (<https://www.newsvoir.com/release/npci-presents-unified-payments-interface-upi-system-6523.html>).

¹⁵ "NPCI's Unified Payments Interface (UPI) Set to Go Live". NPCI, 25 August 2016. ([https://www.npci.org.in/PDF/npci/press-releases/2016/NPCISUnifiedPaymentsInterface\(UPI\)settogoliveAugust252018.pdf](https://www.npci.org.in/PDF/npci/press-releases/2016/NPCISUnifiedPaymentsInterface(UPI)settogoliveAugust252018.pdf)).

users and merchants to raise simultaneous payment requests using its infrastructure. This design makes it a scalable architecture that is powered by a set of open APIs (Application Programming Interfaces).¹⁶ This makes a mobile phone the primary payments device for consumers and merchants, thereby universalising digital payments.

UPI payments transactions involve the following four parties:

- **PSPs:** Payments Service Providers (PSPs) are user-facing entities that provide payments service to consumers and payments infrastructure support to merchants, online and offline. They are UPI applications developed by banks themselves or third parties like Google and Facebook.
- **Issuer Banks:** Banks integrated onto the UPI rails.
- **NPCI and the UPI rails:** Provides the rails and the NFS-UPI switch to enable inter-bank communication. It also holds the NPCI Central Mapper, a repository of customers' information.
- **Customers:** Users with mobile devices.

To transact using UPI, a user needs to create a Virtual Payments Address (VPA) or a UPI ID which is authenticated using their *Aadhaar* number, mobile number, or bank account on a payments application (e.g., BHIM, Tez, GPay). This VPA acts as the financial address of the user. Multiple levels of identifiers can be used to send or receive money. The VPA and Mobile Pin are the first layer of authentication. The VPA makes the need for authentication and transaction-bound One Time Password redundant. A mobile phone, combined with a unique ID, negates the need for issuing costly cards for digital payments and simplifies payments. Biometric integration provides a second-factor authentication, providing a second layer of security to each transaction.

The architecture allows two kinds of transactions to take place:

- 1 Push Requests: These are requests by users to push money into the accounts of beneficiaries.
- 2 Pull requests: These are "collection requests" initiated by beneficiaries who could be persons or merchants to a payer using the VPA. The payer receives a collect request on their UPI app and authenticates using their four-digit MPIN.

The UPI was designed with a single-click double authentication system in mind, making secure transactions possible at a click of a button. The first factor is the hard-bound mobile device fingerprint, which is authenticated by the PSP UPI app. The second factor to validate the transaction is a four-to-six-digit MPIN, which is created by the user and captured on the NPCI libraries embedded in the app.

The VPA also enables pull requests in peer-to-peer transactions, a first in India. This dramatically simplifies merchant payments, as businesses can now use pull requests for transfers from payers. Users experience ease as a single app can be used for managing multiple bank accounts as well as multi-party transfers. For the sustainability of the UPI architecture, the NPCI charges a Merchant Discount Rate (MDR) fee. MDR is the cost paid by a merchant to a bank for accepting

¹⁶ An API is an interface that enables interactions between software applications, to share content and data. Open APIs are publicly accessible.

payments from their customers via digital means. MDR charges are revenue sources for banks, companies, and terminal providers who have hopped on the UPI rails, and allow the building, maintenance, and delivery of the digital finance infrastructure.¹⁷

3.2 Widening the Net: Coupling with the *99# Service

UPI is integrated with another product created by the NPCI, the *99# mobile banking service based on the Unstructured Supplementary Service Data (USSD) communications protocol – a communications technology used by mobile phones for payments transactions. The *99# service, developed by the NPCI, provides financial, non-financial, and value-added services without internet access using SMS.¹⁸ A user can send and receive payments, get access to banking services, and access account information regarding the Pradhan Mantri Jan Dhan Yojana (PMJDY), India's National Mission for Financial Inclusion. The PMJDY is the biggest financial inclusion initiative in the world, aimed at providing access to financial services, bank accounts, credit, insurance, and other social security measures rolled out by the government of India. JAM¹⁹ gave a push to the UPI payments architecture and created integration across multiple government services. The UPI coupled with the *99# service has helped widen the net of financial services.

3.3 Key Features of the UPI

The UPI has become admirable owing to its unique features. The “digital goods” approach allows for several internet companies to build onto the UPI framework, allowing users a choice across PSPs, leaving them to manage user experience from start to the completion of the transaction. This also fosters competition in a rapidly growing market. Most UPI apps are available in multiple languages, and competition has encouraged differential products that enhance consumer experience. The key features of UPI are as follows:

- Interoperability across banks in India
- Payments occur in fiat money inside the formal financial system
- Zero transaction costs for users
- The rails approach ensures that parties act within a financial regulatory framework set by the Reserve Bank of India
- Pull requests from individuals and merchants
- Merchant payments using QR code scans (Bharat QR) at physical outlets
- Usability on mobile devices with or without internet access (with the USSD service)
- Daily limit of ₹1 lakh (a hundred thousand) per user

¹⁷ “No MDR charges applicable on payment via RuPay, UPI from Jan 1.” Economic Times, 28 December 2019. (<https://economictimes.indiatimes.com/industry/banking/finance/banking/no-mdr-charges-applicable-on-payment-via-rupay-upi-from-jan-1-sitharaman/articleshow/73008967.cms?from=mdr>).

¹⁸ “*99# Product Overview.” NPCI, 2020. (<https://www.npci.org.in/product-overview/99-product-overview>).

¹⁹ Launched in 2014, Jan Dhan Yojana (JAM) is India's nationwide scheme for financial inclusion which includes access to credit, public schemes, insurance, pension and other banking and financial services.

4 The BHIM App: Creating a Competitive Payments Service Provider

BHIM (Bharat Interface for Money) is a Payments Service Provider (PSP) application developed by the NPCI and launched on 30 December 2016. BHIM got a boost owing to the state announcement of banknote demonetisation in November 2016, as a result of which 86% of currency notes were rendered worthless.²⁰ To push digital payments, BHIM was launched within a month. It could be used on any mobile device and was built with user-friendly features. It is one step ahead of mobile-wallets like Paytm, MobiKwik, mPesa, etc. that hold money, and decrease the amount of interest users earn on their savings. Leveraging the UPI rails, it did not need to hold cash in a wallet. BHIM is a multilingual app, currently available in 20 Indian languages.²¹ This is a crucial aspect in a country like India, which has immense linguistic diversity. Its functionality was designed keeping concerns around ease of use, privacy, and user diversity in mind. To boost usage, the government began several referral and cashback programmes to incentivise the use of the app. A corpus of ₹4950 million (\$6754 million) was set aside by the Ministry of Electronics and Information Technology in 2017. However, the PSP market is open and competitive, allowing companies like Tez, PhonePe, and GPay to

²⁰ "Gazette, Government of India." *Gazette of India, Government of India, New Delhi*, 2016.

²¹ "BHIM Product Overview." NPCI, 2020. (<https://www.npci.org.in/product-overview/bhim-product-overview>).

build on top and provide better user experience. Several apps have included features designed for greater accessibility for those with visual impairment and the elderly, like the “talk-back” option.

The BHIM app, along with other private apps, has allowed India to leapfrog to a cashless system, bypassing card-based transactions as well as mobile wallets. However, its presence has not prevented market dominance by foreign firms. In 2016, BHIM accounted for 45% of all UPI transactions by volume;²² however, that number had reduced to 5.37% in March 2020.²³ Google Pay and Walmart’s PhonePe are in a race to the top place in the Indian payments app market,²⁴ followed by Alibaba-backed Paytm and about 150 other PSPs.²⁵

22 FE Bureau. 2018. “BHIM share in UPI pie shrinks in December.” Financial Express, 3 January. (<https://www.financialexpress.com/market/bhim-share-in-upi-pie-shrinks-in-december/999404/>).

23 Ajay, Kumar Shukla. 2019. “BHIM loses sheen as market share shrinks to 5.37%.” The Economic Times, 6 September. (<https://government.economictimes.indiatimes.com/news/digital-payments/bhim-loses-sheen-as-growth-shrinks-to-5-37-market-share/71009004>).

24 Manish, Singh. 2020. “Google and Walmart establish domicile in India’s mobile payments market as WhatsApp Pay struggles to launch.” Tech Crunch, 4 June. (<https://techcrunch.com/2020/06/03/google-and-walmarts-phonepe-establish-dominance-in-indias-mobile-payments-market-as-whatsapp-pay-struggles-to-launch/>).

25 Mahesh, Uppal. 2020. “Keeping India’s payments market competitive.” MSN, 9 June. (<https://www.msn.com/en-in/money/markets/keeping-indias-payments-marketcompetitive/ar-BB15gtQU?li=AAg-fW3S>).

5 Governing the UPI: The National Payments Corporation of India

The NPCI is a “not for profit” company, promoted by a consortium of public sector, private and foreign banks in India. It was set up in 2008 to play the role of a multi-payment system operator by India’s central bank, the Reserve Bank of India (RBI), and the Indian Banks Association (IBA). The Indian Banks Association represents 237 banks operating in India. Among its many objectives is to develop and implement innovations, operations, and procedures in the Indian banking industry.²⁶ The NPCI plays a strategic role in the state-driven financial technologies ecosystem. NPCI acts as the governing authority for all digital transactions that occur on the UPI. It is also the settlement agency that powers the UPI network and provides a Software Development Kit (SDK) to enable the building of consumer-facing applications.

²⁶ “Indian Banks Association: Objective.” Indian Banks’ Association, 2020. (<https://www.iba.org.in/objective.html>).

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The NPCI is an umbrella organisation for operating retail payments and settlement systems across the country. The NPCI was instituted under the Payment and Settlement Systems Act, 2007. Section 4(2) of this Act mandates that public sector banks must hold not less than 51% of the equity of its payments system. At the time of its incorporation in 2009, the ten founding public sector banks held 60% of its equity. By 2016, this base had expanded to include 56 banks across the public and private sector, to increase cross-sectoral representation.²⁷ This move decreased the share of the public sector by 57%. NPCI became the first not-for-profit Indian company “offering equity shares through private placement and thus, creating a historical milestone. This is a strategic investment for the banks as investors will not be entitled to dividend on their investments”, stated Sanjay Saxena, the Chief Financial Officer of the NPCI. The expansion is set to make NPCI a truly “community-owned” institution.²⁸ The NPCI has expressed interest in decreasing the public sector share to the legal minimum and in bringing smaller banks on board. These steps will increase accountability in NPCI’s governing architecture. In November 2020, the NPCI expanded its stakeholder base beyond banks to include one public sector bank, five private sector banks, forty foreign banks, ten small finance banks (SFBs), six payments banks and 80 payments service providers, including Paytm, PhonePe and Amazon Pay.²⁹

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Along with the UPI, the NPCI plays a pivotal role in introducing several banking services, across last-mile technologies, including cheques, biometric ATMs, smart cards, mobile phones, and smartphones. It has also created structures for recurring payments services under the Bharat Bill Payments System and the automatic road toll payments system called FASTag. The Watal Committee on Financial Payments in 2016 recommended that the NPCI must improve its holding architecture to reflect greater infrastructure neutrality.³⁰ The committee recommended a move towards diffused shareholding, where no individual shareholder along with persons acting in concert can hold more than five percent of the equity share capital. The committee also recommended including all classes of Payment Service Providers to expand the scope of UPI. To ensure that the board of the NPCI should have majority-independent directors, representing the interests of consumers in payments markets and who do not have any association which might conflict with their role.³¹

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27 “About NPCI.” NPCI, 2020. (<https://www.npci.org.in/who-we-are/about-us>).

28 “NPCI expands shareholder base adding 46 banks.” The Hindu Business Line, 16 January 2018. (<https://www.thehindubusinessline.com/money-and-banking/npci-expands-shareholder-base-adding-46-banks/article9099863.ece>).

29 Palepu, Advait. 2020. “NPCI diversifies shareholding with 131 new partners.” Medianama, 9 November. (<https://www.medianama.com/2020/11/223-npci-diversifies-shareholding-with-131-new-partners/>).

30 Nikhil, Pahwa. 2017. “Improve NPCI shareholding, governance within 60 days, says Watal Committee.” Medianama, 13 January. (<https://www.medianama.com/2017/01/223-npci-shareholding/>).

31 Komal, Gupta. 2018. “Panel suggests board to oversee digital payments industry.” Livemint, 18 September. (<https://www.livemint.com/Industry/UrjaT-kyrIrfLF9t1bv2jdO/Panel-suggests-board-to-oversee-digital-payments-industry.html>).

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India Stack: The "Three Rails" of Pub- lic Digital In- frastructure

A technology stack usually refers to a set of interconnected yet independent single-purpose technologies – called “platforms” – that work together towards general-purpose tasks. Such a set is called a “stack” because it is modular in structure and its components can be stacked upon each other to build a digital infrastructure. Platforms are complex systems that connect several users, involving the exchange of information, goods, or money. Uber can, therefore, be understood as a platform which allows for data transfers and payments to occur within itself, and enables services outside it. Platforms also show powerful network effects that increase access, reduce costs of operation, and improve service delivery. Such stacks, when developed by public entities, can serve as public infrastructure in an information economy.

India Stack is a foundational public digital infrastructure, designed to onboard public and private sector innovators to operate within a regulatory infrastructure regardless of their size. At the heart of the India Stack lies *Aadhaar* – a biometric database based on a 12-digit digital identity, authenticated by fingerprints and retina scans. *Aadhaar* is India’s unique biometric identification system, which covers 88.6% of the population. The UPI forms the second, cashless layer of India Stack, while the *Aadhaar*

is its presence-less bottom-most layer. UPI can be understood as the payments rail built on top of the *Aadhaar* identity stack. The *Aadhaar* features three services that allow UPI to function:

- 1 The e-KYC (e-Know Your Customer) used to identify banks;
- 2 E-Sign or digital signatures for safely signing digital documents; and
- 3 DigiLocker, a digital repository for storing identification and authentication documents. The third layer of India Stack is the data-sharing framework, a consent layer, which is used to manage user data across the stack.

While each of these layers exists in many countries across the world, the uniqueness of India Stack is in its integration to enhance user experience. It promotes a host of new services, from lending to insurance and wealth management. Many public platforms have been developed over *Aadhaar*, each for a single purpose, but enabling other services and capable of scaling up. Using the payments systems terminology, these platforms are called “rails”, as they serve as an infrastructure for other applications to run on top of.³² The rails approach of the UPI is an innovation in the open banking space, but is different from an integrated systems approach like Europe’s PSD2. The PSD2 is a European regulation for electronic payments services that aims to create an open banking payments ecosystem. While the PSD2 seeks to create an integrated banking system that requires banks to open their APIs to process payments, UPI creates a centralised payments architecture which onboards banks using a public API.

India Stack was inaugurated with the development of *Aadhaar* in 2009 and enabled government service delivery through the *Aadhaar*-enabled Payments System (AePS). The AePS created a framework for the state to electronically channel benefits and subsidies to citizens in 2011³³, revolutionising government services through a leakage-free model. India Stack has helped overcome two simultaneous challenges: first, the exclusion based on lack of identification, and second, creating payments services within the formal economy. India Stack is a state-led initiative, materialised using private sector collaborations, at the centre of which is the iSpirt Foundation. This private non-profit company built the India Stack APIs. India Stack also enables ease of regulation, as it is owned and operated by the Reserve Bank of India. By bringing a Big Tech firm and a bank onto the same platform, it also ensures financial stability, and risks involved with private control are warded off.³⁴

Since its inception, India Stack has emerged as an innovation that can exemplify how a unified public technological ecosystem with multi-layered platforms can significantly improve access to financial services.³⁵ A United Nations high-level panel on digital cooperation launched by General Antonio Guterres lauded India for undertaking revolutionary digital initiatives to ensure economic inclusion for its 1.3 billion citizens. The panel report

32 D’Silva et al. 2019. “The design of digital financial infrastructure: Lessons from India.” Bank for International Settlements BIS Papers No 106. (<https://www.bis.org/publ/bppdf/bispap106.pdf>).

33 “What is India Stack.” India Stack, 2020. (<https://www.indiastack.org/about/>).

34 D’Silva et al. 2019. “The design of digital financial infrastructure: Lessons from India.”

35 Olivier, Garret. 2017. “India Is Likely To Become The First Digital, Cashless Society.” *Forbes*, 28 June. (<https://www.forbes.com/sites/oliviergarret/2017/06/28/india-is-likely-to-become-the-first-digital-cashless-society/#5d97b46f3c80>).

recognised the significant role played by India Stack in helping government agencies and entrepreneurs achieve financial inclusion in India.³⁶

The NPCI developed the Unified Payments Interface (UPI) for facilitating real-time fund transfers between bank accounts by using mobile numbers, QR codes, *Aadhaar* numbers, or virtual payment addresses mapped to individual bank accounts. A key enabler was the seeding of personal and biometric *Aadhaar* data with individual bank account information. Transactions executed through the authentication of *Aadhaar* data gave rise to the *Aadhaar*-enabled Payments Systems (AePS). These services have made digital transactions link across various services, smoothed bill payments for government services, and created a single platform for raising complaints.

6.1 UPI as a Government Technology Innovation: The Payments Rail

According to a report by Gateway House, India's public architecture for digitisation and finance is unique as India Stack and the UPI, "highways for a digital future", are public-owned, unlike the US's and China's, where critical parts of such infrastructure are owned by private entities.³⁷ India's early move on financial inclusion has allowed it to leapfrog using state intervention and collaborations with the private sector.³⁸

India offers a compelling example of how the state regulator and the regulated entities can collaboratively run a public digital platform that provides open access to market players and settles payments instantly. This is not without precedent. To take a physical example, states build highways to lower the cost of transportation and offer "open access" to private players to innovate and create value. Many of the foundational technologies of the last few decades, including the internet and GPS, were initially supported by state governments and later made publicly available to the private sector to innovate further. Since its inception, the UPI has been pivotal in creating a flourishing fintech ecosystem in India, which includes Indian start-ups as well as foreign firms. As of 2019, India had fifty UPI-based wallet providers and more than forty-five mobile wallet providers.³⁹ Google credits the success of its digital payments platform, GPay, in India to UPI, hitting sixty-seven million monthly active users in 2019, and becoming a market leader in 2020 by accounting for 857.81 million transactions. Along with PhonePe, it swept 86% of the UPI market share in India this year.⁴⁰ This raises concerns over the UPI market turning duopolistic. Digital payments in India is a competitive landscape, involving telecom companies, e-commerce giants, banks and internet companies. A host of services allied to payments have been enabled through the UPI. This includes financial services, mobile marketplaces, utility and bill payments, payment containers like super-apps and digital literacy campaigns for last-mile adoption of government schemes.

36 UN panel lauds India's digital initiatives for economic inclusion." *The Economic Times*, 13 June 2019. (<https://economictimes.indiatimes.com/news/economy/fice/un-panel-lauds-indias-digital-initiatives-for-economic-inclusion/article-show/69769783.cms>).

37 "Gateway of India Dialogue: Where Geopolitics meets Business." Gateway House, Ministry of External Affairs, Report 2016. (https://www.gatewayhouse.in/wp-content/uploads/2016/02/GOID2016_CONFERENCE_REPORT_WEB_ONLY.pdf).

38 Abraham, Sunil. 2020. "Unified Payment Interface: Towards greater cyber sovereignty."

39 "Fintech in India-powering mobile payments." KPMG, 2019. (<https://assets.kpmg/content/dam/kpmg/in/pdf/2019/08/Fintech-in-India%E2%80%93Powering-mobile-payments.pdf>).

40 Banerjee, Prasad. 2020. "Google Pay, PhonePe account for 86% of UPI transactions by value in Oct: NPCI." *Livemint*, 7 December. (<https://www.livemint.com/news/india/google-pay-phonepe-account-for-86-of-upi-transactions-by-value-in-oct-npci-11607324956131.html>).

Over the last decade, India has created a series of digital platforms built with this approach. Each of these platforms is built within the regulatory architecture and encourages open participation by private sector players, thereby creating interoperability and enabling fair competition on a level playing field. Building digital platforms as public goods with open APIs (Application Programming Interfaces) enables both public and private sector players to participate. Further, it lowers onboarding costs and transaction costs and enables further innovations on top of the platform.

A key question for the design of any infrastructure system is the appropriate mix of public and private involvement. While investment in the digital sector is sometimes seen as a purely private sector activity, there are challenges with the market-led approach. Creating and maintaining digital infrastructure can require significant investment and long lead times. This could disincentivise investments, reduce competition, and potentially exclude weaker, marginalised sections of society. Given the central role of digital infrastructure in the digital economy, there is a case to be made for considering digital public infrastructure as social goods. India's approach takes a middle ground in the GovTech spectrum between fully state-led digitisation approaches with zero private sector participation and entirely private payments platforms (like VISA and PayPal) through creating a hybrid "rails" model where the government builds and maintains public digital infrastructure that is open for multiple private players to build upon. It fosters an ecosystem of services, pushes innovation, and ensures regulatory compliance.

The success of India Stack's rails approach to building public digital infrastructure with open APIs has encouraged the Indian government to build upon and extend this approach to other areas. A key example is the Bharat Bill Payment System, a common bill collection and payments platform that supports multi-channel (web, mobile, offline) and multi-payment methods (cash, card, UPI, etc). The open architecture brings banks, billers, aggregators, payment gateways, and customers onto a single platform with open-access APIs to enable instant, interoperable bill settlements. Paid bills can go into the digital locker from the India Stack. Similar models are proposed for a National Health Stack and an open credit network that enables instant access to formal credit by catalysing several credit marketplaces. While private infrastructures continue to be exclusionary, and fully state-run enterprises like the railways in India can be burdensome for the state, the UPI model offers a middle path, designed to foster innovation across sectors, public and private, within the bounds of a regulatory framework.

6.2 Challenges: Making UPI Robust and Accountable

Despite its success on many fronts, UPI has faced several challenges. One key challenge has been the announcement of a zero Merchant Discount Rate by the Ministry of Finance on all UPI payments starting January 2020⁴¹, in a move to promote digital payments. While this policy sounds good on paper, it might stifle digital payments by increasing transaction costs and thereby disincentivising users and merchants from using UPI. The Payments Council of India⁴²

⁴¹ No MDR charges applicable on payment via RuPay, UPI from Jan 1." Economic Times, 28 December 2019. (<https://economictimes.indiatimes.com/industry/banking/fice/banking/no-mdr-charges-applicable-on-payment-via-rupay-upi-from-jan-1-sitharaman/articleshow/73008967.cms?from=mdr>).

⁴² No MDR on RuPay, UPI payments will kill industry, warns industry." Economic Times, 30 December 2019. (<https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/no-mdr-on-rupay-upi-payments-will-kill-industry-warns-industry/articleshow/73031159.cms>).

has criticised this move. This could also leave a negative impact on innovation in fintech and render private companies' revenue models unviable. The UPI has also been criticised for its vulnerabilities. While the UPI does not use *Aadhaar* for authentication, but only for identification, the lack of tokenisation and the availability of the *Aadhaar* numbers with several data controllers increases the risk of fraudulent transactions.⁴³ UPI's lack of openness has also been in the spotlight amongst promoters of Free Open Source Software in India, as the UPI's technical standard is not publicly available.⁴⁴ UPI applications are vulnerable owing to their dependence on biometric data and centralised data, and the lack of a patched system, which could lead to identity thefts and doxing (leaking of personal sensitive and financial data for coercion purposes).⁴⁵ UPI frauds have increased along with the fast rise in transaction volumes. This includes fraudulent push requests to banks, as was the case with the Bank of Maharashtra, costing the bank ₹60 million (\$82 million) in losses. The lockdown during the pandemic also saw an increase in the number of financial frauds committed via UPI, including stealing of debit cards linked to UPI, fake UPI IDs to generate pull requests, and use of loopholes such as SIM updates and lack of KYC verification to loot customers.

UPI's overwhelming popularity owing to apps developed by tech giants also raises concerns. New literature on risks also suggests that service delivery by Big Tech firms often comes with a lack of risk management processes, creating a lack of resilience in financial ecosystems. As Big Tech firms use their network and infrastructure to provide service delivery, like in the case of the UPI payments ecosystem, over-dependence on private third-party services creates vulnerabilities. Big Tech also pushes harder for its own services and products, designed to increase the ease of transactions and payments while integrating with a system such as the UPI, to customers and in many ways hampers easy access over time. Finally, leveraging open banking systems like the UPI allows Big Tech (like Google Pay in India) to expand and deepen its footprint in markets in countries of the Global South. Such a presence involves access to huge swathes of data for these companies, which they then use to develop paid services.⁴⁶ A recent announcement by WhatsApp India of its intention to introduce micro-pensions and extend lines of sachet-sized healthcare coverage soon after the launch of WhatsApp Pay in India⁴⁷ is an example of how access to a broader user base also allows companies to extend financial services, which could be risky from a long-term sustainability perspective.

At the governance end, several organisations have argued that the NPCI needs to provide greater accountability to the public, given the complex nature of its role in India's finance ecosystem. Given that it is a technical regulator, under the control of the RBI, public transparency measures must be adopted to raise accountability and trust. Despite its immense power, the NPCI remains opaque and is a private body, not subject to disclosure under the Right to Information Act.⁴⁸ Despite

43 Abraham, Sunil. 2020. "Unified Payment Interface: Towards greater cyber sovereignty."

44 Srikanth, Lakshma. 2018. "As UPI 2.0 Is Unveiled, It Remains Very Much a Transaction in Progress." *The Wire*, 21 August. (<https://thewire.in/tech/upi-2-0-is-unveiled-transaction-in-progress>).

45 Patil, Chakrabarty and Sameer, Sagnik. 2019. "A Cybersecurity Agenda for India's Digital Payment Systems." Indian Council of Global Relations, Report. (https://www.gatewayhouse.in/wp-content/uploads/2019/10/Digital-Payments_FINAL.pdf).

46 "BigTech in finance." Financial Stability Board, 2019. (<https://www.fsb.org/wp-content/uploads/P091219-1.pdf>).

47 Palepu, Advait. 2020. "WhatsApp India To Introduce Micro-Pension And Health Insurance Soon." *Medianama*, 16 December. (<https://www.medianama.com/2020/12/223-whatsapp-india-introduce-micro-pension-health-insurance/>).

48 "Why NPCI and Facebook need urgent regulatory attention." *The Centre for Internet and Society*, 12 June 2018. (<https://cis-india.org/internet-governance/blog/economic-times-june-10-2018-sunil-abraham-why-npci-and-facebook-need-urgent-regulatory-attention>).

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its scope and authority, the NPCI falls under no public accountability architecture and needs to fall under a broader payments regulatory framework in India. Given its centrality (through the switch) in the UPI payments architecture, the NPCI has a full view of a person's financial status through the data it collects to avoid fraudulent transactions. The NPCI collects highly sensitive data when a transaction occurs - including the *Aadhaar* number, device location, device information, bank account numbers and the IP address. Given India's lack of a data protection law, this data lies unchecked, and creates possible vulnerabilities for UPI users.

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7 Conclusion

UPI has thus facilitated the large-scale adoption of digital retail payments in India, increasing from 65% in 2013–14 to 95% in 2018–19.⁴⁹ Aided by a young population⁵⁰ and increased mobile phone penetration, increased connectivity has led to a significant reduction in the costs of mobile data consumption, which means that digital payments in India are bound to grow further. Unlike private standalone systems, UPI is built ground-up to support overlay systems across sectors, by allowing them to leverage it and plug into India's financial system. According to an ASSOCHAM-PwC study, India is expected to clock the fastest growth in the digital payments ecosystem transaction value between 2019 and 2023, with a compounded annual growth of 20.2%. This is an estimated jump from \$64.8 billion in 2019 to \$135.2 billion in 2023.⁵¹ The UPI has made India an attractive destination for companies who want a slice of the rapidly growing payments market in the country. This comes as a double-edged sword – Big Tech companies like WhatsApp and Google have an advantage while hopping onto the rails given their wide user-base in India. This makes it harder for smaller Indian start-ups to onboard customers to their PSP apps and compete fairly in the payments ecosystem. While UPI has been successful in casting a larger financial services net to the next billion users in India, it must be kept in mind that it has also opened these populations to vulnerabilities that accompany using private, third-party financial service mechanisms. For the non-elite in India, the security of financial data shared through the payments interface remains a big question, which a data protection bill may begin to address. UPI system outages and transaction failures have also increased since 2020, as banks are unable to cope with the large volume of transactions.⁵² As UPI onboards more users, the capacity and robustness of the architecture must also be addressed.

While several challenges remain, UPI's success is proof that state-built foundational digital infrastructure can be transformative for a country of India's size. It must be noted that India is a leader in the digital payments space globally, as very few states, including the United States, have developed national payment networks that enable instant settlement. The UPI case can be studied for best practices that are replicable and can be modified to fit contexts. It shows a clear path where government agencies can lead by creating a backbone for a better digital century.

⁴⁹ D'Silva et al. 2019. "The design of digital financial infrastructure: Lessons from India."

⁵⁰ "Data from Census of India, 2011." India Census, 2011. (<https://censusindia.gov.in>).

⁵¹ ASSOCHAM-PwC. 2019. "India's digital payments projected to more than double to USD 135 billion in 4 years." (<https://www.assochem.org/newsdetail.php?id=7138#:~:text=Indias%20digital%20payments%20projected%20to,4%20years%3A%20ASSOCHAM-PwC%20study&text=%E2%80%9CIndia%20is%20expected%20to%20clock,cent%20%27%27%2C%20the%20study%20said>).

⁵² Palepu, Advait. 2020. "Payment Companies Suffer Frequent UPI System Outages." Medianama, 2 December. (<https://www.medianama.com/2020/12/223-payment-companies-suffer-frequent-upi-system-outages/>).

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References

- A** “About NPCI.” National Payments Corporation of India, 2020. (<https://www.npci.org.in/who-we-are/about-us>).
- Abraham, Sunil. 2018. “Why NPCI and Facebook Need Urgent Regulatory Attention.” The Centre for Internet & Society. 12 June. (<https://cis-india.org/internet-governance/blog/economic-times-june-10-2018-sunil-abraham-why-npci-and-facebook-need-urgent-regulatory-attention>).
- Abraham, Sunil. 2020. “Unified Payment Interface: Towards Greater Cyber Sovereignty.” Observer Research Foundation Issue Brief. (<https://www.orfonline.org/research/unified-payment-interface>).
- ASSOCHAM, and PricewaterhouseCooper. 2019. “India’s Digital Payments Projected to More than Double to USD 135 Billion in 4 Years.” ASSOCHAM. (<https://www.assochem.org/newsdetail.php?id=7138#:~:text=Indias%20digital%20payments%20projected%20to,4%20years%3A%20ASSOCHAM-PWC%20study&text=%E2%80%9CIndia%20is%20expected%20to%20clock,cent%20%27%27%2C%20the%20study%20said>).
- B** “BHIM Product Overview.” National Payments Corporation of India, 2017. (<https://www.npci.org.in/product-overview/bhim-product-overview>).
- “BHIM UPI Goes International, Launches at Singapore FinTech Festival.” Business Standard, 2019. (https://www.business-standard.com/article/pti-stories/bhim-upi-goes-international-qr-code-based-payments-demonstrated-at-singapore-fintech-festival-119111300380_1.html).
- D** D’Silva, Derryl. 2019. “The Design of Digital Financial Infrastructure: Lessons from India.” BIS Papers No 106. Bank for International Settlements. (<https://www.bis.org/publ/bppdf/bispap106.pdf>).
- Department of Financial Services, Ministry of Finance. “Pradhan Mantri Jan Dhan Yojana – Scheme Details.” (<https://www.pmjdy.gov.in/scheme>).
- E** European Commission. 2015. “Payment Services (PSD 2).” Directive (EU) 2015/2366.
- F** FE Bureau. 2018. “BHIM Share in UPI Pie Shrinks in December.” Financial Express, 3 January. (<https://www.financialexpress.com/market/bhim-share-in-upi-pie-shrinks-in-december/999404/>).

- G** Garret, Oliver. 2017. "India Is Likely To Become The First Digital, Cashless Society." Forbes, 28 January.
(<https://www.forbes.com/sites/oliviergarret/2017/06/28/india-is-likely-to-become-the-first-digital-cashless-society/#5d97b46f3c80>).
- "Gateway of India Dialogue: Where Geopolitics Meets Business." Conference Report No. 1. Gateway House, Ministry of External Affairs, 2016.
(https://www.gatewayhouse.in/wp-content/uploads/2016/02/GOID2016_CONFERENCE_REPORT_WEB_ONLY.pdf).
- Gazette of India, Government of India, New Delhi. 2016. "Gazette Notification No 2652." Reserve Bank of India.
(<https://www.rbi.org.in/scripts/NotificationUser.aspx?Id=10684&Mode=0>).
- Gochhwal, Rahul. 2017. "Unified Payment Interface – An Advancement in Payment Systems." American Journal of Industrial and Business Management.
- "Google Wants US Federal Reserve to Follow India's UPI Example." LiveMint, 14 December 2019.
(<https://www.livemint.com/news/india/google-wants-us-federal-reserve-to-follow-india-s-upi-example-and-build-fednow-11576335813947.html>).
- Gupta, Komal. 2018. "Panel Suggests Board to Oversee Digital Payments Industry." LiveMint. 19 September.
(<https://www.livemint.com/Industry/UrJaTkyrlrLF9t1bv2jdO/Panel-suggests-board-to-oversee-digital-payments-industry.html>).
- I** "Indian Banks Association: Objective." Indian Banks Association, 2020.
(<https://www.iba.org.in/objective.html>).
- K** Kumar Shukla, Ajay. 2019. "BHIM Loses Sheen as Market Share Shrinks to 5.37%." The Economic Times, 6 September.
(<https://government.economictimes.indiatimes.com/news/digital-payments/bhim-loses-sheen-as-growth-shrinks-to-5-37-market-share/71009004>).
- L** Lakshmanan, Srikanth. 2018. "As UPI 2.0 Is Unveiled, It Remains Very Much a Transaction in Progress." The Wire, 21 August.
(<https://thewire.in/tech/upi-2-0-is-unveiled-transaction-in-progress>).
- M** Manikandan, Ashwin. 2019. "NPCI Sets up Subsidiary for Exporting UPI to International Markets." Economic Times, 16 December.
(<https://economictimes.indiatimes.com/news/economy/policy/npci-sets-up-subsidiary-for-exporting-upi-to-international-markets-rbi-governor/articleshow/72743281.cms>).

Manikandan, Ashwin. 2020. "Record Volumes as Digital Payments Thrive in Time of Pandemic." Economic Times, 3 August.
(<https://tech.economictimes.indiatimes.com/news/internet/upi-clocks-highest-monthly-volume-with-1-5-billion-transactions-in-july/77306734>).

N National Payments Corporation of India. 2012. "99# Product Overview."
(<https://www.npci.org.in/product-overview/99-product-overview>).

National Payments Corporation of India. 2016a. "NPCI Presents Unified Payments Interface (UPI) System."

National Payments Corporation of India. 2016b. "NPCI's Unified Payments Interface (UPI) Set to Go Live." NPCI Press Release, 25 August.
([https://www.npci.org.in/PDF/npci/press-releases/2016/NPCIsUnifiedPaymentsInterface\(UPI\)settogoliveAugust252018.pdf](https://www.npci.org.in/PDF/npci/press-releases/2016/NPCIsUnifiedPaymentsInterface(UPI)settogoliveAugust252018.pdf)).

National Payments Corporation of India. 2020. "Unified Payment Interface: API and Technology Specifications Version 1.0(Draft)."
(<https://www.mygov.in/digidhan/pages/pdf/sbi/NPCI%20Unified%20Payment%20Interface.pdf>).

"No MDR Charges Applicable on Payment via RuPay, UPI from Jan 1." Economic Times, 28 December 2019.
(<https://economictimes.indiatimes.com/industry/banking/finance/banking/no-mdr-charges-applicable-on-payment-via-rupay-upi-from-jan-1-sitharaman/articleshow/73008967.cms?from=mdr>).

"No MDR on RuPay,UPI Payments Will Kill Industry, Warns Industry." Economic Times, 28 December 2019.
(<https://economictimes.indiatimes.com/industry/banking/finance/banking/no-mdr-charges-applicable-on-payment-via-rupay-upi-from-jan-1-sitharaman/articleshow/73008967.cms?from=mdr>).

"NPCI Expands Shareholder Base Adding 46 Banks." Business Line, 12 September 2016.
(<https://www.thehindubusinessline.com/money-and-banking/npci-expands-shareholder-base-adding-46-banks/article9099863.ece>).

O Office of the Registrar General and Census Commissioner. 2011. "Data from Census of India, 2011."

P Pahwa, Nikhil. 2017. "Improve NPCI Shareholding, Governance within 60 Days, Says Watal Committee." Medianama, 13 January.
(<https://www.medianama.com/2017/01/223-npci-shareholding/>).

Parakh, Sandeep and Ram Kumar. 2019. "Digital in India 2019 – Round 2 Report." Nielsen.
(<https://cms.iamai.in/Content/ResearchPapers/2286f4d7-424f-4bde-be88-6415fe5021d5.pdf>).

Patil, Sameer, and Sagnik Chakrabarty. 2019. "A Cybersecurity Agenda for India's Digital Payment Systems." Paper No. 20. Indian Council of Global Relations.
(https://www.gatewayhouse.in/wp-content/uploads/2019/10/Digital-Payments_FINAL.pdf).

R Ramsey, Craig. 2019. "How Far UPI Can Reach in India: After 1 Billion Transactions, This Is Next." Financial Express. 20 December.
(<https://www.financialexpress.com/industry/banking-finance/how-far-upi-can-reach-in-india-after-1-billion-transactions-this-is-next/1799529/>).

Reserve Bank of India. 2012. "Payment Systems In India Vision 2012-15." Department of Payment and Settlement Systems, Reserve Bank of India.

S Singh, Manish. 2020. "Google and Walmart Establish Dominance in India's Mobile Payments Market as WhatsApp Pay Struggles to Launch." TechCrunch, 4 June.
(<https://techcrunch.com/2020/06/03/google-and-walmarts-phonepe-establish-dominance-in-indias-mobile-payments-market-as-whatsapp-pay-struggles-to-launch/>).

T "The U. S. Path to Faster Payments." The Faster Payments Task Force, 2017.
(<https://fasterpaymentstaskforce.org/wp-content/uploads/faster-payments-task-force-finalreport-part-two.pdf>).

U "UN Panel Lauds India's Digital Initiatives for Economic Inclusion." The Economic Times, 13 June 2019.
(<https://economictimes.indiatimes.com/news/economy/finance/un-panel-lauds-indias-digital-initiatives-for-economic-inclusion/articleshow/69769783.cms>).

"UPI API Overview." IndiaStack.
(<https://www.indiastack.org/upi/#:-:text=%E2%80%9CUnified%20Payment%20Interface%E2%80%9D%20>).

"UPI Live Members." National Payments Corporation of India, 2020.
(<https://www.npci.org.in/what-we-do/upi/live-members>)

"UPI Product Overview." National Payments Corporation of India, 2017.
(<https://www.npci.org.in/what-we-do/upi/product-overview>).

Uppal, Mahesh. 2020. "Keeping India's Payments Market Competitive." MSN, 9 June.
(<https://www.msn.com/en-in/money/markets/keeping-indias-payments-marketcompetitive/ar-BB15gtQU?li=AAgfW3>).

W "What Is India Stack." IndiaStack.
(<https://www.indiastack.org/about/>).

World Bank. 2011. "Global Financial Inclusion – Database."
(<https://databank.worldbank.org/reports.aspx?source=1228>).

World Bank. 2017. "Global Findex Database."
(<https://globalfindex.worldbank.org/>).