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DIGITAL PUBLIC INFRASTRUCTURE AS A CATALYST FOR PRIVATE SECTOR INNOVATION: LESSONS FROM FINTECH SECTOR IN INDIA

January 2025

Background Paper No. 29

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I. INTRODUCTION

Over the past decade, India has built an interoperable, open-source digital public infrastructure (DPI) that is operational at population scale. The key building blocks, commonly known as the "India Stack" include issuing the digital ID (Aadhaar), accelerating financial inclusion (Jan Dhan), enabling digital payments (Unified Payments Interface – UPI), transforming health, education and skill development, and envisioning an open network for future urban mobility and digital commerce.[1]

By enabling a policy framework that fosters data privacy and empowerment, mandates interoperability of digital assets and transactions, and promotes market participation, India's DPI has expanded the market for goods and services. Over the last decade, this approach has transformed and dramatically increased the country's financial inclusion, helping India accelerate progress to achieve the Sustainable Development Goals (SDGs).[2]

One of the key value propositions for countries to invest in DPI is that it will build an innovation ecosystem that will attract private capital, promote startups, and provide incentives to entrepreneurs to build locally relevant solutions, thereby generating gainful employment in the emerging digital economy. It is, however, not a given. For DPI to achieve its transformative potential, it is important to understand the pathways through which the governance of DPI enables private investment in the digital economy, thereby creating a virtuous cycle between regulation and innovation that India has witnessed over the past decade. As India's experience illustrates, the government can not only be a regulatory entity but also drive digital innovation and adoption in sectors that are critical for inclusive growth and development, such as financial inclusion.

DPI has been instrumental in the transformation of India's financial sector. In the area of financial inclusion, the proportion of population above 15 years of age having a bank account increased from around one in three in 2011 to almost universal in 2021, largely due to the use of electronic Know Your Customer (e-KYC) through Aadhaar verification.[3] This has coincided with the creation of the UPI in 2016 — a bank led, protocol based payments infrastructure that has propelled India to becoming a leader in instant digital payments globally.[4] With the basic foundations in place, India has become a hub for innovation in digital payments and financial technology, or "fintech," more broadly.

While the numbers are indeed impressive, *how* India's policy and regulations created the conditions for private sector investment is not well understood. First, the paper will provide a framework to assess the roles of public and private sectors to create an innovation ecosystem leveraging the power of DPI. Then it charts India's recent history of regulato-

[1] Cristian Alonso et al., "Stacking up the Benefits: Lessons from India's Digital Journey," International Monetary Fund, 2023, https://www.imf.org/en/Publications/WP/Issues/2023/03/31/Stacking-up-the-Benefits-Lessons-from-Indias-Digital-Journey-531692.
[2] Anit Mukherjee, Rajeesh Menon, and Yukti Sharma, "Digital Development: Emulating India's Digital Public Infrastructure to Reach the Sustainable Development Goals," ORF America, 2023, https://orfamerica.org/newresearch/dpi-india-mukherjee-backgr16.
[3] Global Findex Database 2021, "Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19," The World Bank, 2022, accessed on October 18, 2024, https://www.worldbank.org/en/publication/globalfindex.
[4] Agustin Carstens and Nandan Nilekani, "Finternet: The Financial System of the Future," Bank of International Settlements, April 2024, https://www.bis.org/publ/work1178.pdf.

ry measures to accelerate financial inclusion and digital payments, encouraging private sector investment (including venture capital) and innovation in financial products and services. As the DPI approach has gained currency globally, the authors conclude by distilling the lessons from India's experience to provide a roadmap for countries as they create their own.

II. INDIA'S DPI, FINANCIAL INCLUSION AND REGULATION JOURNEY

Starting with Aadhaar in 2009, India's DPI approach has been to form infrastructure objectives around a set of digital basic building blocks that underpins a network of digitally enabled services leveraging ubiquitous and affordable digital connectivity. The interoperable architecture of Aadhaar enabled a combination of different technology building blocks to create a digital stack with three layers: identity, payments, and data exchange. Known as the India Stack, it allows governments, businesses, start-ups, and developers to build on Aadhaar and similar digital public infrastructure to construct a digital layer that enables presence-less, paperless, and cashless service delivery with user consent. The evolution of these public technologies into a set of building blocks that can be adapted for specific solutions is what is known collectively as digital public infrastructure, or DPI.[5]

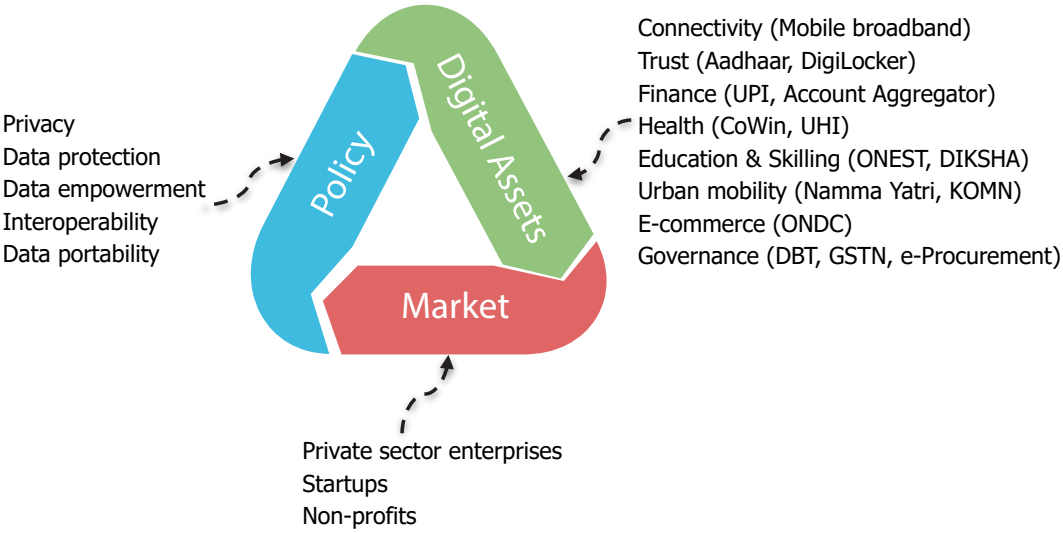
In India, the DPI approach has had a transformative impact on financial inclusion.[6] The foundational infrastructure, however, is extensive coverage of data networks either through fiber optic cables or cellular mobile phones and high adoption of digital services by making them both affordable and accessible even for those who may not be fully digitally literate. Digital public infrastructure and services such as Aadhaar, verifiable credentials, and interoperable data transfer protocols are then used to validate financial transactions. Public investment to support access to digital services at an affordable cost for the most remote consumers and businesses provides incentives for the private sector to create context-specific solutions through investment in an innovation ecosystem at scale (Figure 1).

For the financial inclusion benefits of the new digital infrastructure to be fully realized, private sector innovators must be able to identify large enough market opportunities for various last-mile use cases and be rewarded for the risk they undertake in solving such challenges. New products and services built on top of DPI targeted at previously unreached populations, such as micro-insurance targeted at the lower income segments significantly expand the potential consumer base. Given the right mix of incentives and regulation, countries could attract private capital in order to expand financial services at scale to make it a viable investment proposition.

Figure 2 provides a timeline of key milestones that have been instrumental in creating the regulatory space for private sector innovation in financial services. Although much of the new regulation concerning financial institutions has revolved around recent innovation

[5] Anit Mukherjee and Shankar Maruwada, "A Building Blocks Approach to Digital Public Goods," Center for Global Development, September 16, 2021, https://www.cgdev.org/publication/fast-tracking-development-building-blocks-approach-digital-public-goods.
[6] Yan Carriere-Swallow, Vikram Haksar, and Mansa Patnam, "Stacking Up Financial Inclusion Gains in India," International Monetary Fund, July 2021, https://www.imf.org/external/pubs/ft/fandd/2021/07/india-stack-financial-access-and-digital-inclusion.htm.

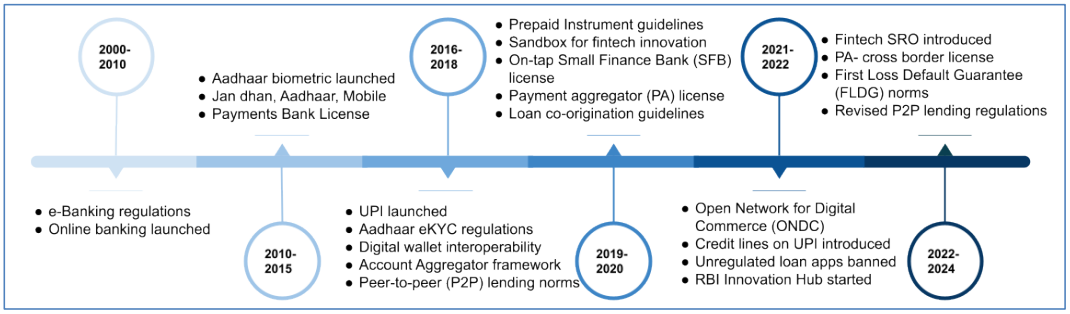
Figure 1: India's DPI framework



Source: Authors' creation.

in digital public infrastructure and fintech driven technological advances, online banking regulations in the early 2000s can be considered the first milestone in India's journey. The digital transformation accelerated in the next decade (2010-20) with the adoption of Aadhaar, e-KYC, Jan Dhan, and Direct Benefit Transfer programs providing the impetus from the government side. However, the rollout of the UPI in 2016 can be considered the turning point, enabling India to leapfrog the rest of the world in instant digital payments within a span of five years.

Figure 2: Key Regulatory and Public Sector Initiatives for Fintech Innovation, 2000-2024



Source: Authors' creation.

The success of the UPI highlights the transformative potential of leveraging DPI and financial inclusion for digital payments and other value-added services provided by the private sector. Launched by the National Payments Corporation of India (NPCI) in 2016, UPI is a peer-to-peer payment building block that enables instant sending and receiving of money from a mobile phone through a UPI ID and personal identification number (PIN) connected to a verified mobile number and any verified bank account or digital wallet of the customer's choice.

As a digital building block, the UPI protocol supports any form factor (device), any authorization credential (PIN, biometric, etc.), and any stored value account (allowing a mobile money wallet to be interoperable with bank account, for example). UPI is interoperable with bank accounts enabling innovators to create applications that combine multiple banking accounts. This provides a level playing field and low barrier to entry for fintech companies and startups to compete for users, reducing the market concentration risk in a digitized financial system.

Payment Aggregators

With the growth of DPI in India, non-bank digital payment companies facilitating transactions on UPI, credit cards, and debit cards became a growth segment of the financial services market. Most notably, these companies had enabled a large part of Indian consumers and businesses to transact online which furthered the goal of India's financial regulator, the Reserve Bank of India (RBI), of promoting financial inclusion and digital transactions. An integral part of the digital payments process was the collection, pooling, and timely remittance of consumer payments by these payment gateways. Due to their involvement in the actual payment, clearing and settlement of funds between consumers and merchants and the systemic risk of default at the time of settlement, the RBI introduced a regulatory framework for payment intermediaries. Instead of prohibiting such entities, it streamlined the regulatory structure for governing payments companies that handle consumer funds and made it mandatory for them to use an escrow account mechanism for collection, pooling, and disbursal of funds. Since then, 39 entities have been granted regulatory approval to operate as payment aggregators in India.[7]

Credit lines on UPI

Following the success of retail digital payments, RBI saw it fit to allow users to transact via credit cards on UPI, eventually paving way for utilizing pre-sanctioned credit by licensed financial service entities. This was also partly in response to multiple illegal lending apps that leveraged UPI to lend at usurious rates, often pushing borrowers into a debt trap. Formalizing the regulatory guidelines for credit and credit cards on UPI and a parallel ban on apps of unlicensed entities helped weed out these illegal platforms. In this case, the regulator addressed an emerging risk for users of digital financial system — and the financial sector more broadly — without stifling the potential for innovation in the fintech ecosystem.

Fintech Self-Regulatory Organization

A major leap forward in terms of systematizing innovation as a part of financial services was RBI's recent recommendation for fintech entities to set up a self-regulatory organization. This will not only give fintech companies a chance to build their own best practices, tinker with novel ideas and launch new financial products in the mainstream but also prevent excessive regulatory drag on innovation. In this regard, the RBI governor has very rightly noted that, "it is the industry participants who possess the deepest understanding of the processes and practices within the trade. Therefore, they are best suited to establish common rules, enforce them, and effectively handle disputes that may arise

[7] Reserve Bank of India, "Approvals / Certificates of Authorisation issued by the Reserve Bank of India under the Payment and Settlement Systems Act, 2007 for Setting up and Operating Payment System in India," Reserve Bank of India, 2024, https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/ATH190315ENTPSP.PDF.

from non-compliance." This provides a signal to the fintech investors vis-à-vis RBI's confidence and faith in the fintech ecosystem to be able to build consumer friendly, ethical and financially sustainable businesses with high integrity that operate mutually agreed upon principles by the participants as opposed to micromanaging every aspect of their business through more formal regulation by the RBI. In conjunction with this "light touch" approach, the regulator reserves the right to sanction any market participant who it feels does not comply with prudential rules.[8]

The value proposition for governments to adopt and support DPI, therefore, is not just for its inclusion and efficiency. It is also to create a thriving innovation ecosystem and use regulations strategically to support the private sector while reducing systemic risks, especially in the financial sector. We explore this balance between regulation and innovation in the next section, taking India's recent experience as an example with lessons for other countries.

III. DPI AND THE PRIVATE SECTOR: FINDING THE RIGHT BALANCE BETWEEN REGULATION AND INNOVATION

India's vibrant digital financial services sector has benefited from a strong and stable foundation built on the principles of digital access, verifiable identity, and financial inclusion at population scale, supported by a regulatory framework that is open to innovation with accountability. From the perspective of the private sector, with table stakes taken care of by DPI, startup founders can focus on innovations that lead to execution at scale with regulatory compliance as applicable for the sector.

In this regard, DPI for Indian startups has had the impact analogous to what affordable cloud infrastructure did for software startups in the United States a decade earlier. Just as cloud services like Amazon Web Services, GoogleCloud, and Microsoft's Azure made it significantly cheaper and easier to start a software business in the United States in 2010s, DPI for startups has ensured a notable reduction in costs and timelines for scaling some businesses.[9] This includes a decrease in the cost of failing as well. Entrepreneurs can now fail and iterate quickly by raising low initial capital to beta-test their ideas first. For instance, DPI has led to a significant reduction in the cost of individual e-KYC from $12 earlier to 6 cents presently.[10] This ties directly to risk and return outcomes for early-stage investors. In venture capital, outliers matter and there are strict constraints on exit periods. The reduced costs and duration for testing ideas means investors can cut losses faster and focus more on backing visible winners from the portfolio to generate better outcomes overall.

Sustained innovation in financial services is the result of an interplay between multiple factors, among them policy stability, regulatory openness, and access to private capital.

[8] Reserve Bank of India, "Action against Paytm Payments Bank Ltd under Section 35A of the Banking Regulation Act, 1949 – Additional Steps," Reserve Bank of India, February 23, 2024, https://rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx?prid=57376.

[9] Michael Ewens, Ramana Nanda, and Matthew Rhodes-Kroff, "How Cloud Computing Changed Venture Capital," *Harvard Business Review*, October 25, 2018, https://hbr.org/2018/10/research-how-cloud-computing-changed-venture-capital.

[10] Government of India, "Monetary Management and Financial Intermediation: Stability is the Watchword," Economic Survey 2024, https://www.indiabudget.gov.in/economicsurvey/doc/eschapter/echap02.pdf.

Paramount amongst these is the willingness of regulators to embrace disruptive technologies that materialize from this innovation. DPI in and of itself is not sufficient — it requires services on top of this infrastructure to diffuse at scale and therefore requires innovation to ensure they thrive.

A foundational principle of building digital public infrastructure with financial services at the center is having enabling regulation in place to ensure it scales smoothly. In most developing countries, regulators view fintech companies as the means to support financial inclusion — not as a substitute for banks but as a tool to leverage their core competencies, like payment gateways and treasury management, and public trust. However, with rapid adoption of digital financial services, fintech companies can be large enough to become systemically important entities within the financial system that either need to be regulated or scaled down to prevent fallouts of unfettered growth and unforeseen risks.[11] This sends conflicting signals to both innovators and investors that can ultimately hamper the vibrancy of a digital ecosystem.

As Figure 3 shows, there are four possible scenarios where regulation is either excessive or reasonable, and innovation is either unfettered or managed. As we discussed above, the success of India's fintech sector reflects the desirable equilibrium where reasonable regulation connects with innovation that adds value to consumers and solves societal challenges, with governments supporting the creation of an open and interoperable digital public infrastructure at population scale.

Figure 3: Balancing Regulation and Innovation

	Unfettered innovation	Managed innovation
Reasonable regulation	Potential for emergence of systemic risks	Thriving innovation with systemic risks under control
Excessive regulation	Public-Private policy coordination failure	Regulation stifles private sector innovation

Source: Authors' creation.

The persistence of this equilibrium is, however, not a certainty in the long run. Both regulation and innovation are dynamic processes that require careful calibration and feedback loops in a growing digital ecosystem. Moreover, DPI itself is evolving both as an idea as well as in its scope. As DPI diffuses globally, countries will choose their own models (data exchange conforming to a national legal framework for privacy, for example), as well as their scope and pace of adoption, especially in a highly regulated sector such as digital financial services.

[11] Alan Gelb, Anit Mukherjee, and Brian Webster, "Models of Social Payments through Inua Jamii," Center for Global Development, January 19, 2023, https://www.cgdev.org/sites/default/files/models-social-payments-through-inua-jamii.pdf.

Whatever the DPI model that a country adopts, feedback loops between regulation and innovation are critical to prevent adverse outcomes, such as the lower right box in Figure 3. In Kenya for example, the government mandated periodic biometric verification for beneficiaries of social grants by payment service providers. This proved to be a disincentive for its innovative mobile money payment companies which had a higher level of penetration in poor and remote regions of the country than commercial banks.[12] A positive feedback loop is especially important since frontier technologies like artificial intelligence and algorithmic decision-making are already used extensively in the fintech sector. Consequently, moves to regulate data access, sharing, and use, in conjunction with calls to regulate AI, will have implications for the digital financial services both in the near and longer terms.

In the fintech sector, there is an increasing interest in "regulatory sandboxes" facilitating such feedback loops. They can also function as a signaling mechanism for regulators, innovators, and investors. In the case of India, the RBI created a regulatory sandbox that enables startups to test out their ideas in a controlled environment. Advanced technologies such as voice-enabled payments, offline UPI payments, fraud prevention, AI chatbots, and algorithmic credit disbursement have been included in the sandbox over the last several years. This has had an important signaling and informational effect on the flow of private investment, including venture capital, in India's fintech sector (Figure 4). RBI's tacit approval and controlled testing with respect to certain emerging technologies gives venture capitalists reliable information on regulatory risk tolerance for certain types of innovations compared to others.

While regulatory risk is often baked into a fintech investor's projection and expectation of future returns, active involvement and intervention of the regulator with respect to the adoption of certain technologies helps de-risk investment decisions. Coupled with greater breadth and depth of DPI, it becomes easier for to pick winners by relying on both policy and regulatory signals, thereby making the country an attractive destination for private investment over the medium and long run.

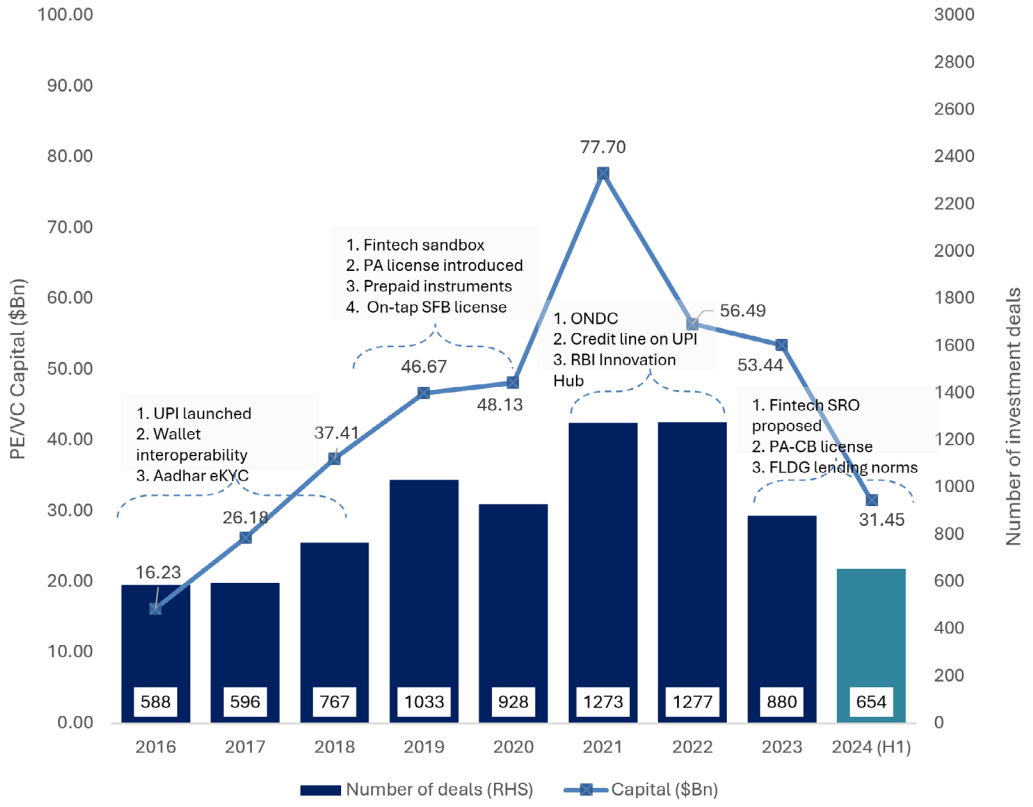
IV. LESSONS FROM INDIA'S EXPERIENCE

With DPI gaining prominence in global conversations around digital transformation, India has proposed the setting up of the One Future Alliance (OFA), now Social Impact Fund (SIF), during its G20 presidency in 2023. The objective of SIF will be to build capacity, provide technical assistance and funding support for implementing DPI in low and middle-income countries.

As a key sector where the impact of DPI has been transformative, India's financial inclusion and digital financial services journey holds lessons for countries interested in adopting a DPI approach to create their own ecosystem of fintech innovation and adoption.

[12] Alan Gelb, Anit Mukherjee, and Brian Webster, "Models of Social Payments through Inua Jamii," Center for Global Development, January 19, 2023, https://www.cgdev.org/sites/default/files/models-social-payments-through-inua-jamii.pdf.

Figure 4: Growth of Private Equity and Venture Capital investments in India, 2016 - 2024



Source: Authors' creation, based on data from EY – IVCA Monthly PE/VC Round Up June 2024.[13]

First, it is important to ensure the implementation and adoption of DPI at population scale through active policy intervention and private sector participation. An open architecture is necessary to make certain that a fledgling startup ecosystem gets built on top of these digital rails over time.

Second, a strategic approach to DPI involving stable policy and regulatory frameworks kickstarts the flywheel of global private capital inflow that makes it easier for startups to scale their solutions. In an optimal scenario this results in broad-based adoption of digital products in the economy and further promotion of new innovative technologies.

Third, regulatory evolution is necessary to sustain private sector innovation leveraging DPI at scale. This is both for promotion of adoption of digital financial services, as well as to minimize risks to both consumers and the financial system. As core fintech products become more widely adopted, regulatory intervention for early mitigation of systemic risks is welcomed by private investors. Reasonable regulation, along with signaling risk tolerance towards technology adoption in financial services, helps de-risk private investment and support innovation over the long run.

[13] Ernst & Young, "In today's frenetic world, how does private equity set the pace?" Ernst & Young, June 2024, https://www.ey.com/content/dam/ey-unified-site/ey-com/en-in/industries/private-equity/documents/2024/06/ey-ivca-monthly-pe-vc-roundup-june-2024.pdf.

Finally, achieving a balance between regulation and innovation is a dynamic process. As DPI grows in scale and scope, regulation and innovation need to be calibrated taking into consideration both the systemic risks as well as the opportunities to leverage the ongoing digital transformation to achieve development outcomes, especially in the area of financial inclusion and adoption of digital financial services.

In sum, DPI at population scale has the power to transform sectors such as fintech, helping developing countries create a vibrant and innovative digital payments ecosystem within a short period of time. This will, however, depend on how countries adopt a regulatory approach that fosters innovation while minimizing the systemic risks to the end consumer and the increasingly digitized financial system as a whole.

ACKNOWLEDGEMENTS

The authors would like to thank Kathleen McGowan, Jordan Sandman, and Brian Webster for their review, comments and suggestions on an earlier draft of this paper. The paper is part of ORF America's Shaping our Common Agenda initiative supported by the Children's Investment Fund Foundation (CIFF). This background paper reflects the personal research, analysis, and views of the authors, and does not represent the position of either of these institutions, their affiliates, partners, or employers.

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