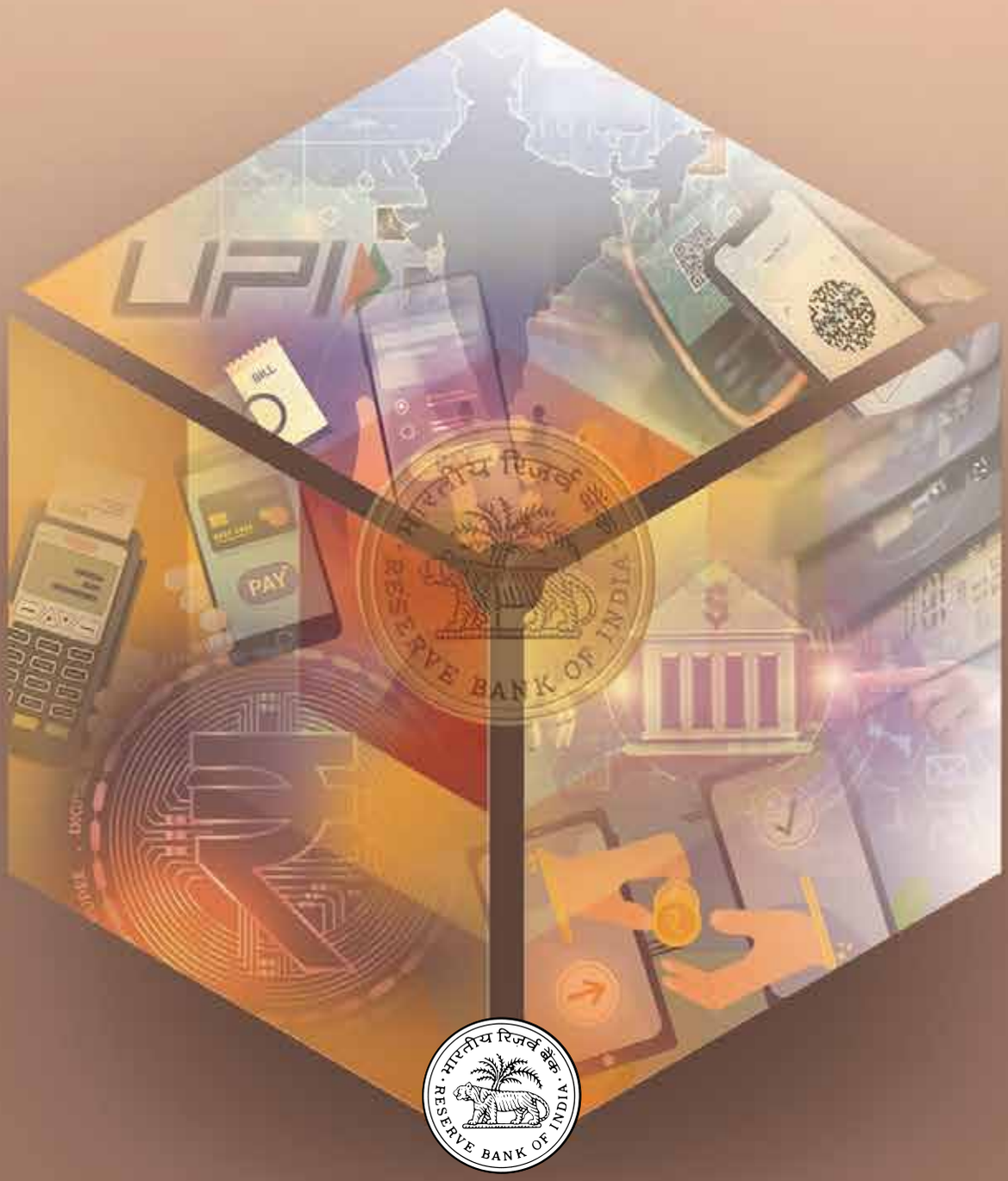
Report on Currency and Finance

2023-24

India's Digital Revolution



RESERVE BANK OF INDIA

REPORT ON CURRENCY AND FINANCE 2023-24

INDIA'S DIGITAL REVOLUTION

RESERVE BANK OF INDIA

"The findings, views and conclusions expressed in this Report are entirely those of the contributors from the Department of Economic and Policy Research (DEPR) and do not represent the views of the Reserve Bank of India".

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FOREWORD

The digital wave embracing the world is unprecedented and transformative. No aspect of life is untouched by its sweep. Digitalisation is driving innovation and efficiency, fostering a new model of economic growth, and facilitating quality improvements. Digital transformation is also evident in the financial sector, where adoption of technology solutions by financial institutions, coupled with the advent of new market players like financial technology firms (FinTechs) and large corporations (BigTechs), is reshaping the conventional notions of finance. Frontier technologies involving application programming interfaces, artificial intelligence and machine learning, and cloud computing are powering financial innovations worldwide. In turn, this revolution is expanding and diversifying the role of central banks and financial regulators.

India is leading the global digital revolution, emerging as a frontrunner on the back of its robust digital public infrastructure, rapidly evolving institutional arrangements, and a growing tech-savvy population. Globally, India ranks first in biometric-based identification (*Aadhaar*) and real-time payments volume; second in telecom subscribers; and third in terms of the startup ecosystem.

The flagship Unified Payments Interface (UPI) has revolutionised the retail payment experience for end-users, making transactions faster and more convenient. In the digital currency arena, the Reserve Bank is at the forefront with pilot runs of the e-rupee, the central bank digital currency (CBDC). The digital lending ecosystem is becoming vibrant with initiatives such as the Open Credit Enablement Network, the Open Network for Digital Commerce and the Public Tech Platform for Frictionless Credit. FinTechs are collaborating with banks and non-banking financial companies (NBFCs) as lending service providers. They are also operating platforms to facilitate digital credit. BigTechs are backing payment apps and lending products as third-party service providers.

Digitalisation in finance is paving the way for next-generation banking; improving access to financial services at affordable costs; and enhancing the impact of direct benefit transfers by effective targeting of beneficiaries in a cost-efficient manner. Loans in the retail segment are being enabled by online payments and innovative credit assessment models with instant disbursements. E-commerce is being boosted through embedded finance. All these innovations are making financial markets more efficient and integrated.

On the external front, digitalisation is driving growth in India's services exports and lowering remittance costs. India's digital journey is setting a benchmark for peer economies. The Reserve Bank's initiatives for internationalisation of home-grown payment modes, cross-border fast payment network linkages and knowledge and experience sharing with peers is energising the transformation of its digital public infrastructure as a global public good.

At the same time, digitalisation also presents challenges related to cybersecurity, data privacy, data bias, vendor and third-party risks, and customer protection. Increased inter-connectedness may lead to systemic risks. Additionally, emerging technologies can introduce complex products and business models with risks that users may not fully understand, including the proliferation of fraudulent apps and mis-selling through dark patterns. Digitalisation may induce human resource challenges in the financial sector, necessitating strategic investments in upskilling and reskilling.

In this rapidly evolving landscape, balancing financial stability, customer protection and competition will remain the key policy challenge. Regulatory and supervisory frameworks must scale up and become more sophisticated to navigate these complexities and future-proof the financial system. The goal is to balance effective regulation with fostering financial innovations in a safe, robust and trustworthy ecosystem.

The Reserve Bank has taken several measures in this regard, including the issuance of guidelines on account aggregators, peer-to-peer lending, digital lending, regulatory sandbox, Reserve Bank Innovation Hub, framework for self-regulatory organisations and strengthening of the supervisory approach by going beyond an entity-focused approach towards a more thematic and activity-based approach. The Reserve Bank is also fostering a strong risk culture focused on customer centricity, governance and business conduct in financial sector entities. The endeavour is to promote a sustainable and resilient financial sector.

Against this backdrop, this year's Report on Currency and Finance has adopted "*India's Digital Revolution*" as its theme. The Report has been prepared by a team from the Department of Economic and Policy Research (DEPR), with inputs from several operational departments. The Report is supported by surveys of key stakeholders and data-based analysis. The comprehensive assessment of the country's digital transformation, with a focus on the financial sector and the payments landscape, should shed more light on the range of opportunities and challenges associated with digitalisation. It is expected that the Report will enable appreciation of the various contours of digitalisation in finance and the ways in which the common person is served while contributing to overall economic and financial development of the Indian economy. I am confident that the Report will spur further deliberations on strengthening and deepening India's digital transformation.

Shaktikanta Das
Governor
July 29, 2024

CONTENTS

LIST OF BOXES

LIST OF TABLES

LIST OF CHARTS

ANNEX

LIST OF ABBREVIATIONS

5G	Fifth Generation
A2A	Account-to-account
AA	Account Aggregator
AD	Authorised Dealer
ADB	Asian Development Bank
AE	Advanced Economy
AePS	Aadhar Enabled Payment System
AFA	Additional Factor of Authentication
AGR	Alternate Grievance Redress
AI	Artificial Intelligence
AML	Anti Money Laundering
AML/CFT	Anti-Money Laundering and Combating the Financing of Terrorism
APBS	Aadhaar Payments Bridge System
API	Application Programming Interface
APR	Annual Percentage Rate
AR	Augmented Reality
ARDI	Annual Report Digitalisation Index
ARDL	Autoregressive Distributed Lag
ASAG	Advanced Supervisory Analytics Group
ASEAN	Association of Southeast Asian Nations
ASUSE	Annual Survey of Unincorporated Sector Enterprises
ATM	Automated Teller Machine
B2B	Business-to-business
B2C	Business-to-consumer
BAU	Business as Usual
BBPOU	Bharat Bill Payment Operating Unit
BBPS	Bharat Bill Payment System
BCBS	Basel Committee on Banking Supervision
BFSI	Banking, Financial Services and Insurance
BHIM	Bharat Interface for Money
BigTech	Large Technology Company
BIS	Bank for International Settlements
BNPL	Buy Now Pay Later
BoP	Balance of Payment
BPSS	Board for Regulation and Supervision of Payment and Settlement System
BRICS	Brazil, Russia, India, China and South Africa
BSA	Bilateral Swap Agreement
C-DOT	Centre for Development of Telematics
CASA	Current Account Saving Account
C2B	Consumer-to-business
C2C	Consumer-to-consumer
CAGR	Compound Annual Growth Rate
CBDC	Central Bank Digital Currency
CBDC-R	Central Bank Digital Currency-Retail
CBDC-W	Central Bank Digital Currency-Wholesale
CBS	Core Banking Solutions
CBUAE	Central Bank of the UAE
CCIL	Clearing Corporation of India Limited

CCPA	Central Consumer Protection Authority
CD	Certificate of Deposit
CECPA	Comprehensive Economic Cooperation and Partnership Agreement
CEPA	Comprehensive Economic Partnership Agreement
CERT-In	Indian Computer Emergency Response Team
CFL	Centre for Financial Literacy
CiC	Currency in Circulation
CIMS	Centralised Information Management System
CLS	Continuous Linked Settlement
CoFT	Card-on-File Tokenisation
CoWIN	COVID-19 Vaccine Intelligence Network
CPMI	Committee on Payments and Market Infrastructures
CPMI-IOSCO	Committee on Payments and Market Infrastructures - International Organisation of Securities Commissions
CPS	Centralised Payment System
CRPC	Centralised Receipt and Processing Centre
CTS	Cheque Truncation System
DBT	Direct Benefit Transfer
DBU	Digital Banking Unit
DEA	Data Envelopment Analysis
DEA	Digital Economy Agreement
DeFi	Decentralized Finance
DEPA	Data Empowerment and Protection Architecture
DFS	Digital Financial Services
DGFT	Directorate General of Foreign Trade
DIGIT	Digital Infrastructure for Governance, Impact and Transformation
DILRMP	Digital India Land Records Modernisation Programme
DIP	Digital Intermediation Platform
DLAI	Digital Lenders Association of India
DLG	Default Loss Gurantee
DLT	Distributed Ledger Technology
DNA	Data-Network-Activity
DP	Digital Payments
DPDPA	Digital Personal Data Protection Act
DPG	Digital Public Goods
DPI	Digital Public Infrastructure
DPI	Digital Payment Index
DPIIT	Department for Promotion of Industry and Internal Trade
DSGE	Dynamic Stochastic General Equilibrium
DSL	Digital Subscriber Line
DSTRI	Digital Services Trade Restrictiveness Index
DSUT	Digital Supply and Use Tables
e-BAAT	Electronic Banking Awareness and Training
e-Commerce	Electronic Commerce
e-KYC	Electronic Know Your Customer

e-NAM	Electronic-National Agricultural Market
EASE	Enhanced Access and Service Excellence
ECS	Electronic Clearing Service
EDDPE	Expanding and Deepening of Digital Payment Ecosystem
EFT	Electronic Funds Transfer
EM	Emerging Market
EMD	Earnest Money Deposit
EMDE	Emerging Market and Developing Economy
EME	Emerging Market Economy
EMI	Equated Monthly Instalment
EU	European Union
EUR	Euro
EV	Electric Vehicle
FACE	FinTech Association for Consumer Empowerment
FATF	Financial Action Task Force
FDI	Foreign Direct Investment
FE	Fixed Effects
FEMA	Foreign Exchange Management Act
FI	Financial Institution
FI-Index	Financial Inclusion Index
FIMMDA	Fixed Income Money Market and Derivatives Association of India
FinTech	Financial Technology
FIP	Financial Information Provider
FIRE	Format for Incident Reporting Exchange
FIT	Flexible Inflation Targeting
FIU	Financial Information User
FL	Financial Literacy
FPS	Fast Payment System
FSB	Financial Stability Board
FSDC-SC	Financial Stability and Development Council Sub-Committee
FX	Foreign Exchange
G-sec	Government Securities
G20	Group of 20
G2B	Government-to-business
G2C	Government-to-consumer
G2P	Government-to-person
G7	Group of Seven
GB	Gigabyte
GBIEM	Global Bond Index for Emerging Markets
GBP	Great British Pound
GCC	Global Capability Centre
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GeM	Government Electronic Marketplace
GenAI	Generative Artifical Intelligence
GFC	Global Financial Crisis
GFCF	Gross Fixed Capital Formation
GIFT	Gujarat International Finance Technology-City
GIFT	Global Interchange for Financial Transactions
GIS	Geographic Information System
GoI	Government of India
GPRS	General Packet Radio Service
GST	Goods and Services Tax

GSTN	Goods and Services Tax Network
GVA	Gross Value Added
GVC	Global Value Chain
GW	Giga Watt
HHI	Herfindahl-Hirschman Index
HPJ	Half-Panel Jackknife
IAMAI	Internet and Mobile Association of India
IBCC	Indian Banking Community Cloud
ICAAP	Internal Capital Adequacy Assessment Process
ICMTS	Integrated Compliance Management and Tracking System
ICT	Information and Communications Technology
ID	Identification
IDRBT	Institute for Development and Research in Banking Technology
IFAD	International Fund for Agricultural Development
IFSC	International Financial Services Centre
IFSCA	International Financial Services Centres Authority
IFTAS	Indian Financial Technology and Allied Services
ILO	International Labor Organization
IMF	International Monetary Fund
IMPS	Immediate Payment Service
INFINET	Indian Financial Network
INR	Indian Rupee
IoRS	Interoperable Regulatory Sandbox
IoT	Internet of Things
IPP	Instant Payment Platform
IPR	Intellectual Property Right
IRDAI	Insurance Regulatory and Development Authority of India
IRTG	Inter-Regulatory Technical Group
ISO	International Organization for Standardization
IT	Information Technology
JAM	*Jan Dhan*-Aadhaar-Mobile
KCC	*Kisan* Credit Card
KFS	Key Fact Statement
KLEMS	Capital (K), Labour (L), Energy (E), Materials (M) and Services (S)
KYC	Know Your Customer
LAN	Local Area Network
LA	Loan Agent
LCS	Local Currency Settlement
LDA	Latent Dirichlet Allocation
LDE	Loss Data Exchange
LEI	Legal Entity Identifier
LFPR	Labour Force Participation Rate
LLM	Large Language Model
LMIC	Low- and Middle-Income Country
LSP	Lending Service Provider
M0	Reserve Money
M1	Narrow Money
M3	Broad Money
Mbps	Megabits Per Second

mCBDC	Multiple Central Bank Digital Currency
MeitY	Ministry of Electronics and Information Technology
MICR	Magnetic Ink Character Recognition
ML	Machine Learning
MOSIP	Modular Open Source Identity Platform
MoU	Memorandum of Understanding
MPI	Multidimentional Poverty Index
MSME	Micro, Small and Medium Enterprise
MTO	Money Transfer Operator
MW	Mega Watt
NACH	National Automated Clearing House
NASSCOM	National Association of Software and Services Companies
NBBL	NPCI Bharat BillPay Limited
NBFC	Non-Banking Financial Company
NBFC-HFC	Non-Banking Financial Company - Housing Finance Company
NBFC-ICC	Non-Banking Financial Company - Investment and Credit Company
NBFC-MFI	Non-Banking Financial Company - Micro Finance Institution
NCFE	National Centre for Financial Education
NDP	Net Domestic Product
NDS-OM	Negotiated Dealing System - Order Matching
NEFT	National Electronic Funds Transfer
NeGP-A	National e-Governance Plan in Agriculture
NETC	National Electronic Toll Collection
NFC	Near Field Communication
NFS	National Financial Switch
NGCH	National Grid Clearing House
NIM	Net Interest Margin
NIPL	NPCI International Payments Limited
NIS	National Innovation System
NKPC	New Keynesian Phillips Curve
NLP	Natural Language Processing
NPCI	National Payments Corporation of India
NPI	National Payments Interface
NSE	National Stock Exchange
NSO	National Statistical Office
OCEN	Open Credit Enablement Network
OECD	Organisation for Economic Co-operation and Development
OFC	Optical Fibre Cable
OLS	Ordinary Least Squares
ONDC	Open Network for Digital Commerce
ORBIOs	Offices of RBI Ombudsman
OTC	Over the Counter
P2B	Person-to-business
P2M	Peer-to-merchant/Person-to-merchant
P2P	Peer-to-peer/Person-to-person
PA	Payment Aggregator
PDAI	Primary Dealers' Association of India
PFRDA	Pension Fund Regulatory and Development Authority

PG	Payment Gateway
PIDF	Payment Infrastructure Development Fund
PLI	Production Linked Incentive
PMJDY	Pradhan Mantri Jan Dhan Yojana
PoC	Proof of Concept
PoS	Point of Sale
PPI	Prepaid Payment Instrument
PPI-MTS	Prepaid Payment Instruments-Mass Transit System
PPF	Public Provident Fund
PRAVAAH	Platform for Regulatory Application, Validation and Authorisation
PSBA	PSB Alliance
PSO	Payment System Operator
PSP	Payment Service Provider
PSS Act	Payment and Settlement Systems Act
PSTN	Public Switched Telephone Network
PTPFC	Public Tech Platform for Frictionless Credit
PVB	Private Bank
PvP	Payment *versus* Payment
PwC	Pricewaterhouse Coopers
QR	Quick Response
RBI	Reserve Bank of India
RB-IOS	Reserve Bank-Integrated Ombudsman Scheme
RBIH	Reserve Bank Innovation Hub
RCA	Revealed Comparative Advantage
RegTech	Regulatory Technology
RE	Regulated Entity
RoA	Return on Assets
RPC	Regional Payment Connectivity
RRB	Regional Rural Bank
RTA	Regional Trade Agreement
RTGS	Real Time Gross Settlement
RTP	Real-time Payment
RS	Regulatory Sandbox
S-SOC	Sectoral Security Operations Centre
SAARC	South Asian Association for Regional Cooperation
SaaS	Software as a Service
SCB	Scheduled Commercial Bank
SDG	Sustainable Development Goal
SEBI	Securities and Exchange Board of India
SFB	Small Finance Bank
SFMS	Structured Financial Messaging System
SGD	Singapore Dollar
SLBC	State Level Bankers' Committee
SME	Small and Medium Enterprise
SMS	Short Message Service
SNA	System of National Accounts
SRO	Self-Regulatory Organisation
SRO-FT	Self-Regulatory Organisation for FinTech Sector
SRVA	Special Rupee Vostro Account
STP	Straight Through Process
SupTech	Supervisory Technology
SWIFT	Society for Worldwide Interbank Financial Telecommunication

TAPED	Trade Agreement Provisions on Electronic-commerce and Data
TFP	Total Factor Productivity
TPAP	Third-party Application Provider
TPSP	Third-party Service Provider
TRAI	Telecom Regulatory Authority of India
TReDS	Trade Receivables Discounting System
TSP	Technology Service Providers
UAE	United Arab Emirates
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UPI	Unified Payments Interface
US	United States
USD	US Dollar
USSD	Unstructured Supplementary Service Data
UT	Union Territory
UTLBC	Union Territory Level Bankers' Committee
VR	Virtual Reality
WEF	World Economic Forum
WTO	World Trade Organisation
YTD	Year till Date

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URL : www.rbi.org.in

I INDIA'S DIGITAL REVOLUTION: OPPORTUNITIES AND CHALLENGES*

Digitalisation has fundamentally transformed the global economy, reshaping economic growth, employment, consumer welfare and living standards. In the adoption of digital technologies, the internationally recognised India Stack, a growing FinTech ecosystem and a burgeoning digitally-inclined population, combined with expanding internet and mobile connectivity, are driving India to become the fastest-growing digital economy. While digital technologies offer various opportunities for India, such as faster growth, financial inclusion and seamless fiscal transfers and cross-border payments, they also present challenges related to cybersecurity, data privacy and concentration risks. Balancing financial stability, customer protection and fair competition in this dynamic landscape, the Reserve Bank is actively involved in developing a safe, efficient and robust digital ecosystem.

1. Introduction

I.1 Over the past three decades, a silent revolution has been transforming the world, its tides sweeping across advanced and developing economies alike, with countries like India riding its crest. The speed and scale of the digital revolution, as it is ubiquitously known, has eclipsed all past revolutions. Over the past decade itself, the global digital economy has grown 2.5 times faster than the physical world economy to account for more than 15 per cent of global GDP (UN, 2023). As the political commentator and author Thomas Friedman points out, the world's gone from flat to fast, to smart, to deep (Friedman, 2019)!

I.2 Digital technologies are reshaping our lives through their impact on economic growth, employment, consumer welfare and living standards. Process innovations are rapidly being generated, markedly in information collection, storage and exchange. Digital technologies are democratising innovation and entrepreneurship, being less costly than conventional technologies to scale up and are seen as transfiguring innovators into entrepreneurs (Panagariya, 2022). Perhaps the most dramatic effects of digitalisation are evident in the metamorphosis of the financial infrastructure, including through network externalities. Financial transactions are conducted more speedily and efficiently in real time; the ambit of financial inclusion expands over time and space; and fiscal transfers occur seamlessly and with precision.

I.3 India is at the forefront of the digital revolution. As the next section portrays, it embraces not just financial technology (FinTech) speeding up digital payments but also the celebrated India Stack comprising biometric identification, the unified payments interface (UPI), mobile connectivity, digital lockers and consent-based data sharing. The digital revolution is galvanising banking infrastructure and public finance management systems covering both direct benefit transfers and tax collections. Vibrant e-markets are springing up and expanding their reach. It is estimated that the digital economy currently accounts for a tenth of India's GDP; going by growth rates observed over the past decade, it is poised to constitute a fifth of GDP by 2026 (Chandrasekhar, 2023).

* This chapter has been prepared by a team comprising Michael Debabrata Patra, Sarat Dhal, Rakhe Balachandran, Sakshi Awasthy, Kunal Priyadarshi, Soumasree Tewari, Ranjeeta Mishra, Rachit Solanki, Satyarth Singh, Abhinandan Borad, Rajnish Chandra and D. Suganthi.

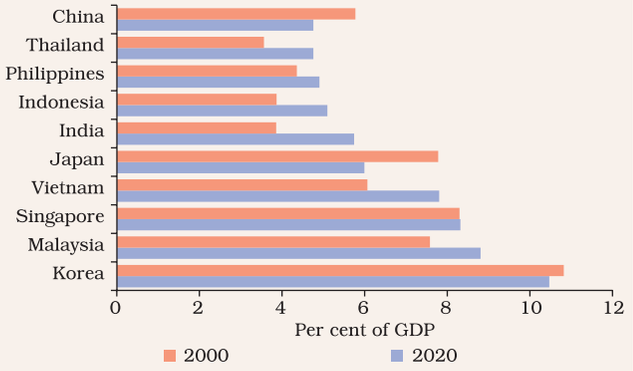
I.4 Several enabling forces have come together to energise this revolution. Although internet penetration in India was at 55 per cent in 2023, the internet user base has grown by 199 million in the recent three years (IAMAI-Kantar, 2024). India's cost per gigabyte (GB) of data consumed is the lowest globally at an average of ₹13.32 (US$ 0.16) per GB (Cable.co.uk, 2024). India also has one of the highest mobile data consumption in the world, with an average per-user per-month consumption of 24.1 GB in 2023 (GSMA, 2024; Nokia, 2024). There are about 750 million smartphone users, which is expected to reach about one billion by 2026. India is expected to be the second largest smartphone manufacturer in the next five years (Deloitte, 2022). India has the world's third largest startup ecosystem with over 1.4 lakh startups and over 100 unicorns (DPIIT, 2024; Tracxn, 2024a). The heavily tech-based startup ecosystem includes various sectors like FinTech platforms, *viz.,* insurance and payments, gaming, software as a service (SaaS)-based tools, logistics, healthcare services, education technology, e-commerce and online markets. India has also leveraged on public-private collaboration in the digitalisation of its economy, with the government working on telecom infrastructure projects with multinational investors. Since 2015, the "Digital India" initiative has been expanding digital infrastructure across the country and further reforms are either operational such as the Open Network for Digital Commerce (ONDC) or on the anvil such as the *BharatNet* project, investments in developing 5G and 6G infrastructure, the internationalisation of digital public infrastructure, the digital rupee and the development of data centres.

I.5 With India on course to reap late mover advantages to become the fastest growing digital economy in the world with a digital ecosystem set to cross US$ 1 trillion by 2025 (MeitY, 2019), the theme of this year's report, *India's Digital Revolution*, virtually selects itself. In this chapter, we peer into the future at the fundamental ways in which it will impact our developmental aspirations and strategies after briefly reviewing the state of play in Section 2. Section 3 takes on a forward-looking perspective, evaluating the exciting opportunities that digitalisation is likely to throw up in this transformation, including through artificial intelligence (AI). Section 4 assesses the trade-offs involved in the challenges of digitalisation, sometimes considered as a disruptive technology at least in respect of traditional technologies, the labour market and the like. Digital transformation is also resource-intensive in demanding substantial investment in technology, learning, infrastructure and above all, adaptability of employees and management to new digital tools and processes. Digitalising operations can expose entities to potential cyber threats and data breaches, necessitating robust cybersecurity measures. The adoption of AI also brings challenges, including ethical concerns, data privacy and potential malicious use. Recent policy initiatives by Reserve Bank of India (RBI) are discussed in Section 5. The chapter concludes with Section 6, which lays out the structure of the rest of the report, the theme of each succeeding chapter and key findings.

2. The State of Play

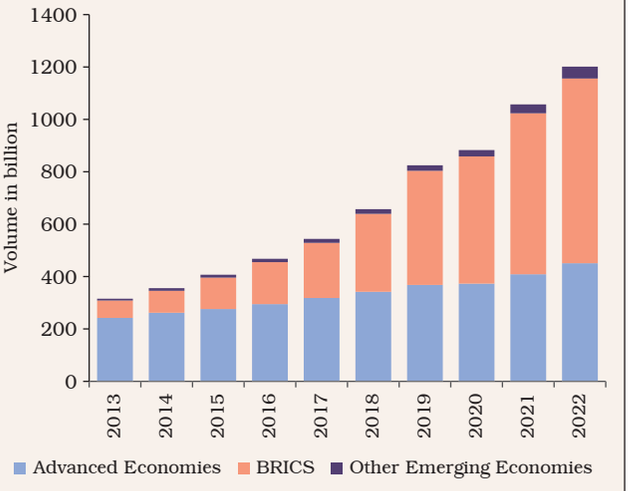
I.6 The term "digital economy" is believed to have been coined in 1996 (Tapscott, 1996; ADB, 2021). In a formal sense, it has been defined as the contribution of any economic transaction involving both digital products and digital industries to GDP - digital products being goods and services with the main function of generating, processing and/or storing digitised data (ADB, 2021). Digitalisation

Chart I.1: Size of the Core Digital Economy in Select Countries



Note: The core aspects of the digital economy comprise hardware technologies (computers and digital communication devices), software and web services (data processing and hosting) and enabling infrastructure (internet and telecommunication networks). The GDP share of the digital economy shows a decline or increase at a slower rate for some economies owing to the falling prices of core digital products and increasing productivity of digital products over time (ADB, 2021).
Source: ADB, 2021.

Chart I.2: Region-wise Cashless Payments



Note: Data pertain to retail digital payments and include payments done through cheques as well.
Source: Committee on Payments and Market Infrastructures, BIS, 2024.

has varied across geographies, reflecting differing levels of infrastructure, regulatory frameworks and technological readiness. For countries like India, Malaysia and Thailand that have been fast adopters, the service-oriented structure of their economies has fostered deeper forward linkages with core digital activities than others (Chart I.1).

I.7 In the financial sector, payment systems serve as the first point of entry for digital technologies (Bech *et al.,* 2018), with digital payment platforms, contactless cards and mobile wallets becoming all-pervasive. Globally, BRICS nations[1] are contributing a larger share to total cashless payments than advanced nations (BIS, 2024) [Chart I.2]. India is leading the world with a share of 48.5 per cent in global real-time payments volume (ACI Worldwide, 2024). Global remittances that are increasingly being effected through mobile money and digital platforms are estimated to have increased to US$ 857.3 billion in 2023, led by India (US$ 115.3 billion), Mexico (US$ 66.2 billion), China (US$ 49.5 billion) and the Philippines (US$ 39.1 billion) [World Bank, 2024; RBI, 2024a].

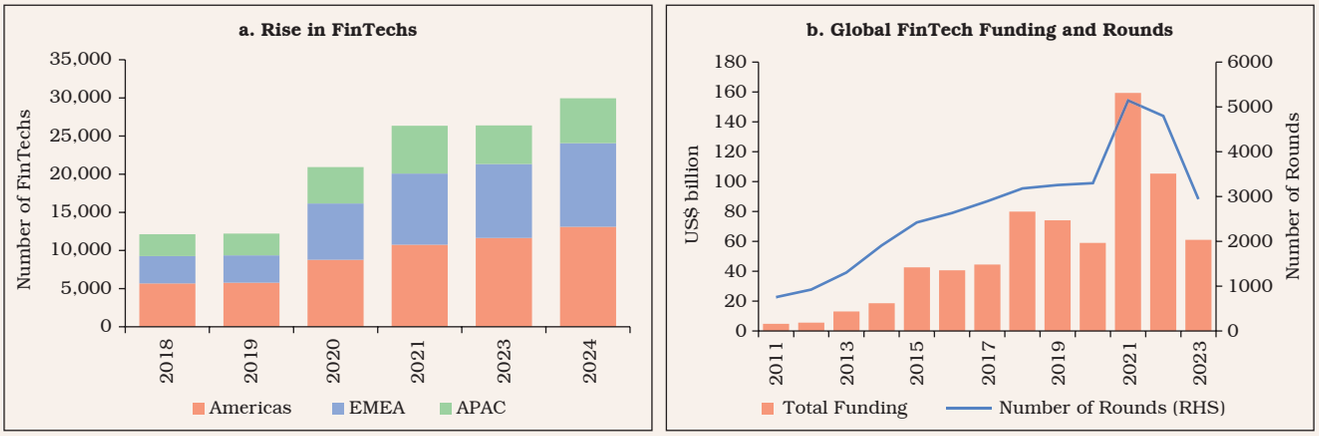
I.8 Digitalisation has diversified the range of players in the financial services industry, with a significant increase in the number of FinTechs across nations (Chart I.3a). FinTechs are attracting funds from a range of investors, resulting in the total value of FinTech investments standing at US$ 61 billion globally in 2023 (Chart I.3b). India is one of the top recipients of FinTech funding in recent years, with US$ 2.6 billion of flows in 2023 (Tracxn, 2024b).[2] Along with FinTechs, large technology companies (hereafter BigTechs) have also entered the financial industry.

I.9 Advancements in digital payment systems, along with the increasing presence of FinTechs and BigTechs in the financial sector, is structurally

[1] Brazil, Russia, India, China and South Africa.

[2] Other countries being the US, UK and China.

Chart I.3: Growth in Global FinTech Ecosystem



Note: Americas include North and South America; EMEA is Europe, the Middle East and Africa; APAC is Asia–Pacific. Data for 2022 is not available in chart a.
Source: Statista, Tracxn Database accessed in May 2024, and RBI staff estimates.

shifting the global credit markets. Lending from FinTechs and BigTechs has steadily increased from US$ 132 billion and US$ 22 billion, respectively, in 2015 to US$ 223 billion and US$ 572 billion in 2019, with BigTech credit projected to reach US$ one trillion by 2023, indicating heightened competition between traditional lenders and new players (Cornelli *et al.*, 2020; Asian Banker, 2022).

2.1 The Indian Experience

I.10 India's digital revolution is a blend of government-led initiatives and enabling regulatory frameworks of financial market regulators (the Reserve Bank and the Securities and Exchange Board of India (SEBI)) [Annex I.1]. This journey traverses four phases since independence (Box I.1).

Box I.1
History of India's Digitalisation

Phase I: Digital Awakening (1950s-1980s)

Prior to the nationalisation of the financial system, computers were mainly seen as labour-saving tools and faced strict controls due to fear of unemployment. In the 1980s, however, a significant shift towards computerisation began [Committee on Mechanisation in the Banking Industry, 1984 (Chairman: Dr. C. Rangarajan); Committee on Communication Network for Banks and SWIFT Implementation, 1987 (Chairman: Shri T.N.A. Iyer) and Committee on Computerisation in Banks, 1989 (Chairman: Dr. C. Rangarajan)]. These initial efforts paved the way for electronic data processing in banks, introduction of automated teller machine (ATM) networks and credit cards, and the implementation of BANKNET[3] and Magnetic Ink Character Recognition (MICR)-based systems. Banks progressed from standalone computers to local area networks (LANs) and to core banking platforms.

Phase II: Liberalisation and the InfoTech Boom (1990s)

During the 1990s, India underwent advancements in computer and telecommunication technologies, influenced by the emergence of the internet. Early

(Contd...)

[3] The Reserve Bank recognised the pressing need to harness information technology for intra-bank and inter-bank communications in the 1980s and set up BANKNET as the communication network for the banking sector.

telecom developments in the preceding decade like the establishment of the Centre for Development of Telematics (C-DOT) and industry associations like the National Association of Software and Service Companies (NASSCOM) laid the foundation for further telecom advancements and modern digital banking. The granting of statutory recognition to the SEBI, the establishment of the National Stock Exchange (NSE) and the subsequent shift from public outcry systems to dematerialisation of securities democratised access to capital markets. Following the recommendations of the Narasimham Committees[4] and active support of the Reserve Bank[5], the decade saw rapid technological modernisation in banking, including the launch of the Indian Financial Network (INFINET) and the adoption of internet banking during the late 1990s. Rising competition from private banks and growing customer expectations drove public sector banks to embrace large-scale information technology (IT) solutions, enhancing operational efficiencies across financial institutions. Concurrently, India's domestic IT and telecom industries grew to cater to the increasing technological needs of the financial sector, driven by supportive central and state government policies.

Phase III: Building the Institutional and Legal Framework (2000 – 2016)

The Information Technology Act of 2000 set the stage by providing legal recognition to electronic transactions and filings. Following major advancements in digital payment systems such as the introduction of Real Time Gross Settlement (RTGS) in 2004 and National Electronic Funds Transfer (NEFT) in 2005, the Payment and Settlement Systems Act of 2007 was enacted to support the rapidly growing payments industry. The National Payments Corporation of India (NPCI) was established in 2008, which led the shift towards digitalisation of retail payments that reached a high point with the launch of the UPI in 2016.[6] The Indian Financial Technology and Allied Services (IFTAS) was set up in 2015 to provide crucial IT services for the Reserve Bank, and other banks and financial institutions. Supporting these initiatives, the government undertook key initiatives such as the *Aadhaar* project (2009), National Telecom Policy (2012), Direct Benefit Transfer scheme (2013) and *Pradhan Mantri Jan-Dhan Yojana* (2014), which promoted affordability, reliability and financial inclusion, culminating in the *Jan Dhan-Aadhaar-*Mobile (JAM) trinity. The Digital India Mission (2015) and Startup India Mission (2016) were also launched to enhance digital infrastructure and innovation. In its debt management function, the Reserve Bank promoted a robust government security (G-sec) market through the Negotiated Dealing System – Order Matching (NDS-OM) platform for anonymous order matching in the secondary market transactions, followed by the fully digital Retail Direct Scheme in 2021.

Phase IV: Digital Financial Innovation at Centre Stage (2017 onwards)

By 2017, India established a robust digital infrastructure, positioning itself as a leader in innovative, large-scale payment systems.[7] A surge in financial innovations, with the round-the-clock availability of all major payment systems, including RTGS and NEFT, functionalities like offline payments, feature phone payments and conversational payments, the launch of Central Bank Digital Currency (CBDC) pilots and initiatives like the Regulatory Sandbox (2019), the Reserve Bank Innovation Hub (2021) and the pilot Public Tech Platform for Frictionless Credit (PTPFC) [2023] fostered FinTech innovations. Currently, the internationalisation of home-grown payment modes is also progressing rapidly, enabling cross border transfers and projection of India's soft power.

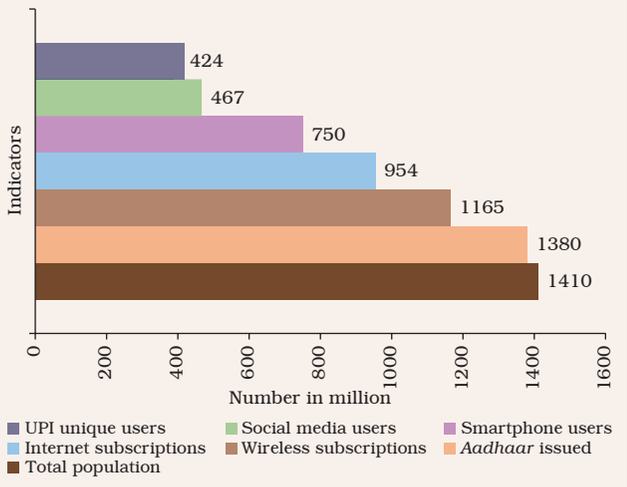
4 Report of the Committee on the Financial System (1991) and the Committee on Banking Sector Reforms (1998).

5 The Reserve Bank established the Institute for Development and Research in Banking Technology (IDRBT) in 1996 and constituted the Committee on Technology issues relating to Payments System, Cheque Clearing and Securities Settlement in the Banking Industry (Chairman: Shri W.S. Saraf) in 1994.

6 NPCI, as the umbrella organisation, created a strong payment and settlement infrastructure in India comprising the National Financial Switch (NFS) in 2004, the Immediate Payment Service (IMPS) in 2010, *Aadhaar* enabled Payment Systems (AePS) in 2010, the *RuPay* network in 2012, National Automated Clearing House (NACH) in 2016, National Electronic Toll Collection (NETC) in 2016 and the *Bharat* Bill Payment System (BBPS) in 2017, among others.

7 The High-Level Committee on Deepening of Digital Payments (Chairman: Shri Nandan Nilekani), 2019, advocated a secure, inclusive, and scalable digital payment ecosystem, promoting feature phone payments and simplified regulatory measures.

Chart I.4: Digitally Connected Population in India



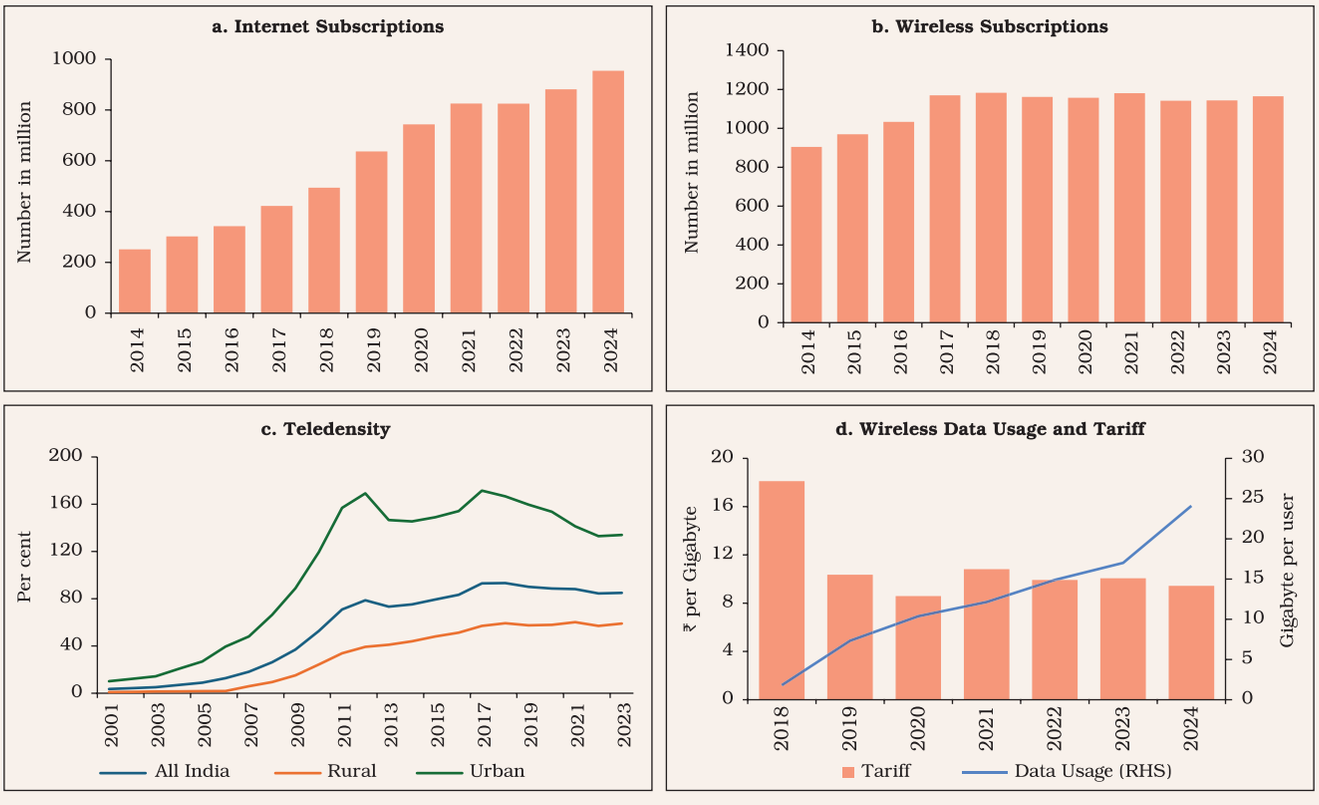
Note: Data for wireless subscriptions, internet subscriptions, smartphone users and social media users are not unique, *i.e.*, one individual may be holding multiple subscriptions.
Source: *Jan Dhan* Dashboard, Telecom Regulatory Authority of India (TRAI), Statista and RBI staff estimates.

I.11 India has one of the largest digitally connected population worldwide (Chart I.4). The two fundamental drivers of this wave of digitalisation are: (a) ubiquitous connectivity through mobile, internet-connected devices and communication networks; and (b) low-cost computing and data storage.

I.12 India is home to the second largest telecom subscriber base (TRAI, 2023) and internet user base globally (ICRIER, 2024). The growth in digital enablers has been powered by competitive offerings by telecom operators, advent of global tech giants and among the cheapest data prices in the world (Chart I.5).

I.13 The average time Indian users spent online *i.e.*, 6.45 hours per day, is close to the global average (6.4 hours) [Statista, 2024a]. In 2023, Indian internet users logged the second highest application downloads at 26 billion (data.ai, 2024). The median mobile download speed has

Chart I.5: Trends in Digital Enablers in India



Note: Data pertain to end-March.
Source: TRAI, 2024, International Telecommunication Union (ITU), 2023 and Nokia Mobile Broadband Index 2024.

also increased, climbing from 1.3 Megabits per second (Mbps) in 2014 to 107.03 Mbps in June 2024, partly driven by the rollout of 5G (Vaishnaw, 2023; Ookla, 2024).

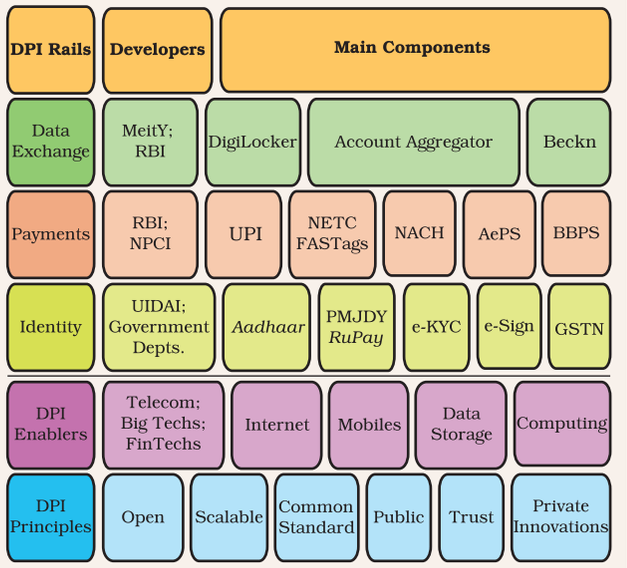
2.2 Digital Public Infrastructure

I.14 India's foundational Digital Public Infrastructure (DPI) – the India Stack – has use cases across a spectrum of economic activities that allow private and public players to innovate and build customer-centric solutions (Chart I.6). Built on the pillars of providing DPI as a public good, encouraging private innovation by providing open access, creating a level-playing field through regulatory framework and empowering individuals through a consent-driven data-sharing framework, India Stack has facilitated population-scale delivery of services in a cost-effective manner, particularly benefitting marginalised segments (D' Silva *et al.,* 2019; Alonso *et al.,* 2023).

I.15 The identity layer of India's DPI enables secure and unique identification of individuals on demand without the need for physical presence and facilitates seamless authentication, verification and integration of identity information. Since its inception in 2009, the 12-digit *Aadhaar* has become the world's largest biometric-based identification system, with 1.38 billion ID holders covering 98 per cent of the population (UIDAI, 2024; MeitY, 2024). The subsequent launch of the *Pradhan Mantri Jan Dhan Yojana* (PMJDY) propelled *Aadhaar*-linked bank accounts for 52.5 crore citizens, increasing threefold since 2017. More than 50 per cent of the account holders are women and 67 per cent of the total accounts are in rural and semi-urban areas of the country (Chart I.7) [PMJDY, 2024]. Account ownership in India has more than doubled in 10 years from 35 per cent in 2011 to 78 per cent in 2021 (World Bank, 2021).

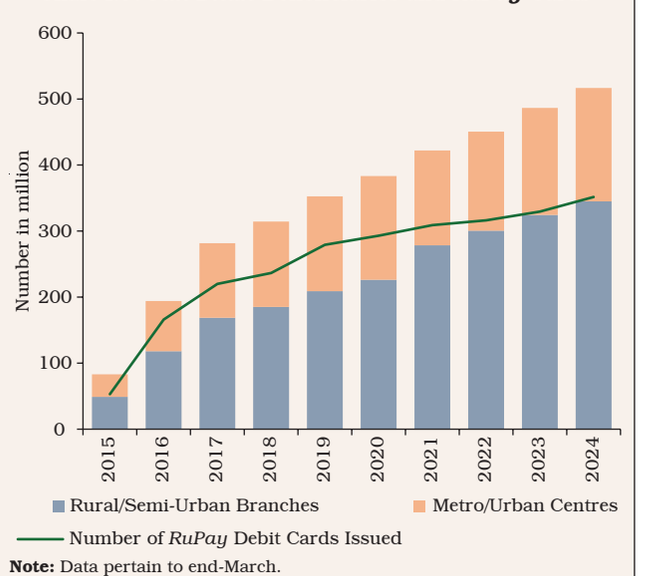
I.16 Since 2014, there have been over 116 billion *Aadhaar*-based authentications and 20 billion electronic-know your customer (e-KYC) authentications.[8] This has helped to formalise

Chart I.6: India Stack – Schematic Presentation



Source: RBI staff illustration.

Chart I.7: *Jan Dhan* Beneficiaries and *RuPay* Cards



Note: Data pertain to end-March.
Source: *Jan Dhan* Dashboard, accessed in June 2024.

[8] Other initiatives include the Co-Win app, Government e-Marketplace (GeM), *Jeevan Praman* and the Unified Mobile Application for New-age Governance (UMANG) app.

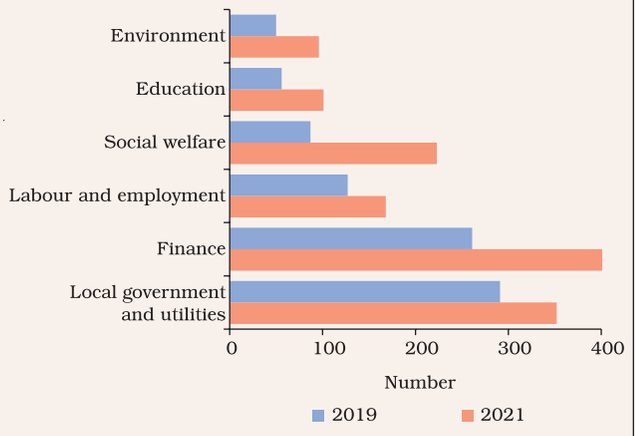
the economy, with the Goods and Services Tax Network (GSTN) onboarding 1.4 crore taxpayers and issuing over 400 crore e-way bills (NASSCOM, 2024; GST, 2024). Direct Benefit Transfers (DBTs) have streamlined subsidies and reduced leakages, with ₹6.9 lakh crore transferred directly for 315 schemes reaching 176 crore beneficiaries (non-unique) in 2023-24. The DBTs have resulted in an estimated ₹3.4 lakh crore in cost savings over the years till March 2023 (DBT, 2024). The e-delivery of government services has expanded across sectors, particularly in finance, local government utilities and social welfare schemes (Chart I.8).

I.17 Under the payments layer, the development of a real-time, round-the-clock, scalable and interoperable retail payment option is enabled by the UPI. It powers multiple bank accounts into a single mobile application, merging several banking features, seamless fund routing and merchant payments. The payment platform has facilitated secure, convenient and low-cost transactions between individuals, businesses and governments on demand, with settlement in fiat money inside the formal financial system.

I.18 Digital payments have recorded a compound annual growth rate (CAGR) of 50 per cent and 10 per cent in volume and value terms, respectively, in the last seven years[9] involving 164 billion transactions worth ₹2,428 lakh crore in 2023-24. Payment infrastructure has also received a boost from the Payment Infrastructure Development Fund (PIDF) [Chart I.9].[10]

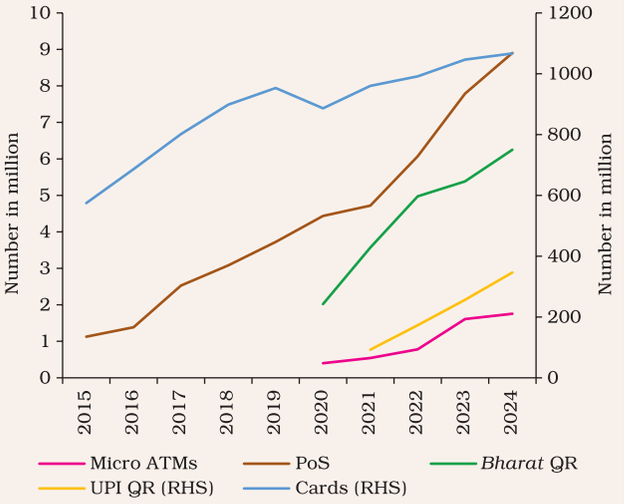
I.19 The UPI has seen a tenfold increase in volume over the past four years, increasing from 12.5 billion transactions in 2019-20 to 131 billion

Chart I.8: e-Delivery of Government Services in India by Sector



Note: Mandatory e-services offered by States and Union Territories (UTs), as reported by National e-Governance Service Delivery Assessment Report, 2021.
Source: Statista and Department of Administrative Reforms and Public Grievances, GoI.

Chart I.9: Payment Infrastructure



Note: Data pertain to end-March. Data for *Bharat* quick response (QR) codes and Micro ATMs are available from July 2020.
Source: RBI.

[9] Between 2017-18 and 2023-24.

[10] The PIDF scheme provides financial support to banks and NBFCs for expanding payment acceptance infrastructure in designated areas, including tier-3 to tier-6 cities and north-eastern India.

transactions in 2023-24 - 80 per cent of all digital payment volumes. Currently, the UPI is recording nearly 14 billion transactions a month, buoyed by 424 million unique users in June 2024. The surpassing of UPI transactions volume for peer-to-merchant (P2M) transactions over the peer-to-peer (P2P) segment and high volume for small-value transaction categories indicate its high usage.

I.20 The data exchange layer provides a standardised, consent-driven and interoperable platform on which individuals, businesses and government agencies can securely share and access data for various purposes. Under the Account Aggregator (AA) framework, entities are governed by the guidelines issued in 2016 by the Reserve Bank. AAs are built on the Data Empowerment and Protection Architecture (DEPA), which serves as consent managers, empowering citizens to seamlessly access their financial data and exchange it with third-party institutions. Since the framework was first launched in August 2021, nearly 80 million individuals and companies have benefited from easier access to financial services through AAs. Adoption is increasing rapidly, with around 40 million new accounts being linked in 2024 alone so far (*Sahamati*, 2024). DigiLocker, the online cloud-based document depository, has issued more than six billion documents, catering to 300 million users in 2024 (DigiLocker, 2024). India has also enacted a Digital Personal Data Protection Act (DPDP Act) in 2023 to navigate the trade-off between ensuring effective regulation and maintaining individual privacy (Annex I.2).

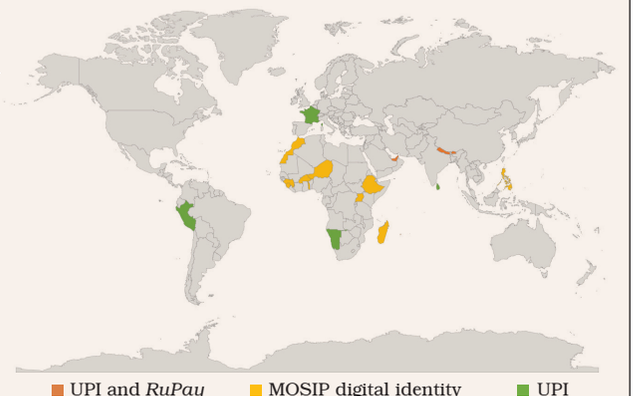
2.3 Internationalisation of Digital Public Infrastructure

I.21 India's DPI is going global by a) collaborating with other nations to develop digital identity solutions under the Modular Open Source Identity Platform (MOSIP) programme; b) interlinkage of the UPI with fast payment systems of other nations like Singapore's *PayNow*, the United Arab Emirates' (UAE) *Instant Pay Platform (IPP)* and Nepal's *National Payments Interface (NPI*) for cost-effective and fast remittances; c) partnering with other central banks and foreign payment service providers to broaden UPI and RuPay acceptance beyond geographical borders, such as in countries like Bhutan, Mauritius, Singapore and the UAE; and d) sharing the Beckn protocol[11] with nations to provide their public and private services through open, lightweight and decentralised specifications (Chart I.10).

3. Expanding the Opportunities Frontier

I.22 Digitalisation is unlocking opportunities across various sectors of the economy. In this

Chart I.10: Global Footprint of India's DPI



Note: The "UPI" category includes initiatives for UPI acceptance *via* QR codes, fast payment interlinkages and partnerships with other countries to develope UPI-like infrastructure. The combined "UPI and *RuPay*" category covers countries where both UPI and *RuPay* acceptance initiatives are undertaken. The "MOSIP digital identity" category involves partnerships with countries to establish MOSIP-based digital identity systems.
Source: NPCI; MOSIP and RBI staff estimates.

[11] Beckn protocol is a set of technology-agnostic specifications that allows the applications on Beckn to exchange information in a standardised manner irrespective of the technology form or medium of exchange.

section, the focus is on areas where digitalisation has permeated and has the potential to make further advances: (i) enhancing financial inclusion; (ii) addressing gender, economic and social inequalities; (iii) channelling formal finance to agriculture; (iv) enabling seamless cross-border transactions; and (v) supporting climate finance and sustainability. In the process, economic value generated by DPIs is expected to rise to 2.9 - 4.2 per cent of GDP by 2030 (NASSCOM, 2024), lifting India's growth while improving total factor productivity (Box I.2).

Box I.2
Role of Digitalisation in India's Future Growth Path

Cross-country evidence has highlighted the positive contribution of information communication and technology (ICT)[12] to productivity (Kallal *et al.,* 2021). Over the period 1980-2021, an augmented Cobb-Douglas production function using KLEMS[13] data with real gross value added (VA) at basic prices as a function of total factor productivity (TFP), labour (L), ICT capital (ICT) and non-ICT capital stock (K) can be written as:

$$VA_t = TFP_t(L)_t^{\alpha}(ICT)_t^{\beta}(K)_t^{\gamma}e^{\varepsilon_t} \quad \text{... (1)}$$

Assuming constant returns to scale, equation (1) can be log linearised as:

$$LogVA_t = LogTFP_t + \alpha(LogL)_t + \beta(LogICT)_t + \gamma(LogK)_t + \varepsilon_t \quad \text{... (2)}$$

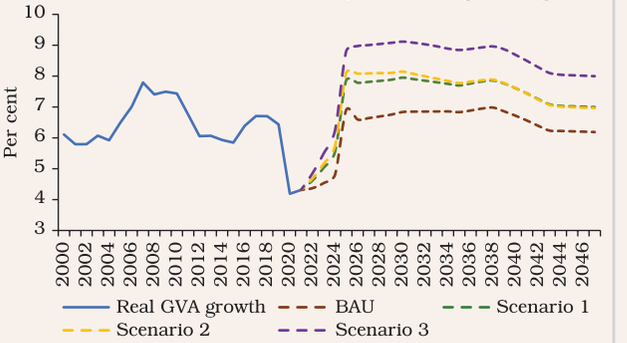
Based on factor income shares which are estimated to be 0.6 for K, 0.1 for ICT and 0.3 for L, the estimation of potential growth paths under different assumptions on factors of production shows that in the business as usual (BAU) Scenario assuming all factors of production grow at historical trend rates and factor productivity growth remains constant, the economy can achieve a growth of 7.1 per cent by 2030, converging thereafter to its long run trend of 6.2 per cent by 2047. As gross fixed capital formation (GFCF) has recorded robust growth in the recent years, increase in investment in non-ICT capital can lead to a higher growth path as indicated in Scenario 1, reaching 8.1 per cent by 2030 and 7.0 per cent by 2047 (assuming growth of 7.8 per cent in non-ICT capital investments in the initial five years, based on the 10-year average of high investment growth years), while investment growth in ICT capital and labour participation remains unchanged (Table 1 and Chart 1).

Table 1: Real GVA Growth (Per cent)

Scenarios	2030	2047
Business as usual (BAU)	7.1	6.2
Scenario 1: Increase in non-ICT investment while ICT investment growth is unchanged, given marginal increase in labour and productivity	8.1	7.0
Scenario 2: Increase in both ICT and non-ICT investment, given marginal increase in labour and productivity	8.2	7.0
Scenario 3: Increase in both ICT and non-ICT investment, augmented by increase in labour employment and improved factor productivity	9.2	8.0

Source: RBI staff estimates.

Chart 1: Real GVA Growth (5 year Moving Average)



Source: KLEMS and RBI staff estimates.

(Contd...)

[12] Includes IT equipment, communications equipment, and software.

[13] The KLEMS – Capital (K); Labour (L); Energy (E); Materials (M); and Services (S) – Database is part of a research project supported by the Reserve Bank to analyse productivity performance in the Indian economy at a disaggregated industry level.

In Scenario 2, ICT investment growth in addition to the non-ICT capital investment under Scenario 1 will lead to a higher growth path. Growth is, however, constrained by the current level of labour employment and factor productivity. In this case, growth can reach 8.2 per cent by 2030. Over time, the initial positive impact of ICT investments diminishes, causing the growth rate to converge to that of Scenario 1. As investment's contribution to growth diminishes with increase in the capital-to-output ratio, the investment-led growth path may lose momentum unless supported by reforms that focus on productivity, human capital and higher labour force participation (RBI, 2022). This is corroborated by Scenario 3 where the maximum growth is achieved with a peak of 9.2 per cent by 2030 and reaching 8.0 per cent by 2047, if investments in ICT and non-ICT capital are augmented by growth in labour employment and improved total factor productivity.

The contribution of ICT capital to GVA growth highlights the crucial role of digital infrastructure. While it is necessary, it is not sufficient to achieve the maximum growth potential. This hinges on technology driven momentum being accelerated by higher employment and improved factor productivity.

References:

Kallal, R., Haddaji, A., and Fitti, Z. (2021). ICT Diffusion and Economic Growth: Evidence from the Sectoral Analysis of a Periphery Country. *Technological Forecasting and Social Change, 162*.

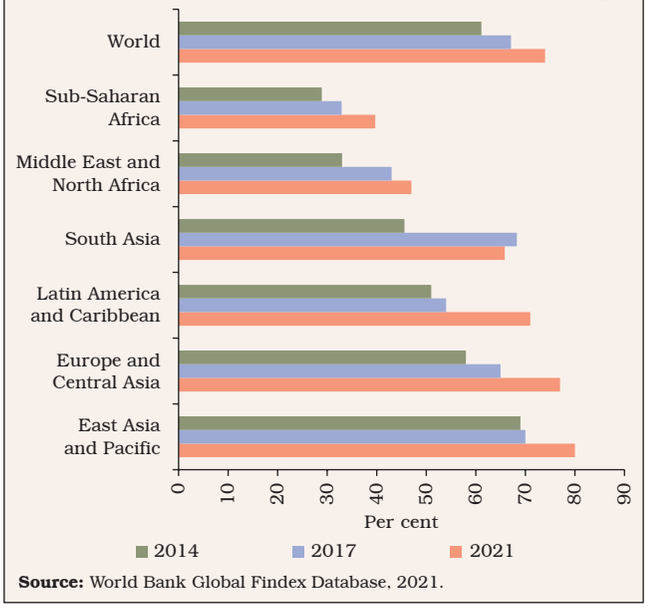
Reserve Bank of India. (2022). *Revive and Reconstruct.* Report on Currency and Finance 2021-22.

3.1 Financial Inclusion

I.23 Digitalisation offers a unique and dynamic opportunity to expand the reach of financial services to the entire population, especially disadvantaged and voiceless sections, thereby formalising the economy. Globally, there has been an increase in bank account ownership from 61 per cent of the adult population in 2014 to 74 per cent in 2021 (Chart I.11).

I.24 The evolution and adoption of technological advancements have led to massive improvement in deepening of digital financial services (Das, 2021). Globally, there has been a notable increase in the use of mobile money accounts, bridging the gap between retail accounts and payments in emerging market and developing economies (EMDEs) [Chart I.12].

Chart I.11: Global Trends in Bank Account Ownership



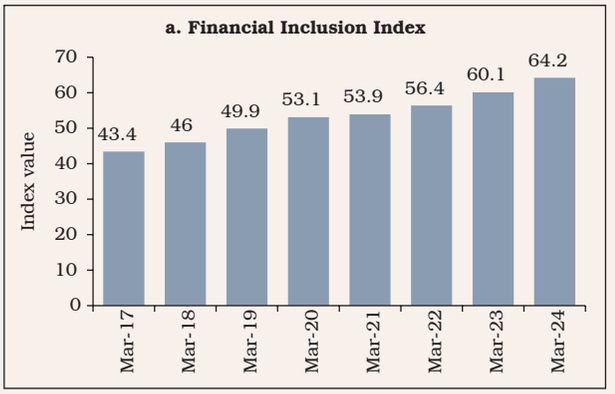
Source: World Bank Global Findex Database, 2021.

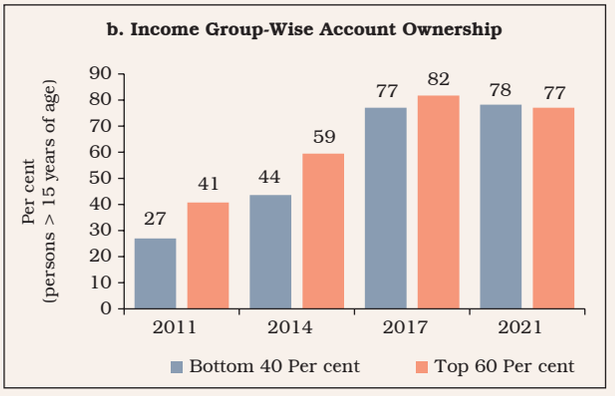
Chart I.12: Global Trends in Mobile Money Account Ownership

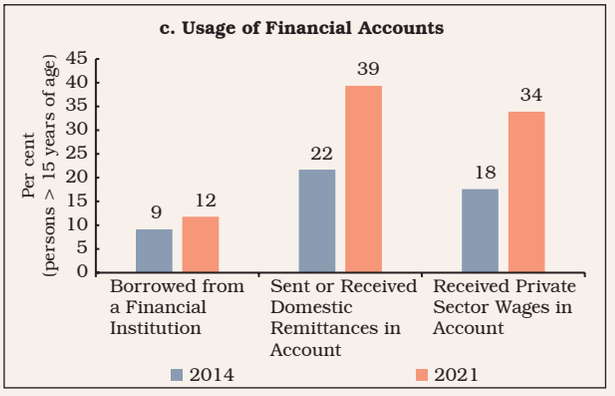
Source: World Bank Global Findex Database, 2021.

I.25 The potential for expanding financial inclusion in India by application of digital technologies is high in view of existing conditions. First, the progress of financial inclusion in India is evident in the Reserve Bank's Financial Inclusion Index and narrowing account access gap between income groups. In addition, usage has increased in borrowings, remittances and the receipt of private sector wages (Chart I.13).

Chart I.13: Strides in India's Financial Inclusion

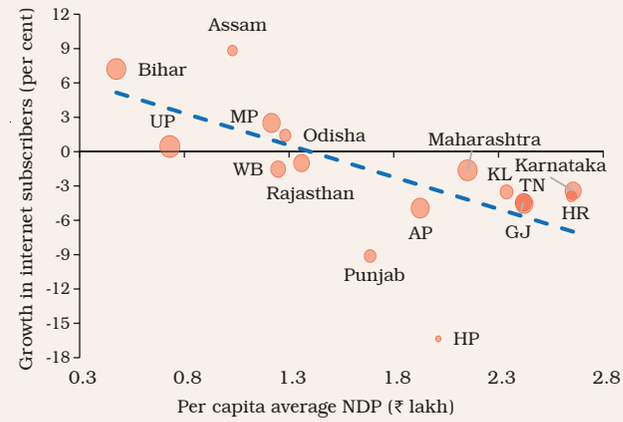






Source: RBI and World Bank Global Findex Database, 2021.

Chart I.14: Digital Penetration - Lower-Income States Catching Up

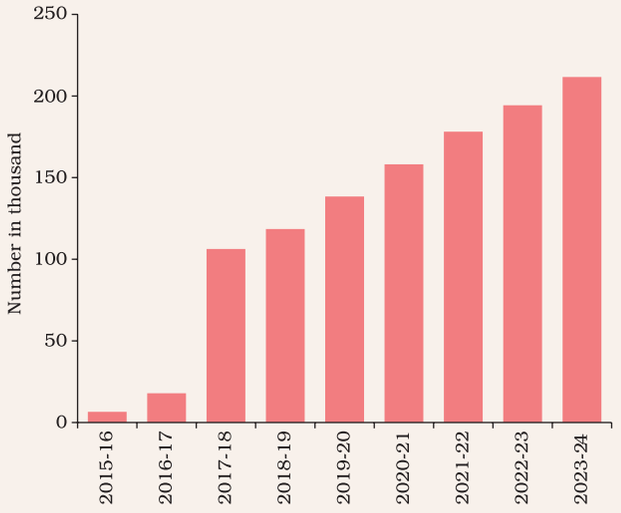


Note: UP: Uttar Pradesh, MP: Madhya Pradesh, WB: West Bengal, KL: Kerala, TN: Tamil Nadu, AP: Andhra Pradesh, GJ: Gujarat, HR: Haryana and HP: Himachal Pradesh. State-wise average per capita Net Domestic Product (NDP) pertain to 2020-21. The growth in internet subscribers is taken for 2022-23 over 2018-19. The size of the bubble is proportional to the number of internet subscribers.
Source: TRAI, National Statistical Office (NSO), and RBI staff estimates.

I.26 Second, in rural India, 46 per cent of the population consists of wireless phone subscribers (TRAI, 2024) and 54 per cent are active internet users (IAMAI-Kantar, 2024). Internet accessibility in low-income states has recorded a higher average growth than in relatively higher-income states (Chart I.14).

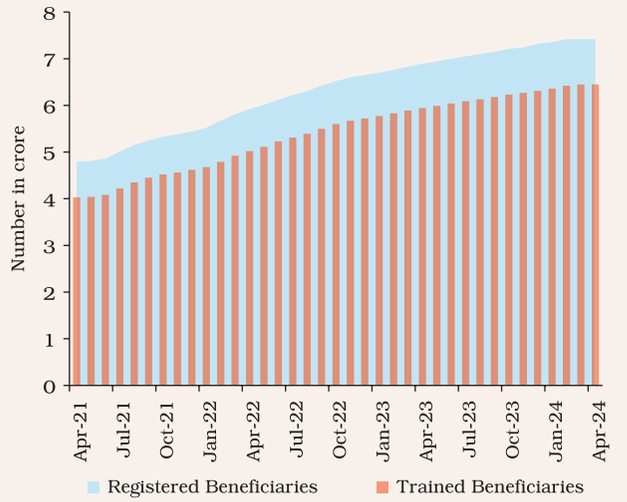
I.27 Third, given that more than half of FinTech consumers are from semi-urban and rural India and more than a third of digital payment users are from rural areas (TransUnion CIBIL, 2023), there is potential for furthering digital penetration and closing the rural-urban gap. Over two lakh *gram panchayats* have been connected through *BharatNet* in the last decade, enabling provision of services like e-health, e-education and e-governance in rural areas (Chart I.15). Various initiatives have also been taken to promote digital literacy in rural India (Chart I.16). The adoption of a community-led participatory approach through the establishment of Centres for Financial Literacy (CFL) and the National Centre for Financial

Chart I.15: Cumulative *Gram Panchayats* Connected through *BharatNet*



Source: Ministry of Communications, GoI.

Chart I.16: Digital Literacy Program Beneficiaries



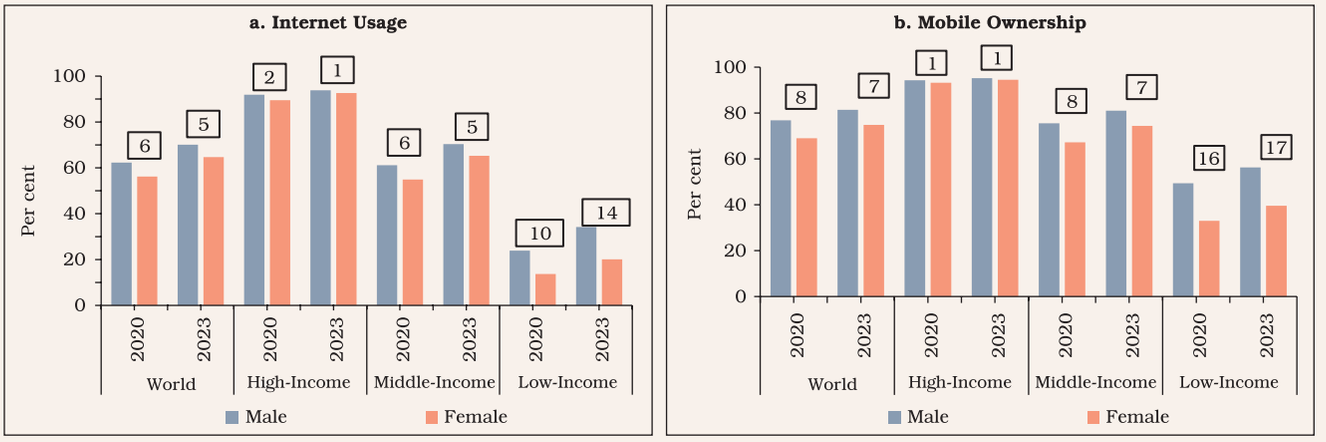
Note: Data pertain to beneficiaries under *Pradhan Mantri Gramin Digital Saksharta Abhiyan.*
Source: MeitY, GoI.

Education (NCFE), along with broadcasting regional language financial education messages and utilising community radio, reflects the public policy strategy for enhancing digital literacy (World Bank and IFAD, 2021).

3.2 Bridging Gender, Economic and Social Inequalities

I.28 Digitalisation can play a vital role in increasing the contribution of women to economic activity and effectively targeting delivery of the public schemes for intended beneficiaries. Globally, men outnumbered women internet users by five percentage points in 2023 (Chart I.17a). For low-income countries, the gap increased to 14 percentage points in 2023, with the mobile ownership gap between genders at 17 percentage points *vis-à-vis* one percentage point for high-income countries and seven percentage points overall (Chart I.17b). In terms of the adoption

Chart I.17: Gender-wise Adoption of Digital Enablers



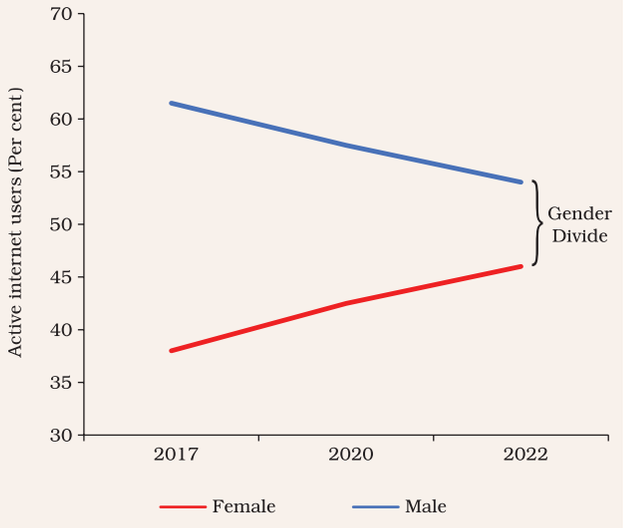
Note: The figures in the box indicate the gender gap.
Source: ITU.

and usage of FinTech products, a significant gap between gender persists globally[14] (Chen *et al.,* 2023).

I.29 Despite gender disparities in internet accessibility in India, the gender gap in internet adoption has narrowed significantly between 2017 and 2022 (Chart I.18). The digital gender gap has implications for expanding the female labour force participation rate (LFPR), which was 41 per cent relative to male LFPR of 78 per cent in 2023 (MoSPI, 2024). Digitalisation, thus, offers a unique opportunity to reap the demographic dividend. Digital tools can contribute to gender-neutral labour markets by offering flexible schedules, virtual workplaces and coworking spaces, aiding women in overcoming mobility barriers and promoting work-life balance. Technologies like virtual reality (VR), augmented reality (AR) and blockchain present exciting opportunities for women (Patra, 2024a). Sectors such as banking, financial services and insurance (BFSI), telecom and e-commerce are increasingly prioritised by women, with half of the female job seekers preferring work-from-home options (Press Trust of India, 2023).

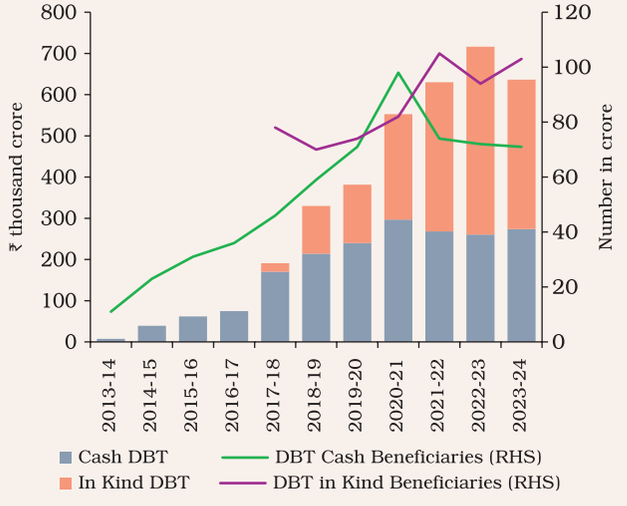
I.30 Digitalisation is empowering India to bridge economic inequalities through a paradigm shift in social welfare schemes *via* DBTs. Over the last decade and especially since the pandemic, funds disbursed directly to beneficiary accounts through DBT have been ramped up, along with an increase in the number of beneficiaries (Chart I.19). By harnessing DPIs in conjunction with social welfare schemes and structural reforms, India has lifted 415 million people from poverty within a span of 15 years between 2005 and 2021 (UNDP, 2023)[15]. Multidimensional poverty has dropped from 29.1 per cent of the total

Chart I.18: Gender Divide goes down in India



Source: IAMAI-Kantar.

Chart I.19: Direct Benefit Transfers in India



Note: Number of beneficiaries are not unique, implying that the same person may receive both cash and in-kind transfers.
Source: DBT Dashboard, accessed in May 2024.

[14] From a sample of 28 countries, including high-income and middle-income countries.

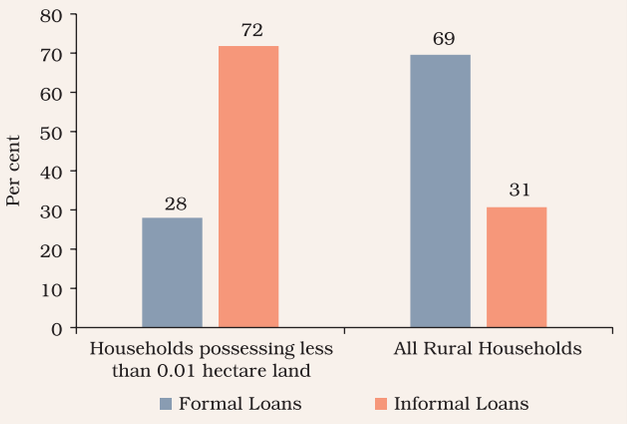
[15] Global Multidimensional Poverty Index (MPI).

population in 2013-14 to 11.2 per cent in 2022-23, surpassing the sustainable development goal well ahead of the deadline (NITI *Aayog*, 2024) [16].

3.3 Addressing Finance for Agriculture

I.31 A significant number of lower-income households and businesses in the informal sector remain excluded from credit registries as they often lack the necessary information that financial institutions need to evaluate creditworthiness. This exclusion decreases their chances of obtaining finance and increases the cost of loans when they do receive them (Carriere-Swallow *et al.,* 2021). Consequently, informal finance is still thriving in rural India, despite the penetration of the formal financial sector. Among the total outstanding loans of rural households, 31 per cent is sourced from informal lenders. Penetration of informal loans is particularly high among the lowest economic strata of households (Chart I.20). Consumption smoothing, social ceremonies and medical emergencies together account for nearly 30 per cent of total loans availed by rural households in 2018-19 (NSO, 2021). This indicates that a significant portion of loans by rural households are driven by immediate and essential needs rather than long-term investment, reflecting vulnerability in their financial position and access to services.

Chart I.20: Composition of Outstanding Loans



Note: Data pertain to loans of rural households including both agricultural as well as non-agricultural households. Agricultural household is defined as "a household which is having production from agricultural activities of value more than ₹4,000 and has at least one household member self-employed in agriculture during the last 365 days" in 77th round.
Source: NSO 77th Round, 2021, GoI.

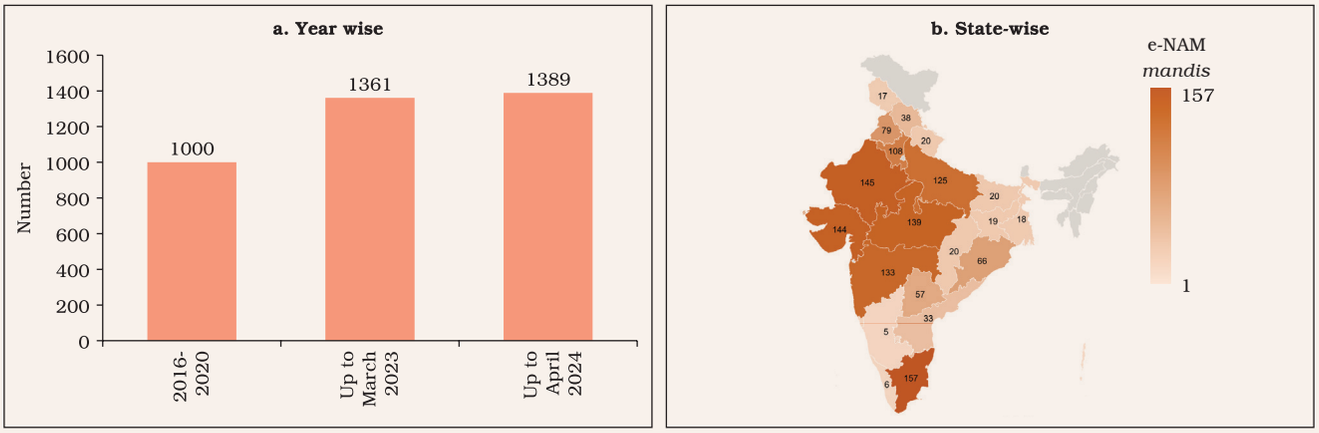
I.32 Digitalisation can significantly transform the agriculture sector. Reforms such as the decoupling of income support for all farmers through direct disbursement of PM-KISAN instalments into bank accounts, the e-national agricultural market (e-NAM) for integrating *mandis* online for transactions and development of *Kisan Suvidha* mobile app to facilitate dissemination of information to farmers are playing a pivotal role. So far, 1,389 wholesale *mandis* located in 23 states and four UTs have been integrated on the e-NAM platform (Chart I.21).

I.33 At end-March 2023, the number of operative *Kisan* Credit Cards (KCCs) stood at 7.4 crore (Chart I.22a).[17] KCC penetration is less than 20 per cent among marginal farmers having less than one hectare of land (Chart 1.22b). The reasons for the low penetration of KCCs are the unavailability of online land and revenue records as well as a lack of awareness about the scheme, among others (Mani, 2016). Amount outstanding under operative KCCs has grown consistently, although there is a wide variation across states (RBI, 2023a). Digitalisation of agricultural finance through digital KCC products under the

[16] Headcount ratios (the proportion of population which is multidimensionally poor) based on NITI *Aayog's* National MPI. The National MPI retains all ten indicators from the global MPI and incorporates two additional indicators - maternal health and bank accounts, aligning with India's national priorities (NITI *Aayog*, 2024).

[17] This includes KCCs issued by scheduled commercial banks, regional rural banks, and cooperative banks.

Chart I.21: Integration of *Mandis* with the e-NAM Platform

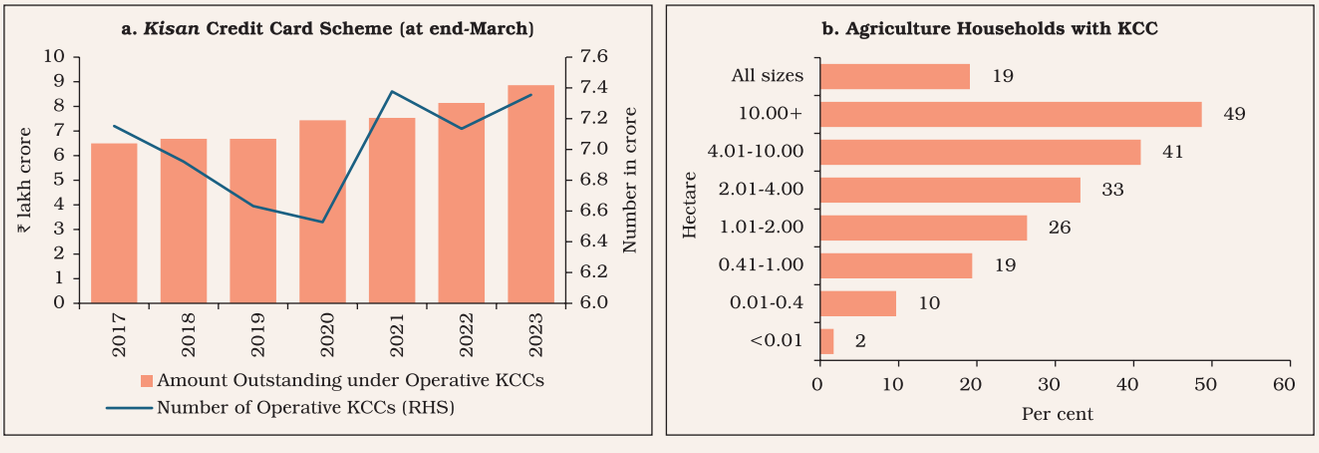


Note: Data up to April 2024.
Source: e-NAM, GoI.

PTPFC will deepen inclusion through hassle-free disbursement of loans.

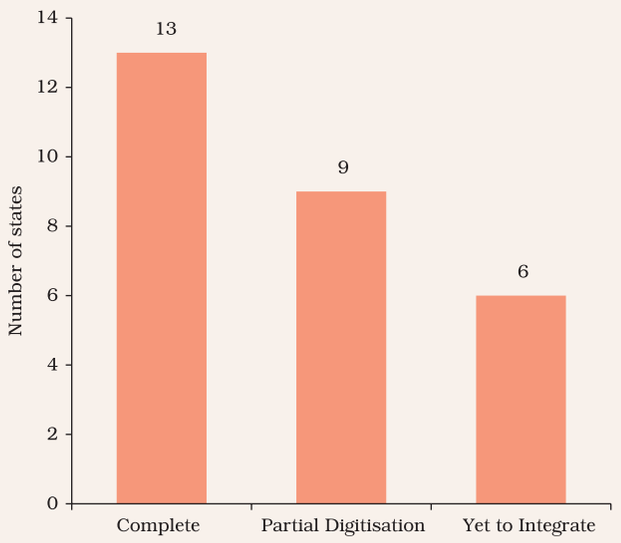
I.34 Central government funding is being provided to state governments through the National e-Governance Plan in Agriculture (NeGP-A) for initiatives involving AI and Machine Learning (ML), robotics, data analytics and blockchain. This is enabling IT-based solutions for crop planning and health, farm credit and insurance, crop estimation and market intelligence. The architecture of three core registries – farmer registry; village map registry; and crop sown registry – has been finalised (PIB, 2023a). The Digital India Land Records Modernisation Programme (DILRMP) is aiding digitisation of land records, minimising discrepancies, enhancing accessibility and facilitating seamless land transactions (Chart I.23). The programme is reducing the time taken to disburse crop loans and will accelerate the formalisation of land leasing within the farm sector, seamless land acquisition and forest clearance for infrastructure planning.

Chart I.22: Distribution of *Kisan* Credit Card among Agricultural Households



Source: Report on Trend and Progress of Banking in India, RBI and NSO 77th round, 2021, GoI.

Chart I.23: Progress in Digitisation of Land Records



Source: PIB, GoI 2023.

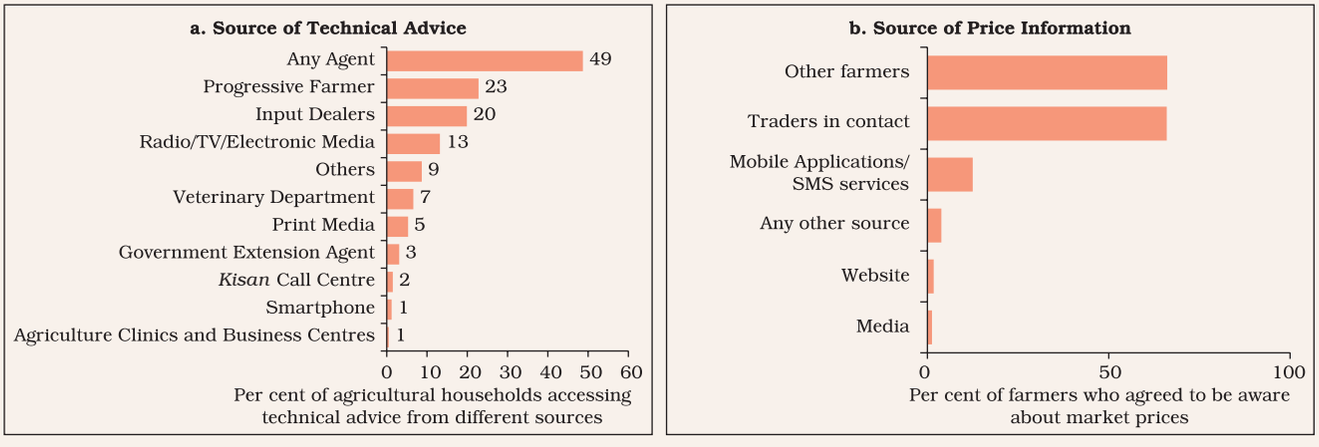
I.35 Digitalisation is also resulting in better price discovery for agricultural households. Around 16 per cent of them accessed technical advice from digital sources, including radio/TV/electronic media (13.2 per cent), *kisan* call centres (1.5 per cent), smartphone-based applications (1.2 per cent) and agricultural clinics and agricultural business (0.5 per cent) in 2018-19 (NSO, 2021) [Chart I.24].

3.4 Enabling Seamless Cross-Border Payments

I.36 Digitalisation is transforming payments for internationally traded goods and services. Technologies like real-time payment systems and blockchain enable instant transfers, reduce delays and improve tracking of funds. Automated processes cut costs, offer better exchange rates and ensure regulatory compliance through data analytics. User-friendly digital platforms also democratise access for small and medium-sized enterprises, making international trade more accessible. Powered by digitalisation, there has been a surge in cross-border payments worldwide in recent decades. India is a pioneer in digitally-enabled remittances and international trade in digitally deliverable services (Chart I.25). It usually takes one to three business days to disburse funds, costing five per cent for sending US$ 200 on average.[18]

I.37 The future of cross-border payments will be characterised by the setting up of dedicated payment rails for instantaneous transfers and greater harmonisation of payment regulations across borders (Patra, 2023). The Association

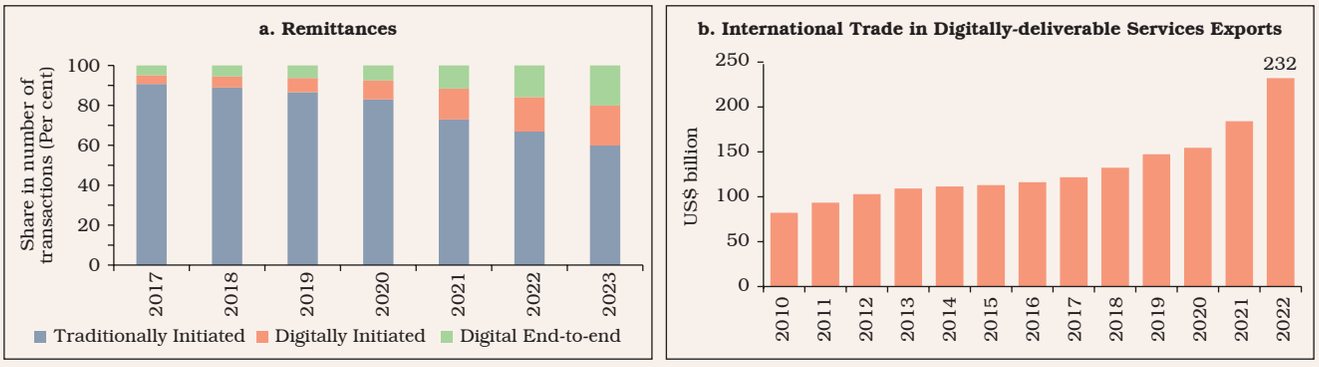
Chart I.24: Usage of Electronic Media by Farmers



Source: NSO, 2021 and Suganthi *et al.*, 2024.

[18] Average cost of remittance to India in the first quarter of 2024 as per the Remittance Price Worldwide Quarterly Report of World Bank (Issue 49, March 2024).

Chart I.25: Digitally-Enabled Cross-border Flows in India



Note: In Chart a, "Traditionally Initiated" refers to payments started with cash or a bank account, with any pickup method. "Digitally Initiated" means payments started with a credit/debit/prepaid card or other digital methods (not a bank account), with cash as the pickup method. "Digital End-to-end" involves payments started with a credit/debit/prepaid card or other digital methods (not a bank account), with the pickup involving a bank account or other cashless payment instruments.
Source: Remittance Prices Worldwide Database, UNCTAD and RBI staff estimates.

of Southeast Asian Nations' (ASEAN) Regional Payment Connectivity (RPC) initiative, akin to India's UPI, is already adopted by countries like Singapore, Malaysia and Thailand and plays a substantial role in facilitating cross-border flows for trade, investment and remittances. Currently, seven countries[19] accept UPI payments (NPCI, 2024). The Reserve Bank's Payments Vision 2025 envisions that integrating with fast payment systems of foreign jurisdictions and increasing participation in global standard-setting bodies will facilitate trade and commerce, reducing remittance costs and time. Increased digital payment adoption will lower cash usage expenses, boost the share of digital payments in GDP and improve transaction transparency. The Reserve Bank plans to migrate all RBI-operated payment messaging systems to ISO 20022 standard to ensure interoperability with systems of other jurisdictions.

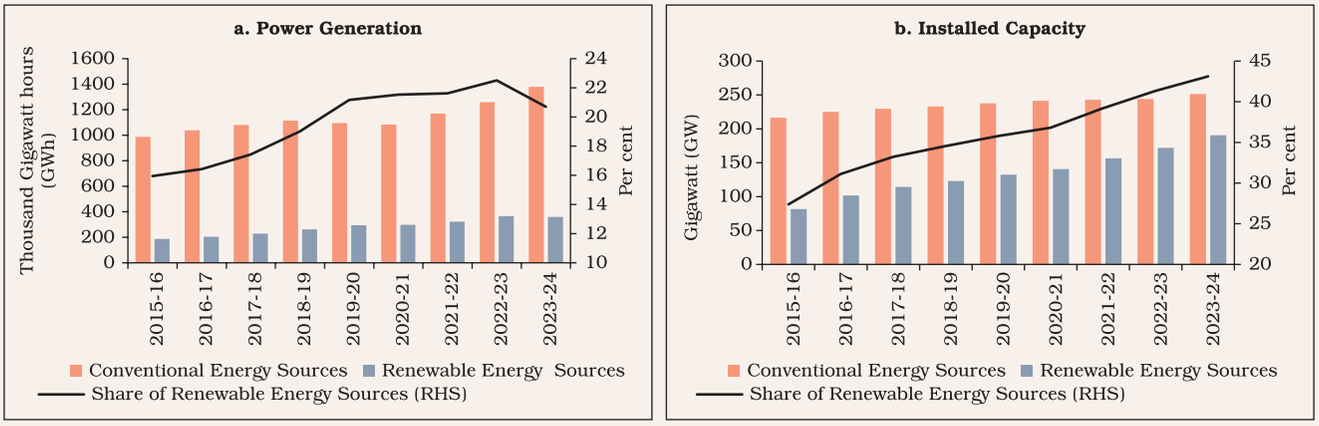
3.5 Greening of Infrastructure

I.38 Digital technologies in finance can facilitate environmental sustainability and a circular economy by creating data-driven digital economy that support a transition towards a net-zero emission economy, protect natural resources and minimise waste (UNEP, 2022). India has committed to (i) achieve 50 per cent cumulative electric power installed capacity from non-fossil energy resources by 2030; (ii) reduce emission intensity of GDP by 45 per cent by 2030 from 2005 level; (iii) create an additional carbon sink of 2.5 to 3 billion tonnes through additional forest and tree cover (UNFCCC, 2022); (iv) achieve 'Net Zero' emissions by 2070; and, (v) reduce projected carbon emissions by one billion tonnes by 2030 (PIB, 2021). The share of renewable energy in India's power generation mix has improved from 15.9 per cent in 2015-16 to 20.7 per cent in 2023-24 (Chart I.26a). India aims to achieve 500 Gigawatt (GW) of renewable energy capacity by 2030 (PIB, 2023b), up from 190 GW as on March 31, 2024 (Chart I.26b).

I.39 The escalating demand for digital services increases data storage needs, raises energy consumption and widespread electronic product adoption generates significant e-waste.

[19] Singapore, Nepal, UAE, Bhutan, France (e-commerce), Mauritius, and Sri Lanka.

Chart I.26: Composition of Power Sector in India

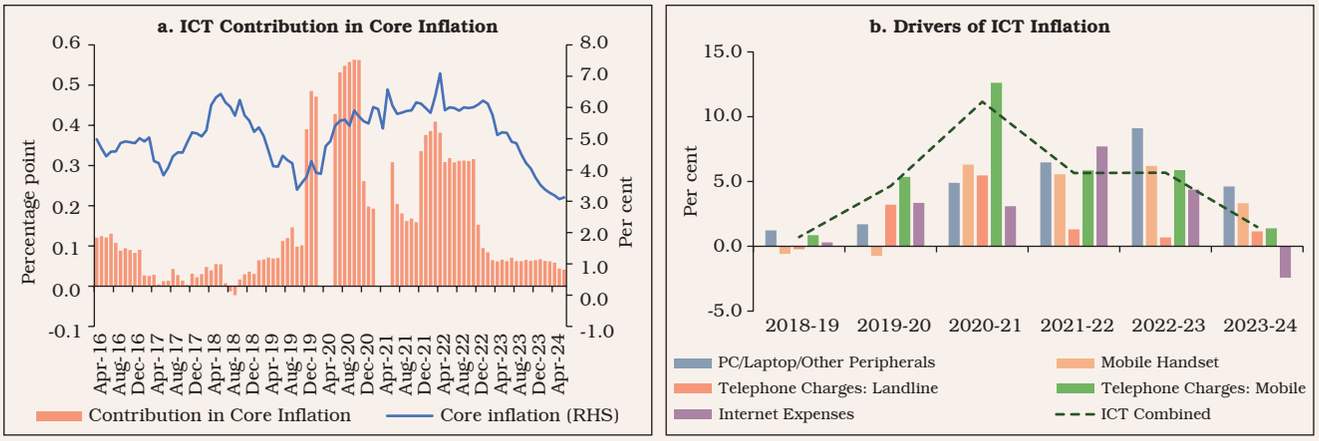


Note: Renewable sources include large hydropower.
Source: Central Electricity Authority, Ministry of Power.

As per the United Nations' Global e-Waste Monitor 2024, India ranks as the world's third largest generator of e-waste in 2022, following China and the US (UNITAR, 2024). Thus, the responsible development and use of technology, coupled with adoption of renewable energy and formal e-waste management, are vital in leveraging digital technologies to combat climate challenges.

I.40 The growing imprint of digitalisation in all these areas is transforming production and consumption patterns of economic agents. Digitalisation influences price levels through direct and indirect channels (Csonto *et al.,* 2019). Under the direct channel, digitalisation can feed into lower inflation rates through a decline in the prices of ICT-related goods, as observed in the post-pandemic period across both hardware and software charges in India[20] (Chart I.27).

Chart I.27: Role of ICT in Inflation in India



Source: NSO, MoSPI and RBI staff estimates.

[20] ICT price index is derived as a weighted average of PC/Laptop/other peripherals, including software, mobile handset, landline charges, mobile charges and internet expenses.

I.41 Digital technologies can also influence inflation indirectly through changes in firms' price-setting behaviour and market dynamics, with new players enhancing competition enabled by e-commerce. Dynamic pricing of goods and services becomes possible with digital technologies, making prices more responsive to economic changes by reducing menu costs, improving access to information and enhancing price update flexibility (Glocker and Piribauer, 2021). Illustratively, price changes for vegetables and food items occur once in two and three days, respectively, on online platforms in India, which is much frequent than corresponding offline price changes (two to three weeks) [Nadhanael, 2022]. As internet penetration expands, there will be a corresponding increase in digitally-influenced retail purchases and number of digitally-influenced consumers and online shoppers (Chart I.28).

I.42 This rise in digital engagement, coupled with increasing price and information transparency, can also put downward pressure on prices by lowering search, replication, transportation, tracking and verification costs (Goldfarb and Tucker, 2019). These developments can potentially make the Phillips curve steeper, enhancing the efficacy of monetary policy in securing price stability (Ari *et al.,* 2023; Friedrich and Selcuk, 2022). Furthermore, digitalisation can improve access to financial services and enhanced financial inclusion is found to improve the transmission of interest rate-based monetary policy impulses (Patra, 2021).

Chart I.28: India's e-Commerce Market – Projected Growth

Note: Figures from 2025 onwards are projections.
Source: IBEF, 2024; BCG, 2022 and RBI staff estimates.

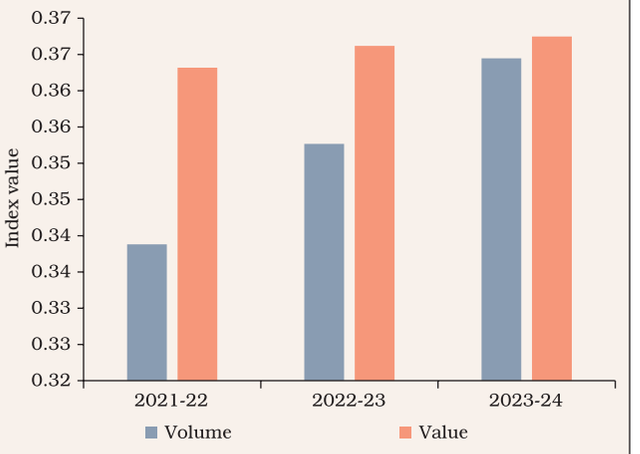
4. Future Shocks: Digitalisation's Challenges

I.43 While digitalisation opens several opportunities across sectors, it also brings in new challenges while accentuating existing ones. In financial markets, this is stark. Digitalisation is leading to the introduction of a variety of complex financial products and services, with implications for market structure and financial stability. The emergence of digital players with unreliable funding models accentuates vulnerability in the system and poses challenges for financial stability.

I.44 The hyper-diversification of financial services may lead to a "barbell"–like financial structure, with a small set of dominant multi-product players leveraging network effects and economies of scale, alongside a large set of niche service providers benefitting from efficiency gains and lower barriers to entry (Feyen *et al.,* 2021).

I.45 In India's digital payment ecosystem, various UPI applications have emerged[21], expanding customer choices and propelling turnover. The major share of transactions is, however, cornered by a few applications, as evident from the Herfindahl-Hirschman Index (HHI) being in the range of 0.35-0.37 for both volume and value of transactions on the platform (Chart I.29). In this context, the NPCI has capped the market share of a single third-party application provider in volume terms to 30 per cent by December 2024 in order to address concentration risks (NPCI, 2022).

Chart I.29: Herfindahl-Hirschman Index (HHI) of UPI Applications



Note: HHI $= s_2^1 + s_2^2 + s_3^2 + \cdots s_n^2$, where s_n is the market share of firm n expressed as a decimal. HHI can range from zero (perfectly competitive) to one (perfect monopoly), with value above 0.25 indicating high concentration.
Source: NPCI and RBI staff estimates.

4.1 Cyber Security

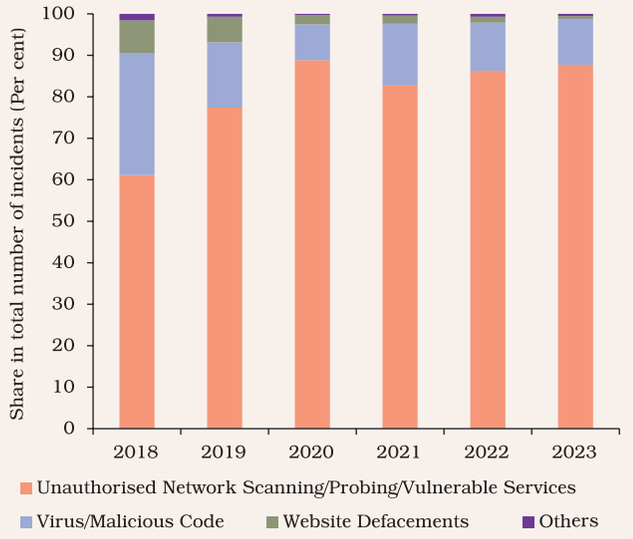
I.46 Cyber security is an important challenge owing to the diverse nature of cyber threats targeting the digital financial infrastructure.[22] In India, security incidents handled by the Indian Computer Emergency Response Team (CERT-In) have increased from 53,117 in 2017 to 13,20,106 during the period January-October 2023 (CERT-In, 2017; RBI, 2023a). Unauthorised network scanning/probing/vulnerable services account for more than 80 per cent of all security incidents in India (Chart I.30).

I.47 Industry-wise distribution of cyber attacks in India shows that the automotive industry is the most vulnerable, with smart mobility application programming interfaces (APIs) and electric vehicle (EV) charging infrastructure emerging as major attack vectors. The BFSI sector, governed by well-defined regulations, is relatively protected from such attacks (Chart I.31).

[21] Currently, over 70 applications are operational.

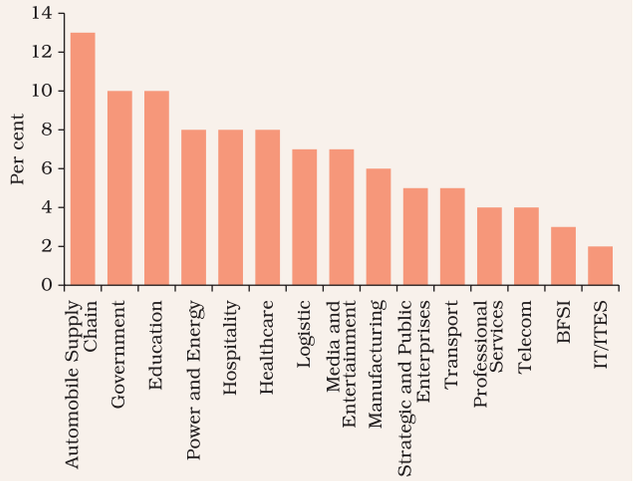
[22] The Colonial Pipeline ransomware attack in 2021, while not directly impacting financial institutions, demonstrated the interdependence of critical infrastructure systems and the potential for widespread effects across sectors, including banking, by triggering a run-on gas station, showcasing the ripple effects of a cyberattack.

Chart I.30: Security Incidents in India



Source: CERT-In.

Chart I.31: Industry-wise Distribution of Cyber Attacks in India - 2023



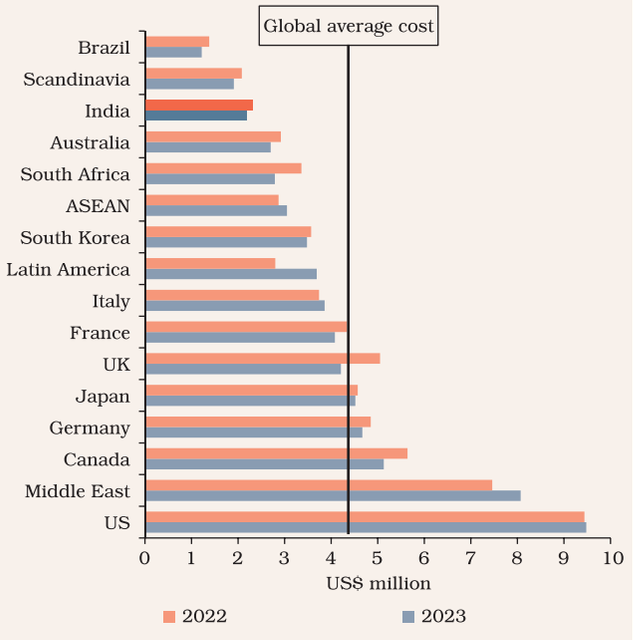
Note: IT/ITES: Information Technology/Information Technology-enabled Services; BFSI: Banking, Financial Services and Insurance.
Source: India Cyber Threat Report 2023, Data Security Council of India and SEQRITE, 2023.

I.48 Globally, cybercrime costs are expected to reach US$ 13.82 trillion by 2028, up from US$ 8.15 trillion in 2023 (Statista, 2023). The average cost of a data breach has also risen to US$ 4.45 million in 2023, a 15 per cent increase over three years (IBM, 2023). Recognising the significant costs involved, most central banks have increased their cyber security investment budgets by five per cent since 2020 (Doerr *et al.,* 2022). In India, the average cost of data breaches stands at US$ 2.18 million in 2023, a 28 per cent increase since 2020 *albeit* less than the global average cost of data breach (Chart I.32). The most common attacks in India are phishing (22 per cent), followed by stolen or compromised credentials (16 per cent) [IBM, 2023].

4.2 Consumer Protection

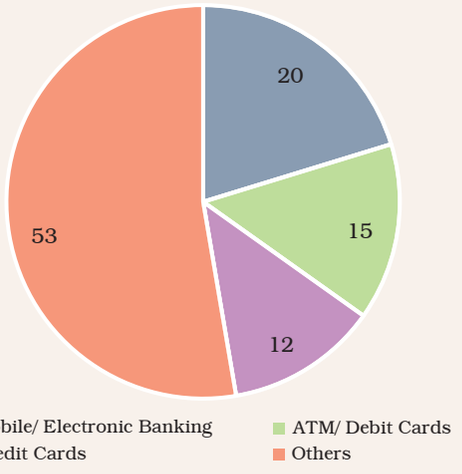
I.49 Customers are the epicentre of the digital economy. The success of any enterprise is intricately tied to the satisfaction and trust of its customers, and thus, adopting a customer-centric approach to innovation is vital for sustainable growth (Das, 2023a). While digitalisation offers enhanced convenience and accessibility, the growing complexity of financial products also introduces new challenges in ensuring customer protection. With the increasing adoption of digital payments, the share of complaints

Chart I.32: Global Average Data Breach Costs



Source: Cost of Data Breach 2023, IBM.

Chart I.33: Complaints under RB-IOS, 2022-23



Note: Others include complaints regarding loans and advances, deposit accounts related, pension payments, remittances, para banking, notes and coins, and others.
Source: Reserve Bank – Integrated Ombudsman Scheme (RB-IOS) Annual Report, 2022-23.

related to mobile/electronic banking, ATM/debit cards and credit cards received in the offices of the RBI ombudsman accounted for 47 per cent of total complaints in 2022-23 (RBI, 2024b) [Chart I.33].

I.50 Digital financial innovations present a trade-off between competition (thereby, enhancing customer convenience) and customer protection. Illustratively, while the digital lending platforms and buy-now-pay-later (BNPL) services bolster consumer convenience, they also entail various costs, including exorbitant charges, coercive recovery practices and hidden fees. In India, BNPL constitutes around three per cent of total e-commerce finance by value (Statista, 2024b). While BNPL is projected to grow every year by 74 per cent, making it a US$ 56 billion market by 2026, the model has a high dependence on late fees to ensure profitability which could become predatory for customers (HDFC securities, 2022). These risks are exacerbated by the seamless nature of digital technologies, facilitating impulsive spending and debt accumulation (Pradhan *et al.,* 2018).

I.51 Digitalisation is also giving rise to certain 'invisible risks' or 'dark patterns', whereby consumers are tricked into making decisions detrimental to their interests (Rao, 2023a) [Chart I.34].

I.52 The use of extensive customer data by companies raises concerns about data protection and privacy, potentially compromising customer trust and security (IMF, 2021). In India, three-fourths of the business-to-consumer (B2C) funded FinTech applications[23] request permission to access camera, photo/media/files, location and storage for using applications (Chart I.35).

I.53 India is one of the top ten countries in terms of embedded finance[24] revenue (Chart I.36) and it is expected to expand at a CAGR of 30.4 per cent over 2022-29 to reach US$ 21.1 billion in 2029 (PwC, 2023). While cross-selling[25] and embedded finance models enhance customer convenience, they may raise anti-competition concerns due to bundled services.

[23] Information is collected from 181 FinTech mobile applications on Google Play Store identified from the Tracxn database with practice area tags, *viz.*, payments, alternative lending, banking tech, forex tech, direct remittance tech.

[24] Embedded finance refers to the integration of banking and various financial services into non-financial applications and services.

[25] Cross-selling involves suggesting related or complementary products to existing customers and leveraging established relationships to offer additional items or services aligned with their needs or previous purchases.

Chart I.34: Dark Patterns

False Urgency — Creating a false sense of urgency to mislead users into quick purchases.

SaaS Billing — Exploiting recurring payment models in software services to charge users subtly.

Forced Action — Compelling users to perform unrelated actions to proceed with their intended purchases.

Subscription Trap — Making subscription cancellations difficult or hiding cancellation options.

Interface Interference — Manipulating user interface to highlight certain information and obscure other details.

Trick Question — Using confusing language or double negatives to mislead users.

The Central Consumer Protection Authority's Guidelines for Prevention and Regulation of Dark Patterns, 2023 prohibit any engagement in these specified practices deemed as dark pattern practices.

Basket Sneaking — Adding items to the cart without user consent, increasing the total payable amount.

Confirm Shaming — Using language to shame users into making purchases or continuing subscriptions.

Bait and Switch — Advertising one outcome but delivering an alternate, often less desirable, result.

Drip Pricing — Not revealing the full price upfront, adding extra costs later in the purchasing process.

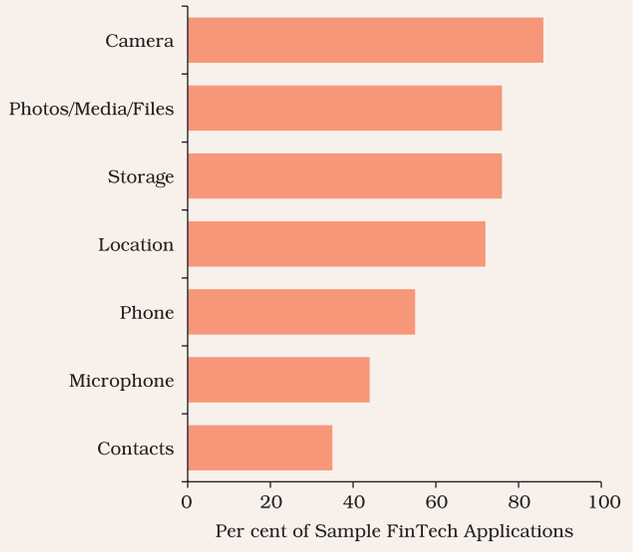
Disguised Advertisement — Posing ads as other types of content to trick users into clicking them.

Nagging — Annoying users with persistent and repeated requests or interruptions.

Rogue Malwares — Using malware or scareware to trick users into paying for fake malware removal tools.

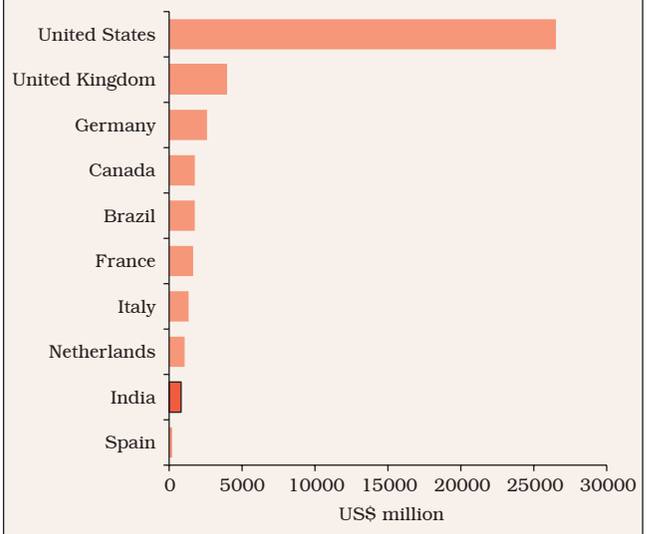
Source: Guidelines for Prevention and Regulation of Dark Patterns, 2023 and RBI staff illustration.

Chart I.35: Privacy Practices in FinTech Applications



Source: Google Play Store and RBI staff estimates.

Chart I.36: Top 10 Countries in Embedded Finance Revenue, 2022



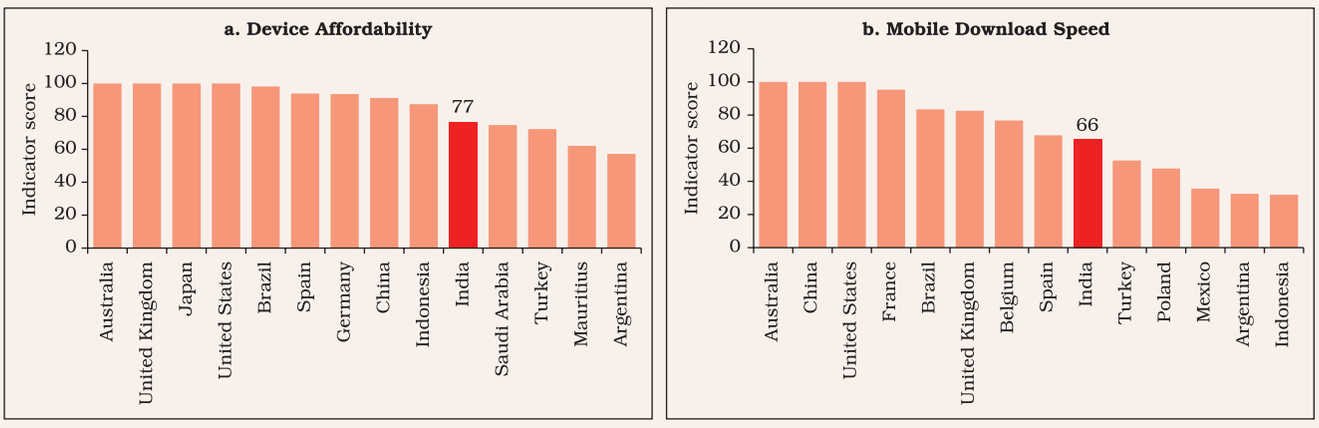
Source: Statista, 2023 and Juniper Research, 2023.

I.54 The declining costs of internet-enabled devices and mobile data have enhanced access; however, affordability remains a barrier to achieving universal internet usage (ICRIER, 2023). India also has immense potential to enhance the quality of digital services (Chart I.37).

4.3 Reshaping of Labour Markets

I.55 Digital technologies are impacting workforce composition, job quality, skill requirements, and labour and regulatory policies. Implementation of AI in financial services is shifting roles to higher-skilled tasks, automating routine functions and aiding decision-making. Digitalisation is decentralising financial labour through outsourcing and telework (ILO, 2022). Automation replacing labour can potentially widen the gap between capital and labour returns, creating a fragmented labour market with low-skill/

Chart I.37: Affordability and Speed of Internet Services



Note: The indicators on "device affordability" and "average dowload speed for mobile users" are part of the Mobile Connectivity Index (MCI) by the Global System for Mobile Communications Association (GSMA) and have been normalised within a range of 0 to 100. In chart a, lower value of the index indicates lower affordability.
Source: GSMA, 2023.

Table I.1 Composition of Employees in Scheduled Commercial Banks (SCBs)

(Per cent)

Year	Officers	Support Staff
2010-11	50	50
2014-15	57	43
2018-19	66	34
2022-23	74	26

Source: RBI.

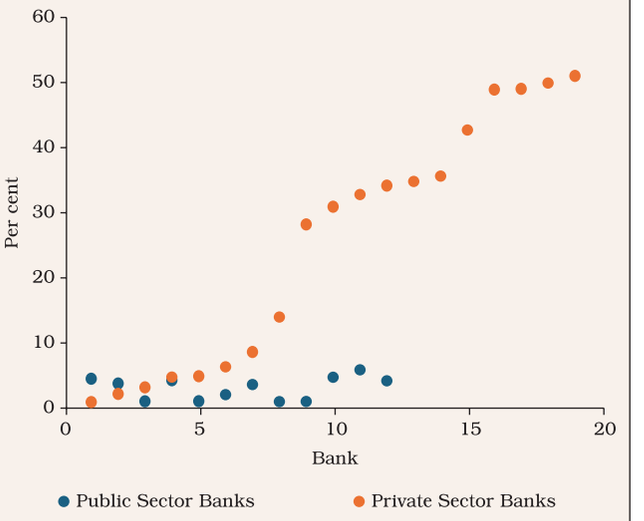
low-pay and high-skill/high-pay jobs, while middle-tier jobs are displaced by technology (Schwab, 2016).

I.56 Between 2013 and 2019, employees in support roles in the financial sector decreased in many countries, while the number of professionals and technicians rose (ILO, 2022). This is evident in the Indian banking sector as well (Table I.1).

I.57 In digital recruitment platforms, a major issue is the high average turnover rate of financial institutions, with some private sector banks in India reporting turnover rates of above 30 per cent in 2022-23 (Chart I.38). This raises significant risks for the financial sector, including loss of institutional knowledge, disruption in services and higher recruitment costs (Jain, 2023).

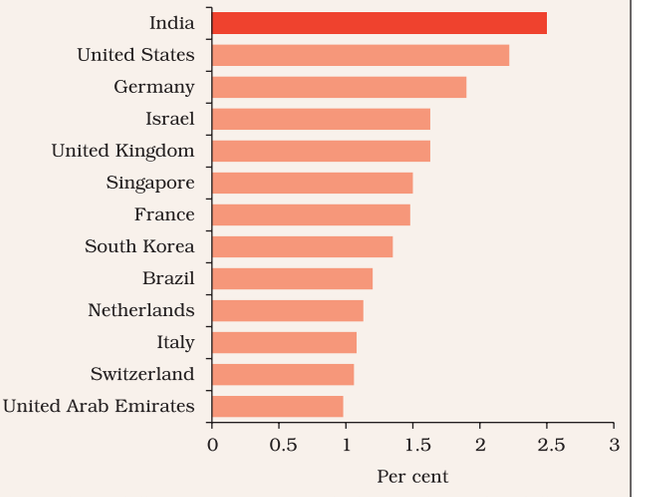
I.58 Upskilling and reskilling the labour force pose significant challenges, given the growing shift towards digital-intensive roles. The rising importance of AI-related skills in the labour market in India is reflected in the growth in AI talent recruitment relative to overall recruitment[26] in 2023 (16.8 per cent y-o-y) and the highest relative AI skill penetration rate (Chart I.39) [Stanford University, 2024]. Pre-existing traditional methods of learning and development, however, are inadequate for this transformation, necessitating significant investments to build the required skills at scale, leverage AI in learning and keep pace with the swiftly evolving demands of digital skills.

Chart I.38: Average Employee Turnover Rates in SCBs - 2022-23



Note: Data pertain to 31 SCBs.
Source: Business Responsibility and Sustainability Reports of Banks.

Chart I.39: Relative AI Skill Penetration Rate



Note: The AI skill penetration rate signals the prevalence of AI skills across occupations, or the intensity with which LinkedIn members utilise AI skills in their jobs.
Source: Stanford University, 2024.

[26] The overall hiring rate is computed as the percentage of LinkedIn members who added a new employer in the same period the job began, divided by the total number of LinkedIn members in the corresponding location. For each month, LinkedIn calculates the AI hiring rate in the geographic area, divides the AI hiring rate by overall hiring rate in that geographic area, calculates the year-over-year change of this ratio, and then takes the 12-month moving average using the last 12 months.

4.4 Emerging Regulatory Challenges

I.59 Digitalisation generates regulatory challenges, necessitating that regulators stay ahead of the financial innovation curve while balancing the complex trade-offs related to financial stability, competition and customer protection. This will require enhancing the capacity of regulated entities and oversight authorities, updating legal and regulatory frameworks, engaging stakeholders to identify risks and expanding consumer education (Patra, 2024b).

I.60 Regulations need to set boundaries to contain the irrational exuberance of participants and ensure a sound and robust set of institutions, thereby promoting financial stability (Rao, 2023b). In the context of peer-to-peer lending applications in India, regulations have been found to have a positive impact in building trust, thereby enabling adoption of financial innovations (Box I.3).

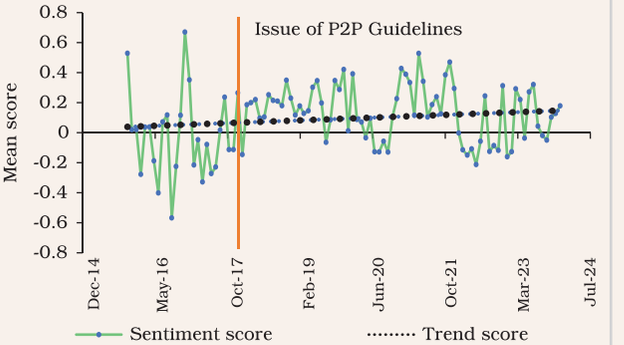
I.61 Challenges facing regulatory and supervisory mandates stem from loosening entry barriers, potentially risking FinTech lending being promoted on weak business models with inadequate cyber infrastructure. Furthermore, unregulated non-bank payment services could disadvantage traditional banks, leading to regulatory arbitrage and deposit disintermediation (Sankar, 2023). Globally, countries have accordingly enacted regulations to strengthen enforcement in FinTech-related activities (Chart I.40).

I.62 BigTechs, that can quickly become 'too big to fail' and dominate markets, may pose significant challenges in assessing risk profiles due to their unique characteristics, extensive group entities, interconnected activities and transnational presence. Partnerships with incumbent firms can encourage excessive risk-taking, especially when

Box I.3
Regulation-Innovation Nexus: Peer-to-peer Lending in India

In order to ensure that the peer-to-peer ecosystem develops in a responsible manner in India, the Reserve Bank issued P2P lending guidelines in October 2017 (RBI, 2017). The P2P platform has gained momentum in recent years. The user experience, measured by sentiment scores computed through text mining of online reviews of 11 P2P lending applications, has shown an improvement over time (Chart 1). The Bai-Perron structural break test indicates a significant break in the month of October 2017, coinciding with the issuance of the P2P lending guidelines. Average sentiment scores rose from (-) 0.04 before October 2017 to (+) 0.13 since then, notwithstanding moderation during the COVID-19 pandemic. Topic modelling using the Latent Dirichlet Allocation (LDA) model suggests that the decline in sentiments during the pandemic could be attributed to loan rejections, registration issues and customer service concerns.

Chart 1: Sentiment Scores over Time



Source: Scraped reviews of 11 P2P Applications from Google Play Store.

Empirical analysis using autoregressive distributed lag (ARDL) models covering the sample period from November 2015 to January 2024 provides interesting perspectives. The baseline scenario (Model 1) illustrates that the sentiment of reviews is positively influenced by the overall digitalisation of the economy proxied by the log of

(Contd...)

Table 1: User Experience of P2P Lending Platforms

Dependent Variable: Sentiment Scores of P2P Reviews

	Model 1	Model 2	Model 3
Model Type	ARDL (1, 0, 0)	ARDL (2, 4, 0, 1)	ARDL (2, 0, 0, 4, 4)
Explanatory Variables [27]			
I. Long Run			
Wireless Internet Subscribers	2.53*** (0.97)	1.84** (0.82)	1.66* (0.84)
Mobile Payments	0.01 (0.00)	0.01** (0.00)	0.01** (0.00)
Regulation		0.30*** (0.09)	0.27*** (0.09)
Sentiment Polarity			0.55 (0.16)
II. Short Run			
COVID-19 Dummy	-0.07 (0.05)	-0.12** (0.05)	-0.12** (0.05)
Error Correction	-0.68*** (0.09)	-0.87*** (0.12)	-0.84*** (0.11)

Note: (1) The standard errors are in parentheses. ***, ** and * refer to significance levels at 1 per cent, 5 per cent and 10 per cent, respectively.
(2) Bounds Test: F statistic: Model 1 (17.9), Model 2 (11.69) and Model 3 (9.74).
(3) Critical values for F statistic at 5 per cent level are around 4.0 and 6.0 for I(0) and I(1) assumptions, respectively.
(4) Model Tests for heteroscedasticity and autocorrelation are insignificant.
Source: RBI staff estimates.

wireless internet subscriber base and the rate of FinTech adoption proxied by the share of mobile payments to total digital payments volume (Table 1). The second model (Model 2) shows a positive and statistically significant impact of regulation, represented by a dummy for the post October 2017 period, on user experience. This suggests that regulation can safeguard customer interests by creating a more trustworthy, transparent, credible, adaptive and fair environment for both borrowers and lenders. The third model (Model 3) reports similar results, with the inclusion of sentiment polarity[28] in online reviews (Schoenmueller *et al.,* 2020). COVID-19 negatively impacts user experience. While extreme reviews are controlled for through sentiment polarity, promotional reviews, if any, may affect the results.

References:

Reserve Bank of India. (2017). Master Directions - Non-Banking Financial Company – Peer-to-Peer Lending Platform (Reserve Bank) Directions, 2017.

Schoenmueller, V., Netzer, O., and Stahl, F. (2020). The Polarity of Online Reviews: Prevalence, Drivers and Implications. *Journal of Marketing Research*, *57*(5), 853-877.

BigTechs handle the customer-facing aspect of the value chain without assuming underwritten risks (Crisanto and Ehrentraud, 2021). Collection of extensive data by BigTechs can be utilised to favour their own products, obtaining higher margins by making financial institutions' access to prospective clients *via* their platforms, engaging in product bundling and cross-subsidising activities. This can give rise to adverse economic and welfare outcomes.

I.63 Digitalisation generates vast amount of data that can facilitate the use of advanced models like AI and Generative AI (GenAI) in the financial sector. The cumulative private investment in AI in

[27] As per the Augmented Dickey-Fuller (ADF) Test, all variables are stationary at levels I(0) or first difference I(1) levels.

[28] Sentiment polarity is computed as a ratio of the sum of the number of reviews with rating 5 and 1 over the total number of reviews (Schoenmueller *et al.,* 2020).

Chart I.40: Adoption of Fintech-specific Regulations Worldwide

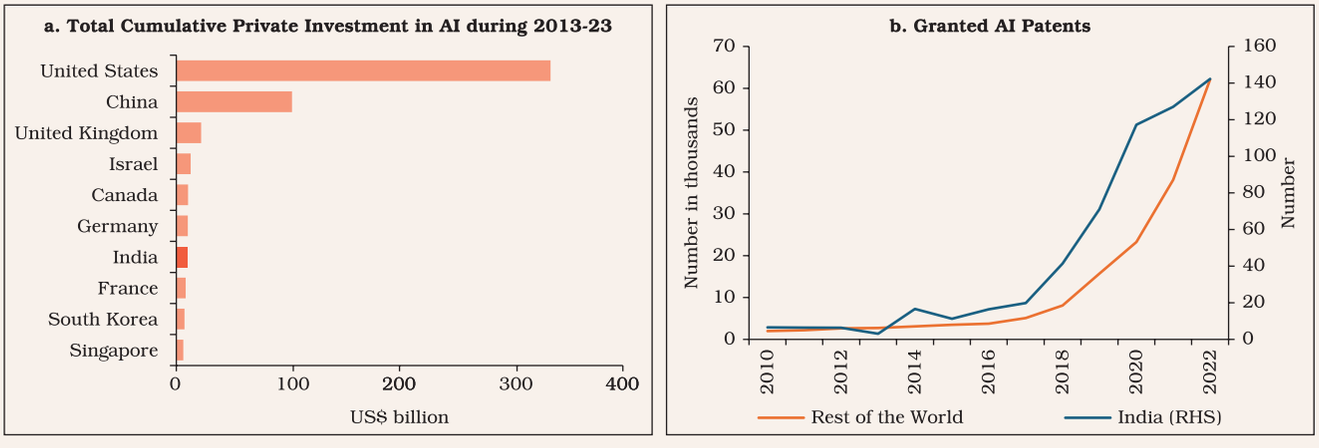
Note: e-Money refers to ability of banks and non-bank financial institutions to issue prepaid payment instruments; Innovation facilitators include innovation hub, regulatory sandboxes and regulatory accelerators; marketplace lending refers to peer-to-peer lending and equity crowdfunding.
Source: World Bank.

India, however, is low relative to the rest of the world (Chart I.41a). The share of India in granted AI patents in the world is also low (Stanford University, 2024) [Chart I.41b].

I.64 On the regulatory front, the challenge is to balance financial security through data analytics with the need to protect individual privacy and customer rights.[29] The increased use of AI algorithms - particularly deep learning models - by financial institutions presents additional challenges, such as lack of explainability, potential discriminatory biases, false signals and substantial investment requirements to integrate with legacy systems. Central bankers must also closely monitor quantum computing developments due to growing concerns about the vulnerability of current cryptographic methods in securing financial transactions (Patra, 2024b).

I.65 It is crucial to ensure that model-based lending in banking and non-banking financial companies (NBFCs) employs robust, regularly tested algorithms to mitigate undue risk accumulation and uphold underwriting standards amidst evolving financial landscapes (Das, 2023b). Designing responsible and ethical AI solutions for financial services would necessitate consideration of ten principles - fairness; transparency; accuracy; consistency; data privacy; explainability; accountability; robustness;

Chart I.41: Artificial Intelligence - Global Landscape



Source: Stanford University, 2024.

[29] Transaction data for monitoring suspicious activities can risk customer privacy and exposure to cyber-attacks. To address this trade-off, open banking regulations are being developed to securely share data with consumer consent.

monitoring and updating; and human oversight (Rao, 2023c).

I.66 The online nature and cross-border reach of digital payments and trade across multiple jurisdictions with diverse regulatory frameworks necessitate effective regulation through international collaboration, harmonisation and promotion of common protocols, standardised APIs and secure communication channels. Globally, efforts are underway to harmonise cybersecurity regulations and anti-money laundering/countering the financing of terrorism (AML/CFT) frameworks. The Group of Seven (G7), the Basel Committee on Banking Supervision (BCBS), the Financial Stability Board (FSB) and the Committee on Payments and Market Infrastructure and International Organisation of Securities Commissions (CPMI-IOSCO) have issued high-level principles on cybersecurity to foster convergence in cyber resilience strategies.

5. Digitalisation and the Reserve Bank of India

I.67 The Reserve Bank, as a full-service central bank and enabler of the market economy, has taken several policy initiatives to address various aspects of financial sector digitalisation, built on the principles of trust, stability and innovation (Das, 2024a). Trust is fostered through market reforms ensuring fair conduct, price transparency and enhanced disclosures. Stability is upheld by orderly market functioning and infrastructure. Innovation is promoted through principle-based regulation, new products/platforms and market access. The regulatory perimeter has also expanded as the Indian financial system has ventured into newer business models, product lines and geographical territories, ushering in a consultative, collaborative and forward-looking approach to regulation with customers at the centre of innovations (Rao, 2023b).

5.1 Financial and Digital Inclusion

I.68 India has established digital banking units (DBUs), improved UPI with offline payments and conversational payments in local languages, extended payment system access to non-bank entities and extended operational hours of various digital modes to foster financial inclusion. Digitalisation of agricultural finance under the PTPFC, as noted earlier, will deepen inclusion. The PIDF has been launched to broad-base payment infrastructure.

5.2 Customer Protection

I.69 In response to regulatory and customer protection challenges in the digital lending ecosystem, the Reserve Bank issued the Guidelines on Digital Lending, based on recommendations of the Working Group on Digital Lending (Chairperson: Shri Jayant Dash). These guidelines include provisions for loan servicing, comprehensive disclosures such as the key fact statement (KFS), grievance redressal mechanisms, credit assessment standards and borrower data privacy (RBI, 2023b). The implementation of the Reserve Bank-Integrated Ombudsman Scheme (RB-IOS) has resulted in structural improvements in grievance redress mechanism (Das, 2024b).[30] Additionally, the Bank has initiated public awareness campaigns like the 'RBI *Kehta Hai'* and electronic Banking Awareness and Training (e-BAAT) programme across the country to educate the public about digital payment products, fraud prevention and risk mitigation (Das, 2024c).

[30] With a complaint disposal rate of about 98 per cent and an average turnaround time of 33 days.

5.3 Data Protection

I.70 To tackle issues relating to misuse of data, the Reserve Bank has implemented data localisation for payments data and issued guidelines preventing digital lending applications from accessing private information without the explicit consent of users. In order to make digital payments more secure, safe and sound, the Reserve Bank has enabled card-on-file tokenisation (CoFT) through card-issuing banks and institutions. This will avoid any breach or leak of data since instead of card details, a specially created token is saved with the merchant.

5.4 Cyber Security

I.71 The measures implemented in India to promote security of digital transactions include two-factor authentication for digital payments, increased customer control over card usage, faster turnaround time for transaction failures, augmented supervisory oversight with simulated phishing exercises. The Reserve Bank also issued comprehensive guidelines and frameworks for IT and Cyber Risk management, encompassing regulations on Digital Payment Security Controls and IT Services Outsourcing.[31]

5.5 FinTech Regulation

I.72 To encourage FinTech innovations, the Reserve Bank has launched the Regulatory Sandbox scheme, the Reserve Bank Innovation Hub and FinTech Hackathons. To foster FinTech regulation through a consultative approach, the Reserve Bank has brought forth a framework for Self-Regulatory Organisations (SROs) in the FinTech sector, laying down the characteristics of FinTech SROs (SRO-FT) and their functions, governance standards, eligibility criteria and the like (RBI, 2024c). The SRO-FT would guide the conduct of its members, ensure adherence to industry standards, compliance with relevant laws and regulations and maintenance of high ethical standards, encourage responsible experimentation, address grievances, conflicts of interest, or disputes and foster a fair, equitable and competitive FinTech environment in India.

5.6 Digital Technologies in Regulation and Supervision

I.73 Digital tools like regulatory technology (RegTech) and supervisory technology (SupTech) are leveraged to broaden the supervisory and monitoring frameworks and reassess the regulatory perimeter. The Reserve Bank has set up an Advanced Supervisory Analytics Group (ASAG) to leverage ML models for social media analytics, KYC compliances and for gauging governance effectiveness. The establishment of an advanced off-site supervisory monitoring system - *DAKSH* - is helping to digitalise supervisory processes. An Integrated Compliance Management and Tracking System (ICMTS) and a Centralised Information Management System (CIMS) are other two major SupTech initiatives being implemented for seamless reporting by supervised entities for enhancing data management and data analytics capabilities, respectively (Patra, 2024b).

6. Concluding Observations

I.74 Digital technology infrastructure will be India's growth engine of tomorrow. The focus is on next-generation communication technologies like 6G and satellite networks, alongside expanding the 5G network to rural and hitherto uncovered urban

[31] The Master Direction on Information Technology Governance, Risk, Controls and Assurance Practices (effective from April 1, 2024) requires REs to put in place a robust IT governance framework and adequate oversight mechanisms to ensure accountability and mitigation of business risks.

areas. Graduating to advanced technologies will unleash opportunities in the last mile. Attaining self-sufficiency in chip manufacturing is another key step in ensuring the realisation of the full potential of the digital revolution. As the semiconductor and chip manufacturing ecosystem matures in India, it will create strong backward and forward linkages in the digital world through a rise in cloud services and data storage including data centres. Converting to renewable energy sources will be critical while embracing these changes, as they involve energy consumption owing to voluminous data generation and data storage requirements. Demographic shifts impacting the demand and operations of financial services will also need to be taken care of while making policies.

I.75 Against the backdrop of the contours of the digitalisation landscape and the opportunities and challenges it presents as it expands, the rest of the report is organised into four chapters. Chapter 2 presents the current uptake of financial innovations by financial institutions (FIs) and customers and discusses economic factors that facilitate the adoption of financial innovations in India. The chapter also highlights major aspects of FIs' collaborations with FinTechs and BigTechs for embracing financial innovations. Digital lending is picking up momentum in India, especially in the retail segment. The digital lending landscape is also getting boosted by several policy innovations. The adoption of digital technologies has improved the efficiency of banks in India, along with increasing competition in the banking sector. Overall digitalisation in the financial sector enables banks to reduce various risks and improves integration across various financial markets, thus, boosting liquidity in these markets. The regulatory concerns raised by financial innovations, especially by the new collaborations in the financial sector are also discussed in the chapter along with major policy initiatives.

I.76 Chapter 3 explores the implications of digitalisation on payment systems architecture, weighing benefits against emerging risks. Against the backdrop of the evolution of payment systems in India, the chapter undertakes a comparison of different modes of digitalisation of payments across countries and lays out the advantages of open-loop payment systems like the UPI where banks and other third-party application providers use the existing platform to process and settle payments. Empirical analysis in a cross-country setting shows that demography, which favours the younger population; penetration of internet; and size of the formal economy are factors that condition the adoption of digital payments. An All-India survey indicates that 42 per cent of the respondents had used at least one form of digital payments in their lifetime (as of end-2022) and the numbers are set to rise as more than three-fourths are aware of the facilities. The usage was found to be higher among metro and urban areas and among younger respondents.

I.77 Chapter 4 provides an assessment of the opportunities for India in an open-economy setting. Digitalisation matters for trade, especially for India's services trade, given India's relative comparative advantage. Digitalisation in international payment systems has the potential to reduce the cost of sending remittances and to achieve the Sustainable Development Goal (SDG) target by 2030. Cross-border digital trade policies and digitalisation, along with measures aimed at internationalising the Indian Rupee (INR) and the CBDC project, would play a crucial role in harnessing new opportunities, supporting seamless international transactions, reducing foreign exchange risks and managing global liquidity. The availability of e-payment services, policy support for digital businesses, development of local digital skills and data security would help attract digital foreign

direct investment (FDI). Going forward, given the significant surge in digital transactions, improving the measurement of digitalisation and digital trade in key macroeconomic statistics such as the System of National Accounts (SNA) and balance of payments (BoP) gains significance for better policy formulation, monitoring and governance of the digital economy.

I.78 Chapter 5 explores the risks and challenges of digitalisation in India from a futuristic perspective. This chapter presents the major findings of a special survey of banks and NBFCs on the opportunities and challenges of digitalisation in India. Enhancing customer experiences, increasing operational efficiency and competitive considerations are seen as prime drivers of digitalisation whereas cybersecurity, data privacy and vendor and third-party risks are highlighted as key emerging challenges. Implications of digitalisation on consumer behaviour, monetary policy and financial stability are also examined. Results from a calibrated New Keynesian model reveal that monetary policy can be more effective in reducing inflation under digitalisation. This emanates from digitalisation-induced reduction in cost and steepening of the slope of the Phillips curve due to lower elasticity of demand. The chapter also discusses new risks and challenges that digitalisation can bring for customer protection and financial stability and the Reserve Bank's proactive approach to mitigate risks while fostering financial innovations.

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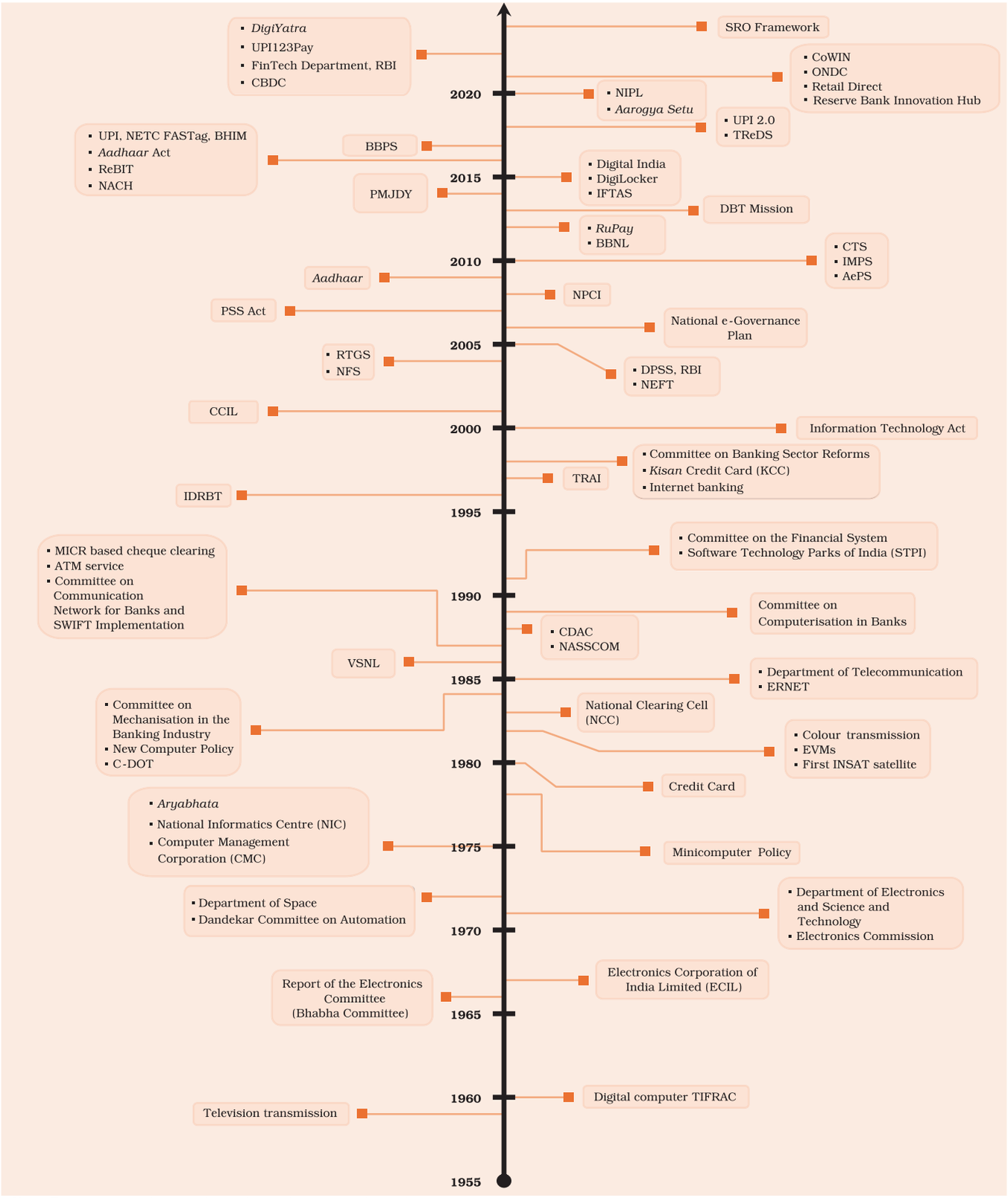
Annex I.1: India's Digital Evolution Timeline



Note: This is not an exhaustive list and includes major policy milestones.
Source: RBI staff illustration.

Annex I.2: The Digital Personal Data Protection Act, 2023

The Government of India has introduced key regulations to ensure safe e-commerce usage, including the Consumer Protection (e-Commerce) Rules, 2020, to prevent unfair trade practices, the Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Rules, 2021, for digital platform accountability and the Digital Personal Data Protection (DPDP) Act, 2023, for comprehensive data protection (MoF, 2024). The DPDP Act of 2023[32] is a landmark legislation designed to fortify the protection of personal data in the rapidly evolving digital landscape. At its core, the Act establishes the Data Protection Board of India, a governing body appointed by the Central Government. This board is composed of individuals with specialised qualifications in data governance, administration, law, and technology, entrusted with the crucial task of overseeing and enforcing the provisions of the Act. Empowered with substantial authority, the Board can direct remedial measures in response to personal data breaches, impose penalties, and conduct inquiries into potential violations.

The Act introduces the concept of "Data Fiduciary" for entities handling sensitive personal data, imposing additional responsibilities like appointing Data Protection Officers and conducting mandatory audits, emphasising secure data handling. It also establishes Consent Managers for individuals to manage their data consent centrally, ensuring accountability. Disputes are resolved through an Appellate Tribunal. Overall, the DPDP Act of 2023 aims to balance technological innovation with privacy protection.

The General Data Protection Regulation (GDPR), enacted by the European Union (EU) in 2018, marked a global shift in data protection laws. India's DPDP Act shares similarities, focusing on consent, data rights, and accountability. It extends jurisdiction broadly and introduces "Data Fiduciary" roles. Unlike GDPR, it offers more flexibility for legitimate data processing and detailed cross-border transfer rules (Table 1). Tailored to India's needs, the DPDP Act presents a forward-thinking framework with potential advantages over GDPR.

Table 1: How DPDP Act 2023 compares with EU's GDPR

Features	*Digital Personal Data Protection Act (India)*	*General Data Protection Regulation (EU)*
Significant Data Fiduciary (SDF)	A data fiduciary or a category of data fiduciaries has been designated by the Indian government.	No equivalent concept present.
Consent Manager	Consent managers, registered with the Data Protection Board serve as representatives of data principals, handling the processes of reviewing, issuing, overseeing, and retracting consent.	No equivalent concept present.
Voluntary Disclosure	As per the act, a data fiduciary can process personal data without the explicit consent of data principals under the condition that the data principal voluntarily provides their personal data to the data fiduciary for a specific purpose and does not raise objections to the processing of said personal data.	The GDPR lacks a dedicated legal foundation for voluntary disclosure.
Right to Grievance Redressal	Data fiduciaries are required to offer data principals accessible and efficient avenues for addressing grievances, promptly responding to any such complaints within the specified timeframe.	Though it does not outline a distinct entitlement to grievance redressal, if a data subject lodges a complaint against a controller, the controller is obligated to make efforts to resolve the data subject's concerns.

Source: Official documents of the respective Acts.

[32] The Digital Personal Data Protection Act, 2023 (No. 22 OF 2023). The Gazette of India, August 11, 2023.

II DIGITALISATION AND FINANCIAL INNOVATION*

Digitalisation is spurring product and process innovations in India's banking and financial sector, while catering to diverse needs of customers. The hallmarks of financial innovations are the collaborations of banks and non-banking financial companies (NBFCs) with FinTechs and BigTechs in provision of financial services. Adoption of emerging technologies is enabling financial institutions to improve customer service, operating efficiency, and risk management, while also enhancing liquidity of financial markets. Leveraging India's digital public infrastructure, platform-based lending and embedded finance are rapidly digitalising the credit space through initiatives like Account Aggregators, Peer-to-peer Lending, Open Credit Enablement Network, Trade Receivables Discounting System, Pilot on Public Tech Platform for Frictionless Credit, and Open Network for Digital Commerce. Several regulatory complexities arise in the wake of emerging financial activities, given the absence of definitive regulatory frameworks governing the technologies involved. Ongoing adjustments to the existing regulatory and supervisory frameworks in line with the transformations in the financial landscape would foster a conducive environment for innovations, while ensuring financial stability.

1. Introduction

II.1 Financial sector has been at the forefront of the ongoing digital revolution, marked by the cascading effect of various innovations. India is a pioneer in financial innovations, benefiting from the Government-led India Stack and enabling policies of the Reserve Bank. The state-of-the-art Unified Payments Interface (UPI), with its potential to integrate across various platforms, has opened new vistas for financial innovations like digital lending. The 'building block approach' to digitalisation has facilitated unbundling of various components, including identity, payments, and data management, and using them as foundational tools for designing tailored financial solutions (Alonso *et al.*, 2023). New market players like financial technology companies (hereafter FinTechs) and other digital players are emerging as the fourth segment of the Indian financial system, alongside large banks, mid-sized banks including niche banks, Small Finance Banks (SFBs), Regional Rural Banks (RRBs), and cooperative banks (Das, 2020a). Globally, BigTech firms (hereafter BigTechs) offer personalised financial services at scale, tapping into their vast customer data that mitigate information asymmetries and reduce the need for collateral (Feyen *et al.,* 2021). The launch of the pilot end-to-end digitally enabled Public Tech Platform for Frictionless Credit (PTPFC) by the Reserve Bank Innovation Hub has reduced the turnaround time of certain categories of loans from a few weeks to less than an hour.

II.2 Financial innovations support economic growth and development through various channels, including reduction in the volatility of consumption (Cavoli and Gopalan, 2023), better risk sharing (Allen and Gale, 1994), enhanced allocative efficiency of capital (Beck *et al.,* 2016), and financial inclusion (Feyen *et al.,* 2023). Innovations have been contributing to banks' business growth and have enabled financial intermediation in areas

* This chapter has been prepared by a team comprising Rakhe Balachandran, Ashish Khobragade, Rajas Saroy, Sakshi Awasthy, Shashi Kant, Akshara Awasthi, Himani Shekhar, Rajni Dahiya, Radheshyam Verma, Anshu Kumari, Priyanka Upreti from the Department of Economic and Policy Research; Prasad Gajinkar, Jyothisree G, Ashis Mittal, Pramanshu Rajput from the Department of Regulation; Parimal Kumar Shivendu from the FinTech Department; and Sanjeev Kumar Gupta and Amarnath Yadav from the Department of Supervision. Valuable insights provided by Shri Manoranjan Mishra are gratefully acknowledged. Assistance received from Mantisha, Rajkumar Bhandare and Uthara is thankfully acknowledged.

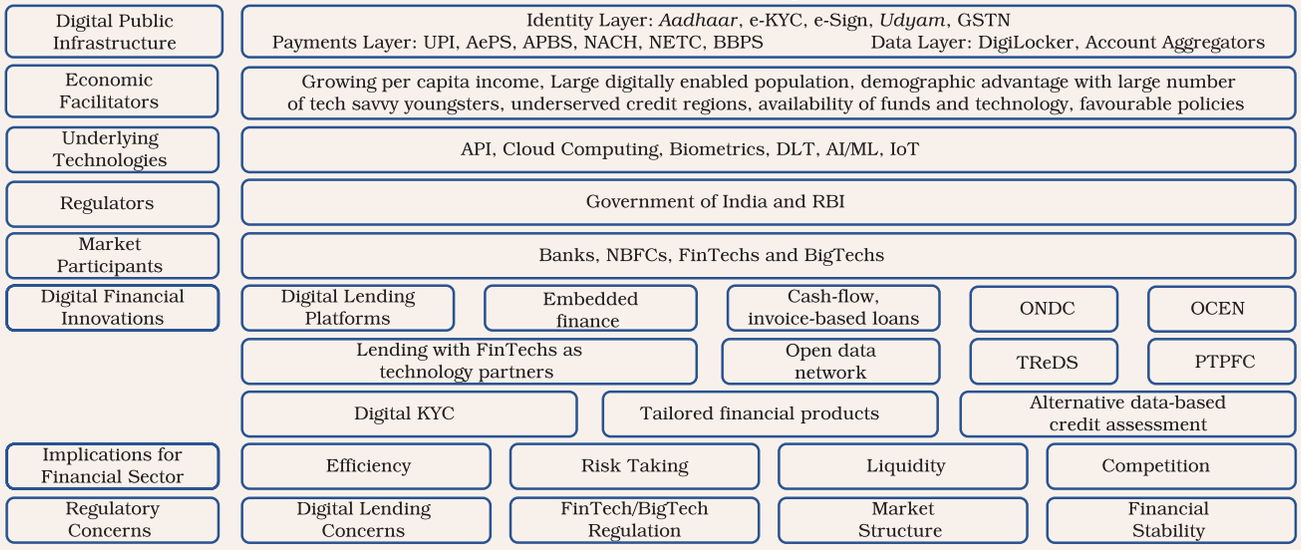
where it was previously unfeasible (Johnson and Kwak, 2012). Digitalisation in finance helps better integrate various segments and boosts liquidity and efficiency of financial markets. While the rapid and widespread integration with technology brings forth benefits, it also poses risks to the financial system. The role of central banks becomes more relevant and multi-faceted with the technological advancements leading to financial innovations (Patra, 2024). An appropriate regulatory approach, considering the inherent limitations and risks of digital technologies, would entail striking a fine balance between enabling innovations and preventing systemic risks (Das, 2022).

II.3 Against this backdrop, the conceptual framework on financial innovations and their economic facilitators are discussed in Section 2. Section 3 provides an overview of the technology adoption by financial institutions and customers. The collaborations of financial institutions (the Reserve Bank's regulated entities) with FinTechs and BigTechs in India are examined in Section 4 while developments in digital lending, characteristics of FinTech and BigTech loans, and regulatory innovations are presented in Section 5. Section 6 explores the implications of financial innovations, followed by regulatory concerns and policy initiatives in Section 7. Section 8 provides concluding observations.

2. Financial Innovations: Conceptual Framework and Economic Facilitators

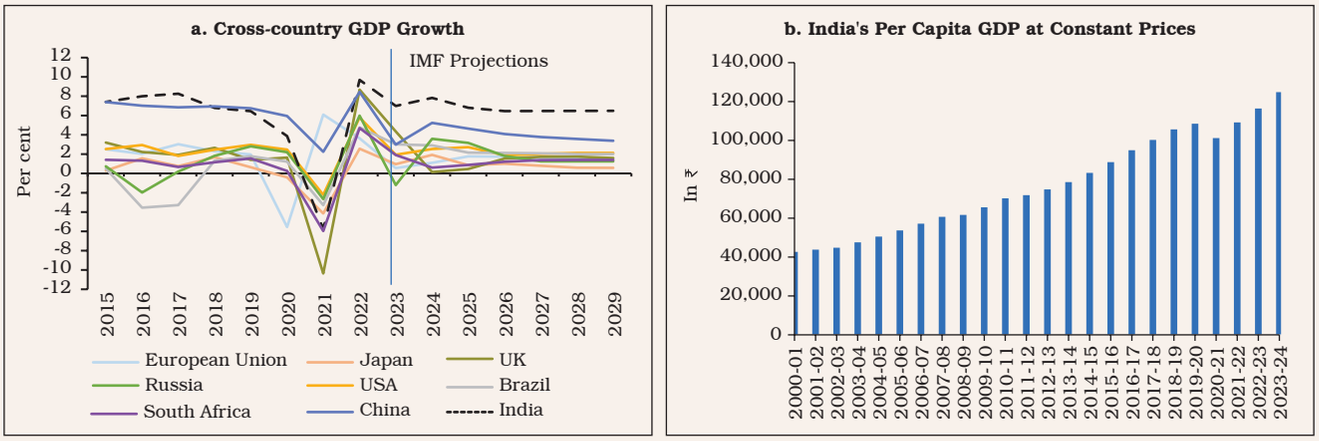
II.4 Financial innovations seek to alleviate financial frictions emerging from regulation and taxes, technology shocks (Silber, 1983), and incomplete markets (Duffie and Rahi, 1995), asymmetric information, and moral hazard (Ross, 1989), high transaction, search, and marketing costs (Merton, 1989), and cross-border integration (Tufano, 2003). Such innovations provide customer-centric financial products and services, spanning payments and credit, in a speedy and efficient manner, and also impact the operational efficiency and risk-taking of traditional financial institutions like banks. Thus, digitalisation in finance has profound implications for all stakeholders within the financial system – consumers, firms, and financial intermediaries (Chart II.1).

Chart II.1: Financial Innovations – A Conceptual Framework



Note: e-KYC: electronic Know Your Customer; GSTN: Goods and Services Tax Network; AePS: *Aadhaar* enabled Payment System; APBS: *Aadhaar* Payments Bridge System; NACH: National Automated Clearing House; NETC: National Electronic Toll Collection; BBPS: Bharat Bill Payment System; DLT: Distributed Ledger Technology; AI/ML: Artificial Intelligence/Machine Learning; IoT: Internet of Things; ONDC: Open Network for Digital Commerce; OCEN: Open Credit Enablement Network; TReDS: Trade Receivables Discounting System.
Source: RBI staff illustration.

Chart II.2: India's GDP Growth



Source: WEO, IMF and National Statistics Office (NSO).

Financial Innovations: Economic Facilitators

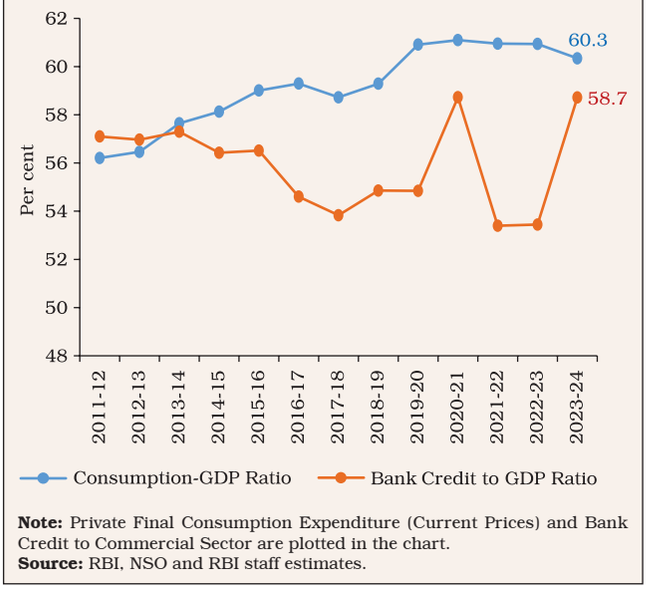
II.5 India is the fastest growing large economy in the world (Chart II.2a). The sustained increase in per capita income (Chart II.2b), ongoing financial deepening, economic dynamism and evolving diverse social needs create strong demand impulses for digital financial services and financial innovations.

II.6 In India, consumption-led-growth is further providing opportunities in areas of embedded finance[1] and the peer-to-merchant (P2M) payment models (Chart II.3). The bank credit to GDP ratio at around 58.7 per cent in 2023-24 leaves room for further financial deepening, which can be facilitated by financial innovations (Chart II.3).

II.7 The share of short-term maturity loans (less than three months) by Scheduled Commercial Banks (SCBs) has reduced over time (Chart II.4). This provides opportunities for digital lending in small ticket loans. Financial innovations that reduce loan processing costs can help regulated entities (REs) penetrate this segment in collaboration with FinTechs.

II.8 The underserved credit regions in the country offer opportunities for digital banking products and services. The share of rural areas (mainly tier 5 and 6 centres) and semi-urban areas (including tier 2, 3 and 4 centres) taken together in total credit of SCBs has increased from 15.0 per cent in June 2017 to 17.7 per cent in December 2023 and therefore, credit flow to these

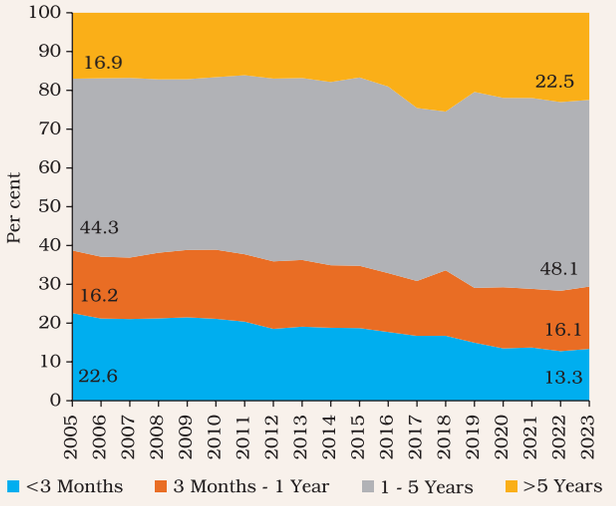
Chart II.3: Consumption and Bank Credit



Note: Private Final Consumption Expenditure (Current Prices) and Bank Credit to Commercial Sector are plotted in the chart.
Source: RBI, NSO and RBI staff estimates.

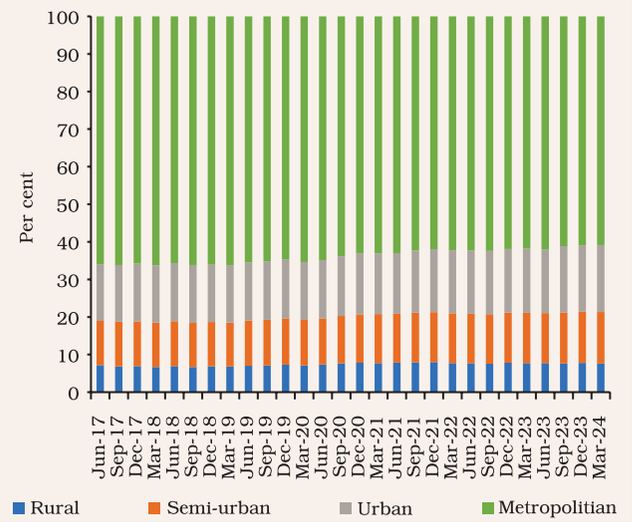
[1] Embedded finance refers to the integration of banking and various financial services into non-financial applications and services.

Chart II.4: Maturity Profile of Loans and Advances by SCBs



Note: Data as at end-March.
Source: RBI.

Chart II.5: Share in Total Credit of SCBs by Population-group

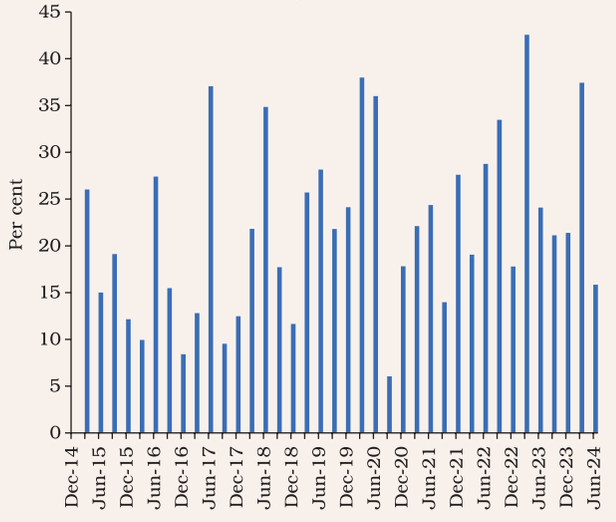


Source: RBI.

areas could benefit immensely from the evolving financial innovations (Chart II.5).

II.9 The availability of funds from domestic and external sources supports the financial innovation ecosystem. India - the third largest FinTech ecosystem (after the United States and United Kingdom) - accounts for close to one-fourth of all the unicorns globally. This is partly reinforced by the extent of funding received by FinTechs in India which is around 30 per cent of the startup funding during 2023 (Chart II.6).

Chart II.6: Share of FinTech Funding in Total Startup Funding in India

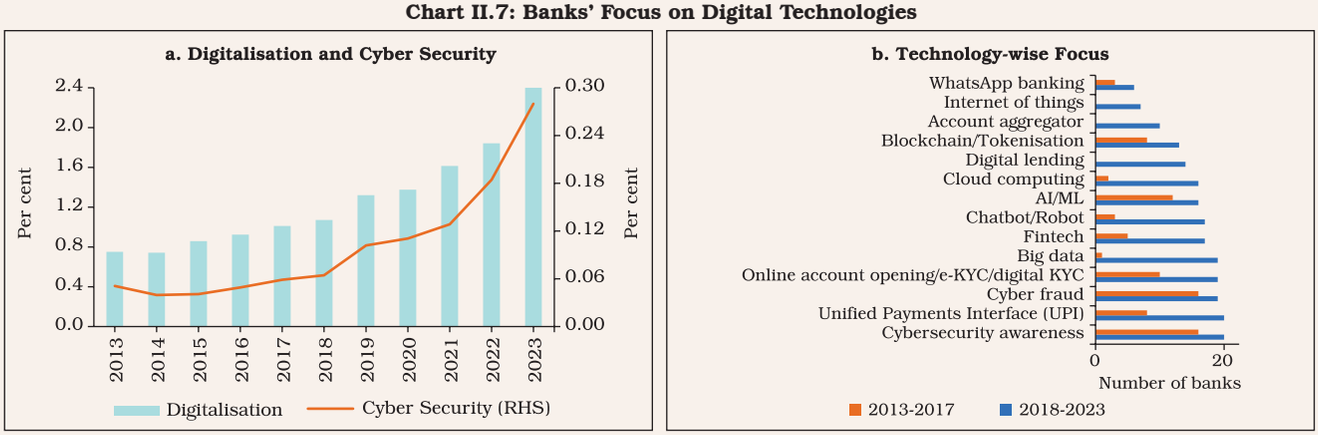


Source: Tracxn accessed on July 5, 2024, and RBI staff estimates.

3. Financial Innovations : Adoption by India's Financial Institutions and Customers

II.10 The benefits of financial innovations reach customers through their interactions with financial institutions. Banks are making extensive use of financial innovations to service their customers and also for enhancing operational efficiency. An analysis of the annual reports of 20 commercial banks shows that the use of words related to digitalisation and cyber security has increased steadily between 2013 and 2023, with a significant acceleration since the COVID-19 pandemic (Chart II.7a). Further, discussions on new topics like 'FinTech', 'Blockchain/Tokenisation', 'Online Account Opening/e-KYC', 'Chatbot/Robot', 'AI/ML' and 'Digital Lending' have gained momentum in the recent period (2018-2023), in addition to the technology buzzwords of the previous period (2013-2017) such as 'UPI' and 'Cyber Security Awareness'. Topics like 'Internet of Things' (IoT),

Chart II.7: Banks' Focus on Digital Technologies



Note: The chart includes data for 20 SCBs. For chart II.7a, the vertical axis represents the number of sentences containing keywords related to digitalisation and cyber security as a share of the total number of sentences in the respective annual reports. For chart II.7b, banks focussing on emerging technologies were found out from the existence of related keywords in their annual reports between 2013-2017 and 2018-2023.
Source: Annual Reports of SCBs for years 2013 to 2023 and RBI staff estimates.

'digital lending' and 'Account Aggregators' have experienced significant traction in discussions post 2018 (Chart II.7b).

II.11 Digitalised financial sector can enhance credit assessment, reduce default rates and broaden the access to finance (Berg *et al.*, 2020). Incorporating alternative digital data, such as cash flow, telecom, utility, and social media sources and leveraging surrogate data allow creditors to comprehensively assess customers' ability and willingness to repay loans and enable real-time credit monitoring (Koulouridi *et al.*, 2020; Agarwal *et al.*, 2019; Calli and Coskun, 2021). Digital transformation can help banks automate and standardise their business processes, reduce human resources and operational costs (Parviainen *et al.*, 2017). Digitalisation, facilitated by RegTechs[2], automates and streamlines compliance with regulatory guidelines. In India, digitalisation has improved the efficiency of banks (Box II.1).

Box II.1
The Impact of Digitalisation on Efficiency of Banks

Financial innovation impacts efficiency of banks by reducing operating costs, creating customer-oriented business models, and strengthening risk control capabilities (Wang *et al.*, 2021). The impact of digitalisation on operating efficiency of Indian banks is analysed using a panel dataset of 29 public and private sector banks at annual frequency for 2015-2023. Digitalisation is proxied by an index of volume of digital payments which reflects relative position of each bank in processing retail digital transactions[3] each year. Bank efficiency is estimated using non-parametric data envelopment analysis methodology, which provides cost efficiency and technical efficiency of banks. The efficiency scores are estimated using net interest income and non-interest income as output variables, and loanable funds, fixed assets, and total

(Contd...)

[2] Regulatory Technology (RegTech) refers to the application of technology to improve regulatory compliance and risk management within financial institutions (FIs). RegTech, a subset of FinTech, offers tailored solutions for compliance, reduces costs, and manages new regulations, litigation, and remediation. This technology streamlines regulatory processes, helping FIs navigate the evolving regulatory landscape efficiently, enhancing compliance, and reducing complexity (Suresh, 2018).

[3] Includes National Electronic Funds Transfer (NEFT), debit and credit card transactions.

Table 1: Digitalisation and Efficiency of Banks: Empirical Estimates

	Dependent Variable	
Independent Variables	**Cost Efficiency**	**Technical Efficiency**
Digitalisation	0.0385*** (0.00407)	0.0321*** (0.00511)
Cost of Deposits	-0.235*** (0.0771)	-0.331*** (0.0952)
Inflation	-0.0156 (0.110)	0.00934 (0.152)
Bank Size	-0.436*** (0.108)	-0.179 (0.132)
Ratio of net NPA to net advances	-0.0366** (0.0147)	-0.0645*** (0.0186)
Return on Advances	0.276*** (0.0460)	0.362*** (0.0569)
Log(GDP)	-0.0992 (0.930)	0.121 (1.442)
Constant	0.142 (15.59)	-3.521 (25.87)
Observations	256	256

Note: 1) ***, **, * indicate significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.
2) Figures in parentheses are robust clustered standard errors.
3) Standard errors are clustered at the bank level.
4) Bank size is proxied by the share of the bank's assets to aggregate banking sector assets.
5) Following Woolridge (2010), cross-section fixed effects are accounted for by controlling for averages of time-varying cross-section variables for each year in the model.
Source: RBI staff estimates.

employees as input variables for technical efficiency. The corresponding prices are used as input variables for cost efficiency. A pooled fractional probit model with clustered standard errors is used to estimate the impact of digitalisation on efficiency of banks, since the efficiency score lies between zero and one. The cross section-level fixed effects have been accounted for in the model following Woolridge (2010). The regression estimates indicate that digitalisation increases efficiency of banks (Table 1).

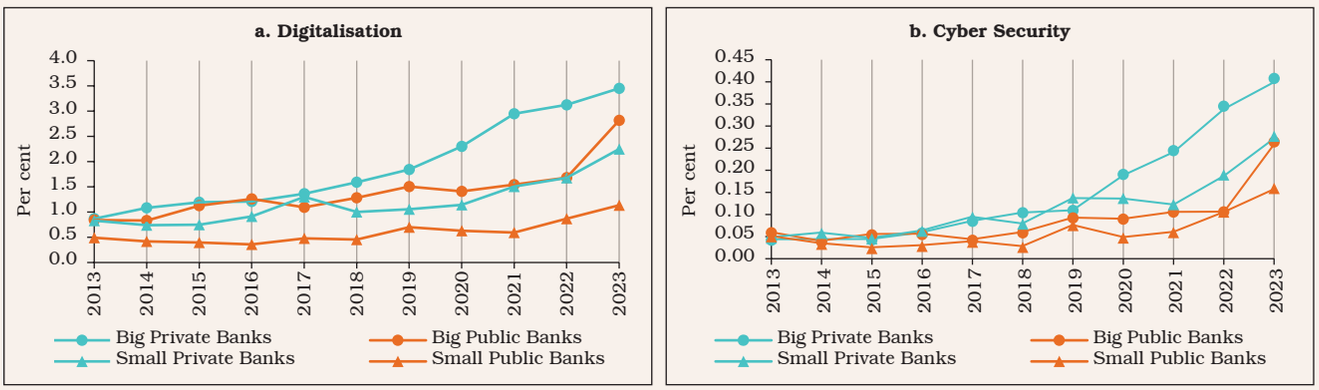
References:

Wang, Y., Xiuping, S., and Zhang, Q. (2021). Can FinTech Improve the Efficiency of Commercial Banks? - An Analysis Based on Big Data. *Research in International Business and Finance, 55,* 201338.

Woolridge, J. (2010). Econometric Analysis of Cross Section and Panel Data. *MIT Press*.

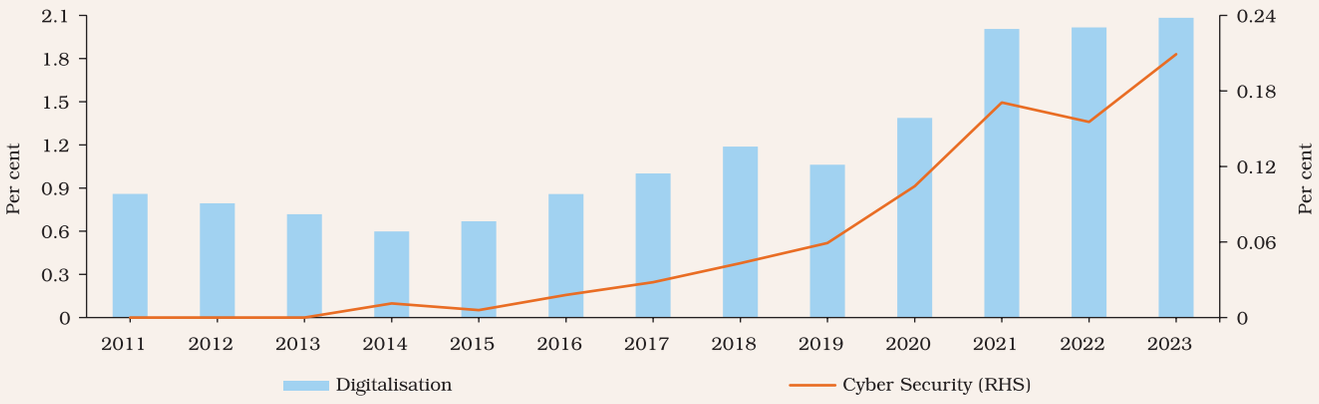
II.12 The adoption of digital technology varies among bank groups. The share of the key words related to digitalisation in the annual reports, an indicator of digitalisation, is higher in private sector banks (PVBs) relative to public sector banks (PSBs) [Chart II.8a]. PVBs are also ahead of PSBs in the realm of cybersecurity (Chart II.8b). Further, in both public and private sectors, small banks

Chart II.8: Bank-group wise Focus on Digitalisation and Cyber Security



Note: The chart includes data for 20 SCBs. The vertical axis represents the number of sentences containing keywords related to digitalisation and cyber security as a share of the total number of sentences in the respective annual reports. Banks were categorised into two groups, namely big and small banks, based on their asset size in 2022-23. The top five banks in each category, public and private, were classified as big banks, while the remainder were categorised as small banks.
Source: Annual reports of SCBs for 2013-2023 and RBI staff estimates.

Chart II.9: NBFC-ICCs' Focus on Digitalisation and Cyber Security



Note: The chart includes data for nine upper layer NBFC-ICCs. Y-axis represents the number of sentences containing the keywords related to digitalisation and cyber security divided by the total number of sentences in the respective annual reports.
Source: Annual reports of NBFC-ICCs, 2011-2023 and RBI staff estimates.

lag behind big banks in terms of digitalisation and cyber security.

II.13 The use of digitalisation and emphasis on cyber security is also increasing in the upper-layer NBFC-Investment and Credit Companies (NBFC-ICCs), as suggested by the frequency of these keywords in their annual reports. The extent of usage is, however, less than that of many SCBs (Chart II.9).

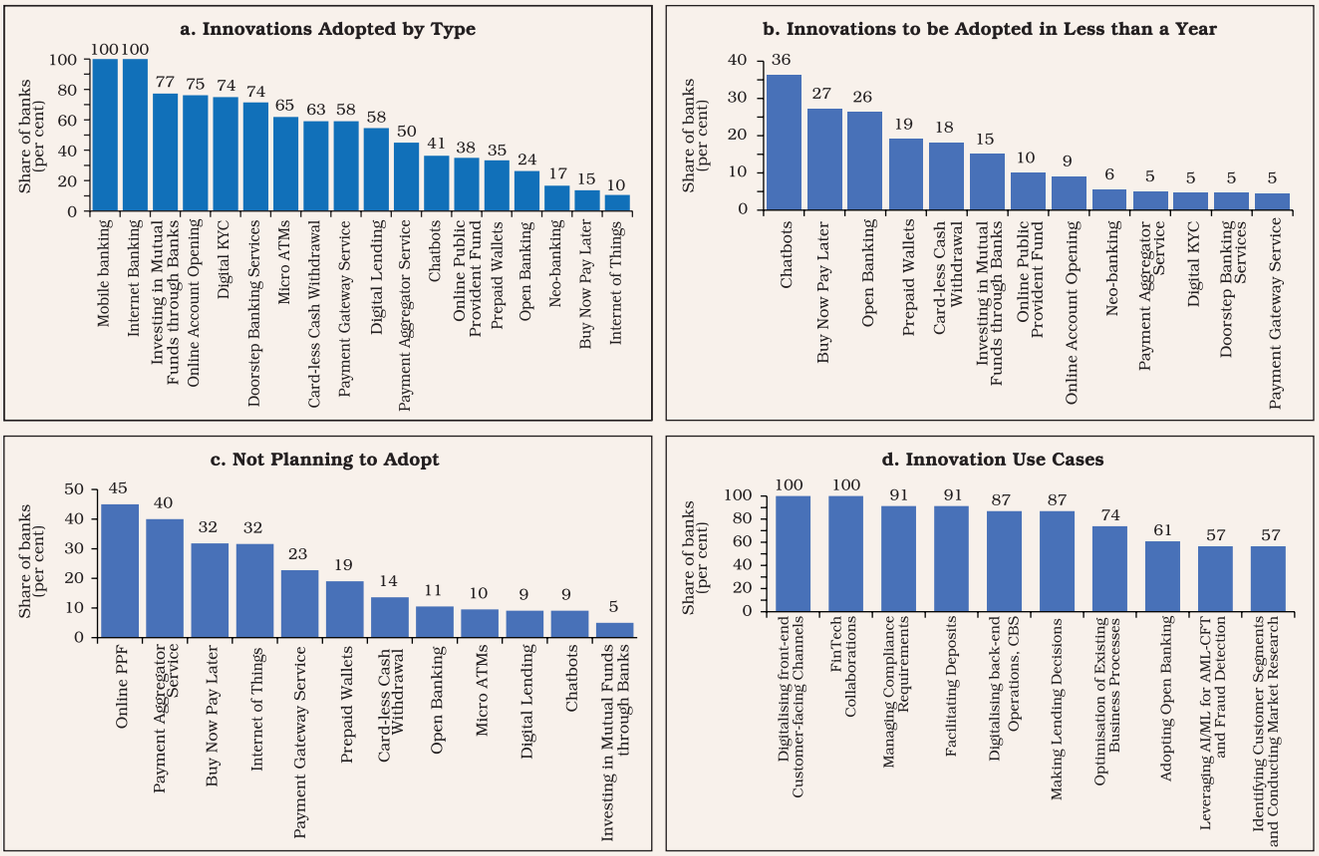
II.14 A special survey of SCBs[4] conducted in March 2024 on the adoption of various types of financial innovations indicates that internet banking, mobile banking, online account opening, digital Know Your Customer (KYC), mutual fund investments, and doorstep banking through digital means are being extensively used across banks (Chart II.10a). The adoption of more recent innovations like payment aggregator services, chatbots, prepaid wallets, open banking, online Public Provident Fund (PPF) and IoT based applications has been relatively lower, with less than half of the surveyed SCBs adopting them. Many SCBs plan on adopting chatbots in less than a year (Chart II.10b). The surveyed banks exhibited muted interest in offering Online PPF, payment aggregator and gateway services, and Buy Now Pay Later (BNPL) [Chart II.10c]. All respondent banks have embraced technology partnerships with FinTechs and have adopted digital technologies to enhance their front-end/ customer interface. Digital technologies are also used for facilitation of deposits, managing compliance requirements, and making lending decisions (Chart II.10d).

PSB Alliance – Innovation Adoption at the Community Level

II.15 Public sector banks are collaborating amongst themselves on financial innovations to enhance the quality of customer service and operational efficiency. PSB Alliance (PSBA), an umbrella entity in collaboration with 12 PSBs, has implemented several community-level financial innovations. Enhanced Access and Service Excellence (EASE) reforms, governed by the

[4] Twenty-five banks participated in the survey.

Chart II.10: Survey on Innovation Adoption by Banks



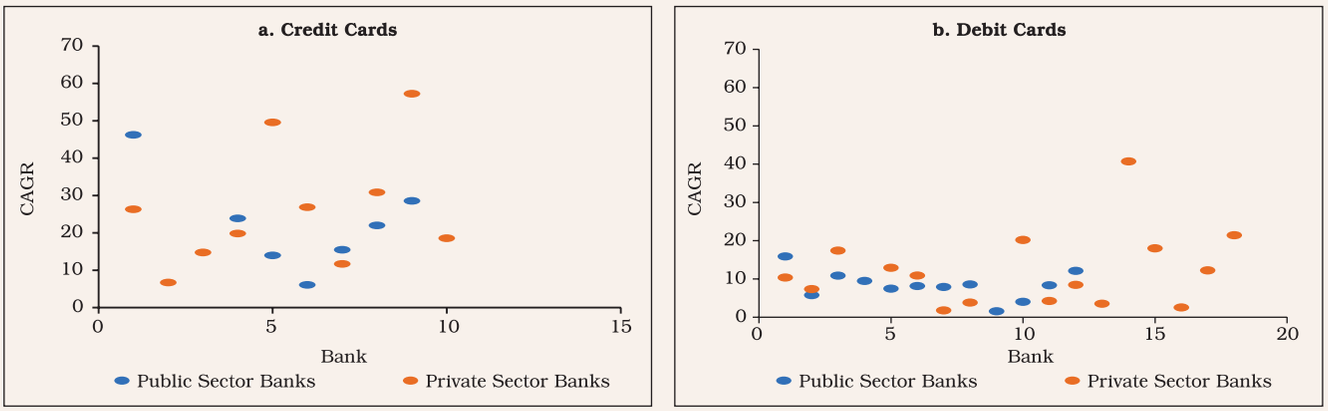
Note: Multiple responses were allowed. For charts a, b and c, banks were asked whether they are planning to adopt the listed categories of innovations and they had six options ('we had introduced it, but the response was not good'; 'we have already introduced it partially'; 'we have introduced it completely'; 'we plan to introduce it in less than a year'; 'we plan to introduce it in coming two years'; 'we do not plan to introduce it at this stage') to choose from. Since the charts are plotted for only three categories ('we have introduced it completely'; 'we plan to introduce it in less than a year'; 'we do not plan to introduce it at this stage'), they may not add to 100.

Source: Special survey of 25 SCBs and RBI staff estimates.

EASE Steering committee of the Indian Bank's Association, aim to enhance the capabilities of PSBs to meet the changing demands of diverse set of customers. With close to 40 per cent of banks' total deposits held by senior citizens (above 60 years of age), PSBA offers doorstep banking facilities for both financial and non-financial transactions across 2,760 centres across India as on July 26, 2024. Further, PSBA is expanding doorstep banking technology to more centres. It has introduced Unified Property Listing and Auction Portal (eBKray) with enhanced features and functionalities, including mobile application, AI-based search engines, loan sourcing capabilities, automated earnest money deposit (EMD) management, and an omni-channel interface. Built on a modular architecture with open APIs, the eBKray platform ensures ease of integration with market ecosystem players. Single portal for pre-auction, auction, EMD management, reporting and post-auction is anticipated to enhance user experience.

II.16 As part of risk management and data exchange, the PSBA has also set up the Operational Risk Loss Data Exchange (LDE). The LDE collects and consolidates the individual bank-level data on operational risk losses and shares the sector-level data with member banks. Industry benchmarks of key risk indicators are prepared based on the Basel Committee on Banking

Chart II.11: Growth in the Issuance of Cards



Note: Data pertain to 19 SCBs for credit cards and 29 SCBs for debit cards. Compound Annual Growth Rate (CAGR) for the period 2015-24 is reported.
Source: RBI.

Supervision (BCBS) guidelines and are also shared among member banks. The data collected by LDE can be used for various purposes by member banks such as stress testing, scenario analysis and calculation of economic capital for Internal Capital Adequacy Assessment Process (ICAAP). The development of a community cloud, agricultural lending and collateral monitoring platform, and digital supply chain finance platform are also under consideration by the PSBA (PSBA, 2024).

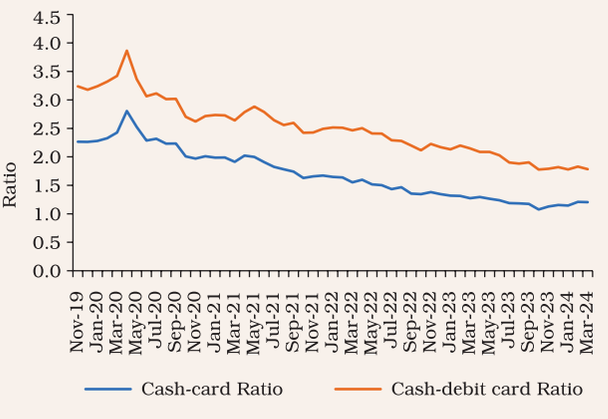
Uptake of Financial Innovations by Banks' Customers

II.17 During 2015-24, the compound annual growth rate (CAGR) of credit cards issued across banks was in the range of 10 to 30 per cent, with a few banks reporting growth of more than 40 per cent, indicating faster adoption of credit cards by customers. The growth in the debit card segment hovered in the range 0-20 per cent across banks, partly reflecting the base effect (Chart II.11).

II.18 In India, the cash-to-card ratio – the ratio of average ATM withdrawal to average card payment – has moderated, with an increase in the usage of digital payments by customers (Chart II.12).

II.19 On an average, ten and four per cent of banks' customers made active[5] use of mobile and internet banking, respectively, during February and March 2024 (Chart II.13). Usage of mobile and internet banking by PVBs' customers

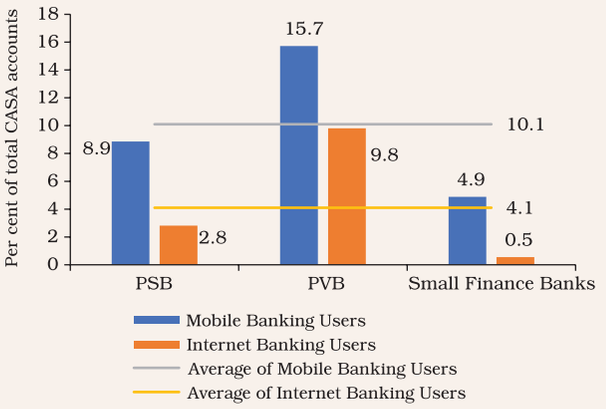
Chart II.12: Adoption of Cards for Digital Transactions



Note: Cash-card ratio is the ratio of monthly average value of ATM withdrawals to monthly average ticket size of card payments (both debit and credit cards). Cash-debit card ratio is the ratio of monthly average value of ATM withdrawals from debit cards to monthly average ticket size of debit card payments.
Source: RBI staff estimates.

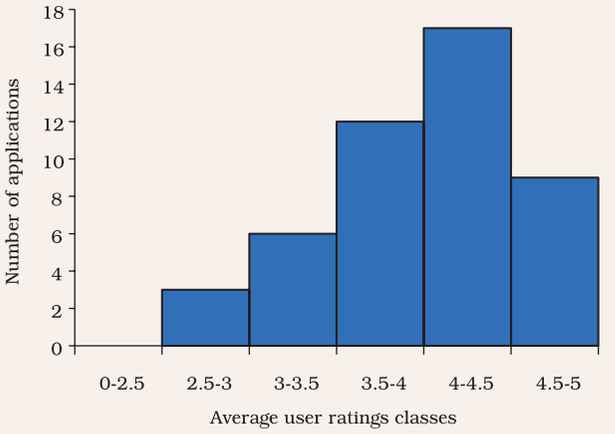
[5] Active customers are defined as those who have used these facilities at least once in two months.

Chart II.13: Usage of Mobile and Internet Banking by Customers



Note: Data on active mobile banking users pertain to 12 PSBs, 21 PVBs and 12 small finance banks. For Internet Banking users, data represent 12 PSBs, 20 PVBs and 11 Small Finance Banks. Number of total savings and current accounts (CASA) is taken as a proxy for total customers of bank groups.
Source: RBI staff estimates.

Chart II.15: User Ratings of Mobile Banking Applications



Note: The data pertain to mobile applications of 47 banks, where in the primary mobile banking application of each bank is included in the analysis, as on May 30, 2024. The sample contains applications available on Google Play Store.
Source: Google Play Store and RBI staff estimates.

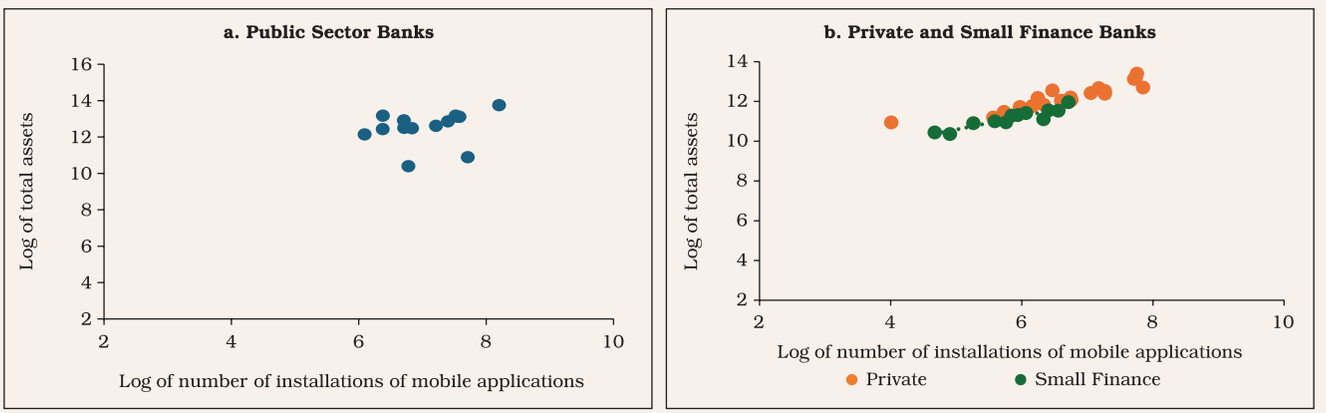
was higher than that of PSBs' customers during these months.

II.20 A correlation analysis reveals a positive association between bank size and their respective mobile banking application installations by customers, especially for PVBs (Chart II.14).

II.21 The frequency distribution of average user rating for primary mobile banking applications of 47 banks in India suggests that 55.3 per cent (26 out of 47) of applications have average user rating of 4 or above, reflecting customer satisfaction with mobile banking. Mobile applications of three banks received a rating of below three from customers (Chart II.15).

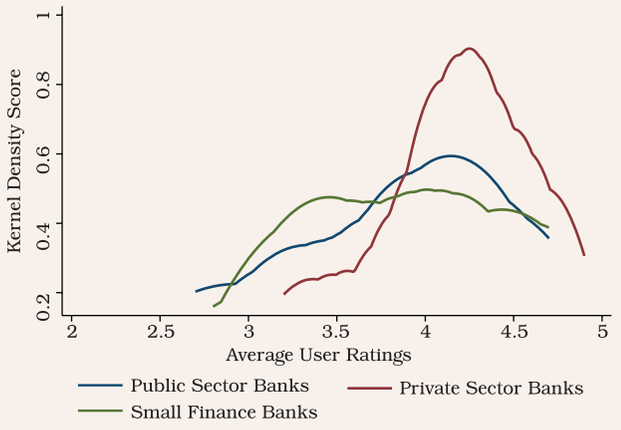
II.22 Bank group-wise analysis of ratings of mobile banking applications of 47 banks in India shows that ratings are generally higher for PVBs as compared to PSBs and small finance banks (SFBs) [Chart II.16].

Chart II.14: Mobile Banking Adoption by Customers *vis-à-vis* Bank Size



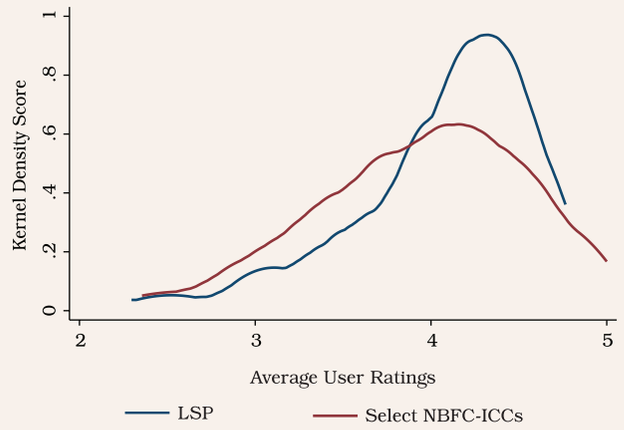
Note: The data pertain to 47 bank applications, where in the primary mobile banking application of each bank is included in the analysis, as on May 30, 2024.
Source: RBI, Google Play Store, and RBI staff estimates.

Chart II.16: Bank-group wise Average User Ratings of Mobile Banking Applications



Note: The data pertain to mobile applications of 47 banks, where in the primary mobile banking application of each bank is included in the analysis, as on May 30, 2024. The sample contains applications available on Google Play Store.
Source: Google Play Store and RBI staff estimates.

Chart II.17: Average User Ratings of Mobile Applications – NBFC-ICCs and LSPs

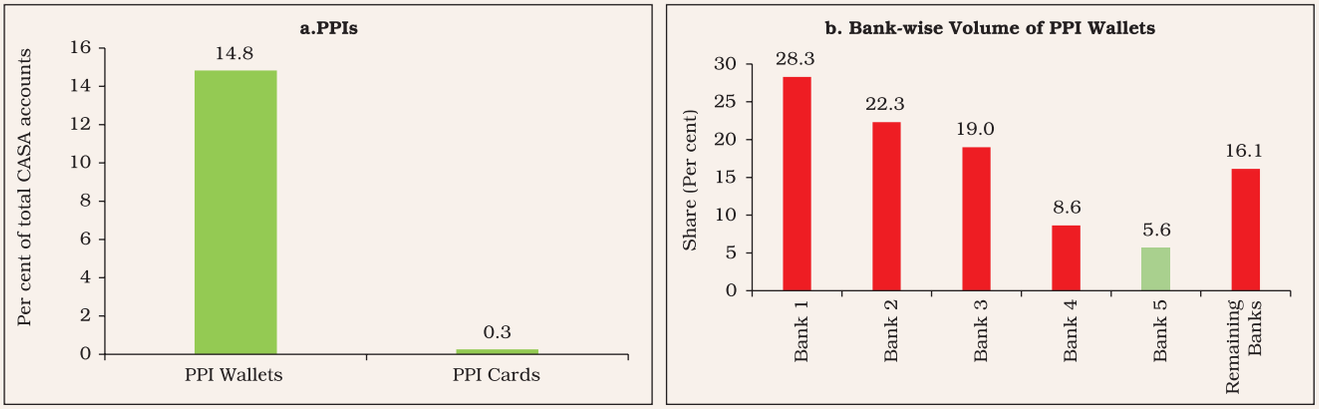


Note: The data pertain to 31 mobile applications (primary universal applications along with dedicated digital loan applications) of 20 upper and middle layer NBFC-ICCs and 48 LSPs, as on May 30, 2024. The sample contains applications available on Google Play Store.
Source: Google Play Store and RBI staff estimates.

II.23 The mobile applications of 20 NBFC-ICCs belonging to the upper layer and middle layer received an average rating of four from the users. The mobile applications of the major FinTech lending service providers (LSPs) of these NBFCs received a higher rating than the applications of the NBFCs themselves (Chart II.17).

II.24 Among the prepaid payment instruments (PPIs), issuance of wallets is higher than cards (Chart II.18a). Private banks lead in the issuance of PPIs to customers (Chart II.18b). Recent initiatives including developments regarding PPIs for Mass Transit Systems (PPI-MTS) may boost issuance going ahead.

Chart II.18: Issuance of Prepaid Payment Instruments (PPIs) to Customers

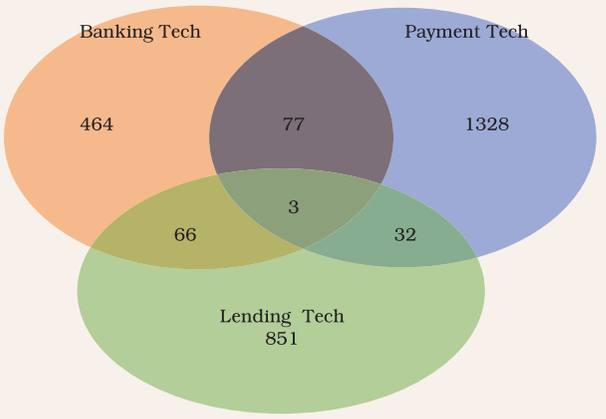


Note: Number of current and savings accounts (CASA) has been taken as a proxy for total customers. In chart b, red bar indicates a PVB and green bar indicates a PSB. The data are as on end-March 2024.
Source: RBI staff estimates.

4. Collaboration of FinTechs and BigTechs with Financial Institutions (Banks and NBFCs)

II.25 FinTechs may be defined as entities that provide technological solutions for delivery of financial products and services to businesses and consumers or encompass regulatory and supervisory compliance in partnership with traditional financial institutions or otherwise (RBI, 2024a). India leads the world with FinTech adoption rate of 87 per cent, higher than the global average of 64 per cent (EY, 2019).[6] According to the Department for Promotion of Industry and Internal Trade (DPIIT), there are 8,011 FinTechs in India as on July 22, 2024. Revenues of FinTechs in India are expected to grow exponentially from US$ 17 billion in 2022 to more than US$ 190 billion by 2030 (BCG, 2023). Between January 2018 and December 2023, the FinTech sector in India has received approximately US$ 27 billion in funding[7], including both domestic and external sources (Tracxn, 2024). The payments segment leads in terms of fundraising within the Fintech sector. FinTechs have not confined to a single market, and some of them have also ventured into several associated activities in India (Chart II.19).

Chart II.19: Overlap in FinTech Activities



Note: The figure shows the number of FinTechs in India categorised under banking, payment and lending business models on Tracxn. Banking Tech includes companies providing software solutions, innovative hardware solutions or tech-enabled services to banking institutions. It also includes internet-first banks.
Source: Tracxn, accessed on May 8, 2024 and RBI staff illustration.

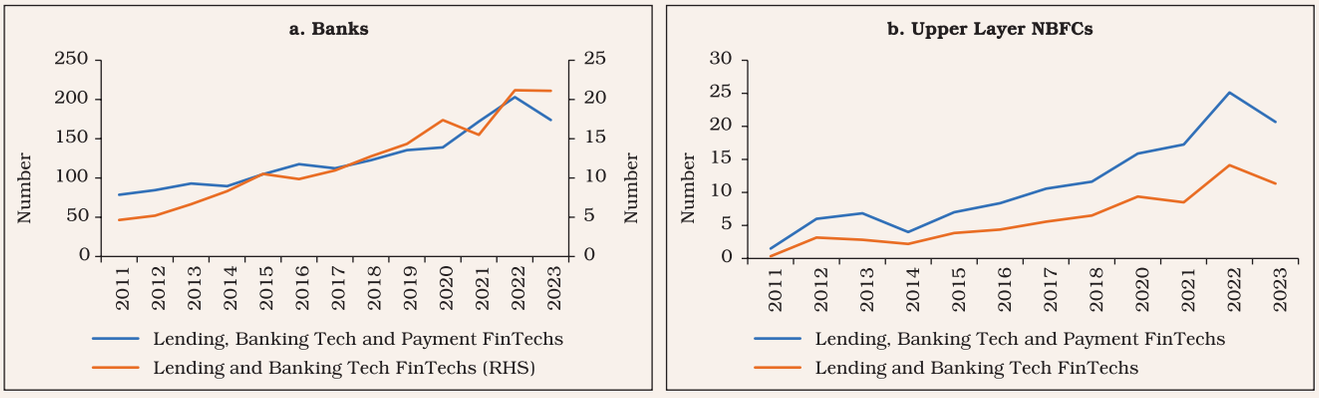
II.26 The partnerships between banks/NBFCs and FinTechs have unique strengths and are mutually beneficial. The comparative advantages of FinTechs include better user experience, agility, use of unconventional data, and the ability to scale rapidly. FinTechs, however, lack a large client base and the necessary expertise to navigate the regulatory landscape of the financial sector. Banks, on the other hand, enjoy customer trust and confidence, a large pre-existing customer base, widespread geographical presence, legal backing to accept deposits, and experience in risk management and regulatory compliance (Mundra, 2017). The annual reports of banks and upper layer NBFC-ICCs have increasingly showcased their growing collaboration with FinTechs (Chart II.20)[8]. The names of payment FinTechs tend to occur more than the lending and banking FinTechs, highlighting maturity of these partnerships in the payment space.

[6] The FinTech adoption rate is the share of consumers who have used at least two categories of FinTech services, including money transfer and payments, budgeting and financial planning, savings and investments, borrowing, and insurance, among the total digitally active adults surveyed (EY, 2019).

[7] Data accessed on May 14, 2024.

[8] Based on text mining of the Annual Reports of the SCBs and the Upper Layer NBFCs from 2011 to 2023. The number of times the names of the FinTechs and the word “fintech” appears in the annual reports is used as a proxy for collaboration between the Banks/NBFCs and the FinTechs.

Chart II.20: FinTech Collaboration Index of Financial Institutions

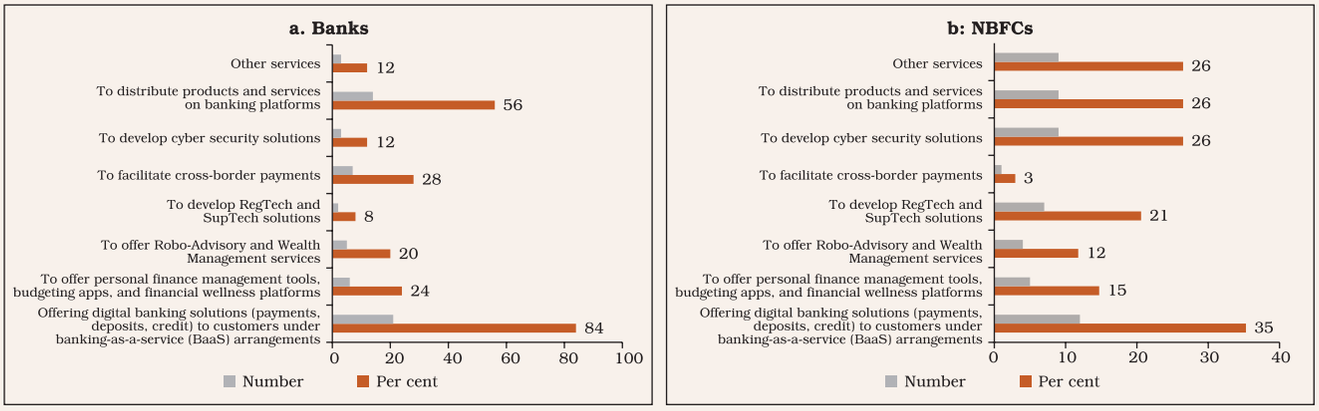


Note: The index has been calculated as average number of FinTech names appearing in the annual reports of SCBs and upper layer NBFCs. Some FinTechs may fall under both, lending, and payments category as classified in Tracxn database accessed as on May 6, 2024. The sample constitutes 30 SCBs (chart a) and nine upper layer NBFC-ICCs (chart b).
Source: Annual reports of NBFC-ICCs and RBI staff estimates.

II.27 An analysis of the empanelled FinTechs of a few SCBs reveals that FinTech collaborations are made for a range of services including lending, remittances and payment services, digitalisation of processes and products, insurance, wealth products, investments, marketing, and API development.

II.28 A special survey of select NBFCs and banks[9] shows that 84 per cent of the surveyed banks and 35 per cent of the surveyed NBFCs are partnering with FinTechs for offering digital banking solutions (Chart II.21). These collaborations with FinTechs are used to distribute products/services on banking platform, including digital banking solutions. According to the survey, 92 per cent of the responding banks reported that collaboration is effective in driving digital innovation as against 60 per cent of NBFCs.

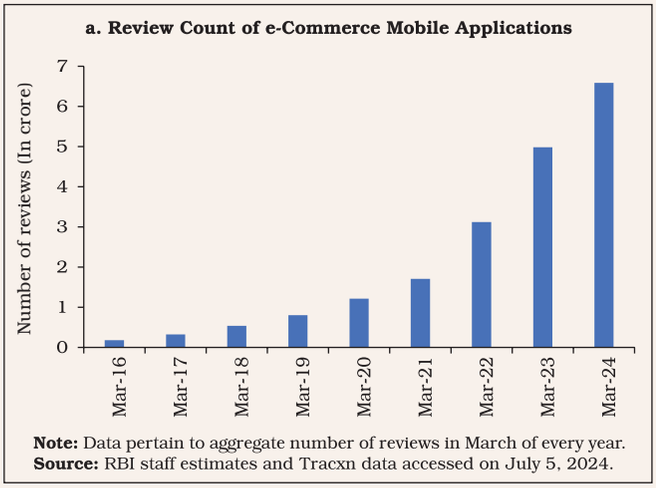
Chart II.21: Services Provided through Collaboration between Banks/NBFCs and FinTechs



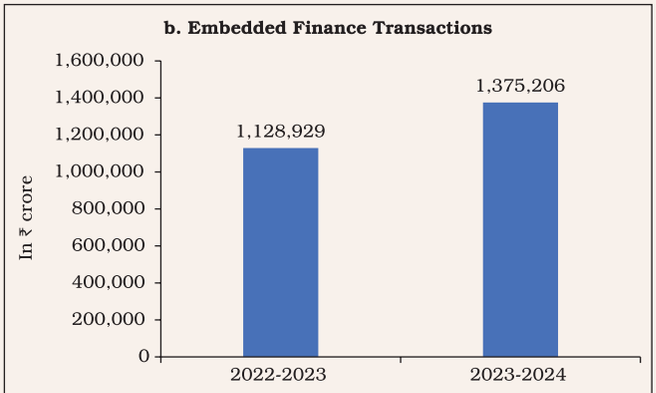
Note: Due to the respondents selecting multiple categories, shares across all categories may not add up to 100. Data pertain to 25 banks and 34 NBFCs.
Source: A special survey of banks and NBFCs and RBI staff estimates.

[9] The survey was conducted in March 2024. Responses were received from 25 banks and 68 NBFCs.

Chart II.22: Indicators of Embedded Finance in India



Note: Data pertain to aggregate number of reviews in March of every year.
Source: RBI staff estimates and Tracxn data accessed on July 5, 2024.



Note: Embedded finance transactions include both debit and credit card transactions on e-commerce platforms. The data in the figure do not include embedded payments using UPI, PPI and pay later options.
Source: RBI staff estimates.

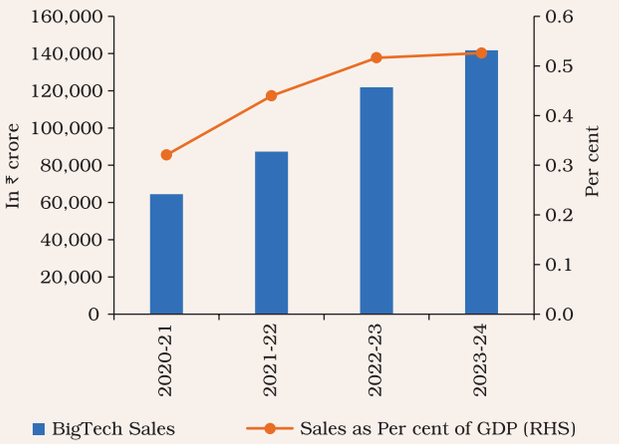
Collaboration with BigTechs

II.29 BigTechs, mainly through e-commerce and payment applications, are reshaping the financial landscape, with implications for public policy, competitiveness, and financial stability. BigTechs mainly operate as online multi-sided platforms, facilitating direct interactions among different user groups like buyers and sellers (Doerr *et al.*, 2023). Rising adoption of e-commerce, as suggested by increasing e-commerce mobile application review counts, may be associated with demand for embedded finance in India (Chart II.22a). Concurrently, the embedded financial transactions and the presence of BigTechs are also rising in India (Chart II.22b and II.23).

II.30 The business models of BigTechs are usually characterised by the data-network-activity reinforcing feedback loop (Shin, 2019). As user engagement on the platform increases, network externalities arise, enhancing the platform's adoption and allowing BigTechs to accumulate more data which enables them to diversify into financial services, such as money management, insurance, and lending, attracting additional users and perpetuating the cycle. Data can also be either sold to third parties or utilised internally to refine services, innovate new offerings, and generate additional revenue streams (Bains *et al.,* 2022). By integrating cutting-edge technology, BigTechs can deliver innovative financial services for households (De la Mano and Padilla, 2018).

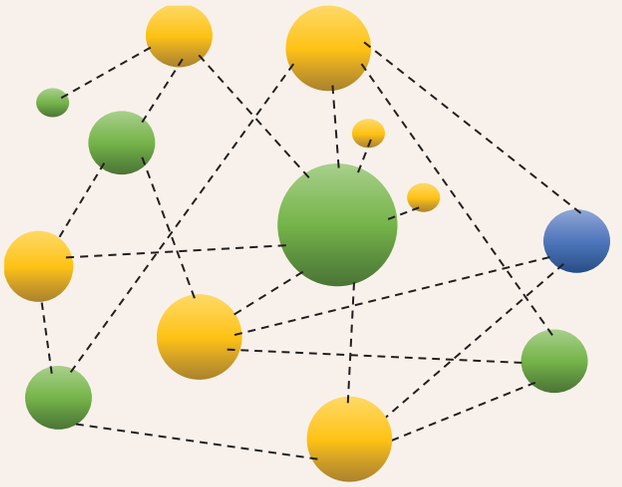
II.31 There exists scope for seamless integration between financial services and non-financial BigTech platforms to enhance user experiences.

Chart II.23: BigTech Sales in India



Note: 1. Aggregated revenues of Indian subsidiaries of five major BigTechs.
2. List of group subsidiaries considered may not be comprehensive.
Source: Profit and Loss Statements accessed from Capitaline and RBI staff estimates.

Chart II.24: Collaborations of BigTechs with Banks for UPI



Note: Green indicates private sector banks, blue indicates public sector banks and yellow indicates BigTechs. Size of the bubble is proportional to the number of collaborations.
Source: NPCI and RBI staff illustration.

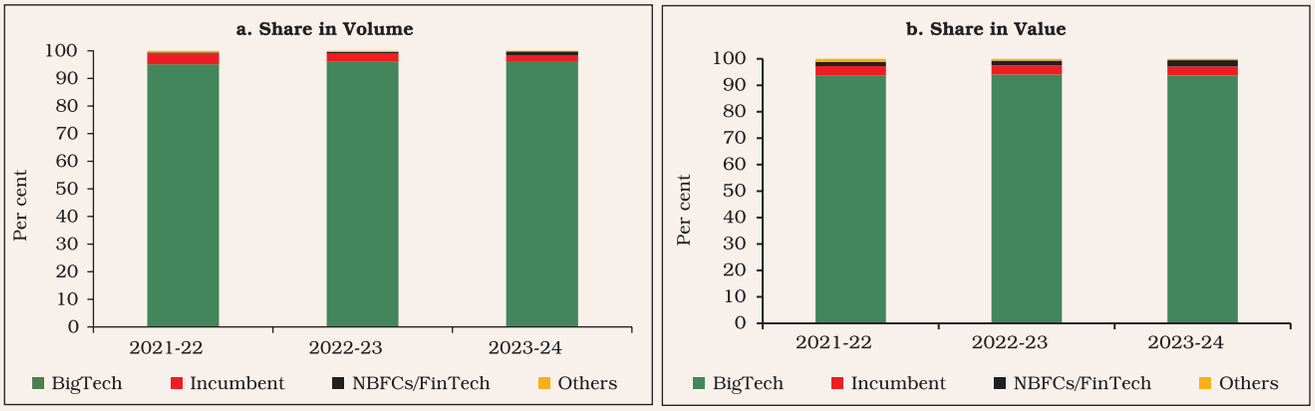
Within the financial services industry, BigTechs first entered the payment segment (BIS, 2019). In India, six banks have collaborated with seven BigTechs in the UPI payment space (NPCI, 2024). Most of these collaborations involve PVBs (Chart II.24). BigTech-backed applications have made their mark in the Indian payment industry, with more than 90 per cent share in UPI payment volume and value (Chart II.25).

II.32 BigTech platforms offer multiple contactless payment options such as payment through gateways, platform-specific digital wallets, co-branded credit cards, converting purchase bills into equated monthly instalments (EMIs or No-cost EMI) and BNPL. In India, five BigTechs have entered into collaborations with four PVBs and five NBFCs for offering BNPL through their platforms. Co-branded credit cards are also offered in collaboration with four SCBs (Chart II.26).

II.33 For lending activities, BigTechs rely on machine learning for credit risk assessment to address information asymmetries *in lieu* of the traditional collateral-based lending (Doerr *et al.,* 2023; Gambacorta *et al*., 2019). They are positioned to capture a significant share of financial services market, including lending, due to economies of scale and scope (Adrian, 2021). In an environment of lower competition, there is greater opportunity for BigTechs' credit to thrive, attracted by higher profit margins. However, with stringent banking regulations, credit activities of BigTechs might face setbacks (Cornelli *et al.,* 2023).

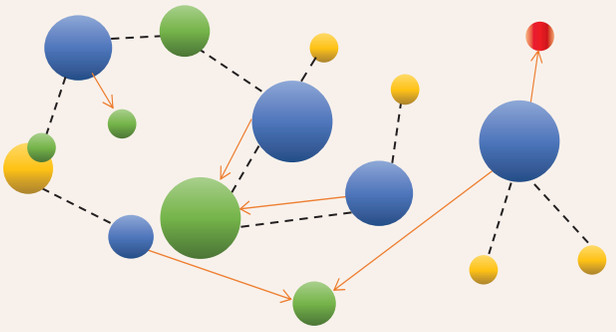
II.34 Standard EMIs and no cost EMIs are the most available lending options on BigTech

Chart II.25: BigTech Penetration in UPI Payments



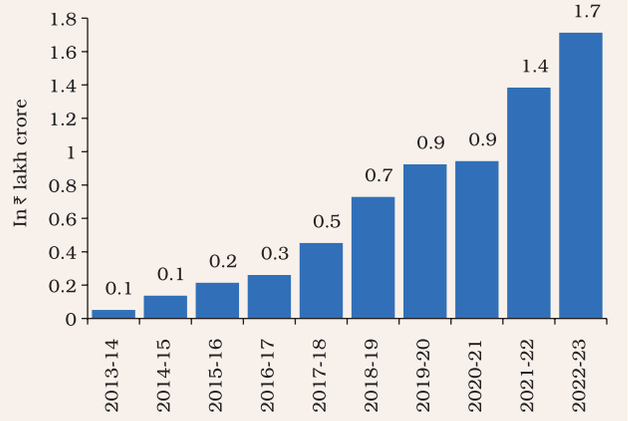
Note: Incumbents include apps by SCBs, Small Finance Banks and Payments Banks. NBFCs/FinTechs include UPI apps operated by companies. Others include *Bharat* Interface for Money (BHIM).
Source: NPCI.

Chart II.26: BigTechs' Collaborations with FIs for BNPL and Co-branded Credit Cards



Note: Blue colour indicates a BigTech, green indicates a PVB, red indicates a PSB and yellow indicates an NBFC. Dotted black line indicates a collaboration for BNPL, while red arrow mark indicates a collaboration for co-branded credit card. Size of the bubble is proportional to the number of collaborations. Overlapping of an NBFC with a bank indicates co-lending model with one of the BigTechs. The same NBFC has an independent contract with another BigTech for BNPL.
Source: RBI staff illustration and websites of BigTechs.

Chart II.27: Revenues of B2C e-Commerce Startups in India

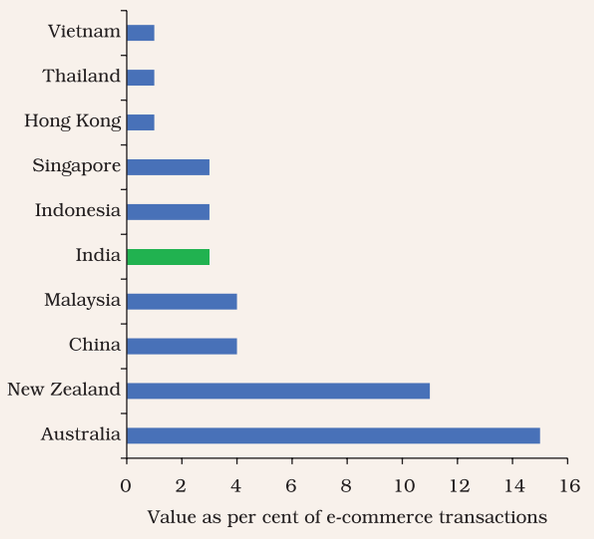


Note: 1) Data on top 50 B2C e-commerce startups in terms of mobile application downloads.
2) In 2022-23, missing data for 11 startups have been linearly extrapolated.
Source: RBI staff estimates and Tracxn Database accessed as on May 10, 2024.

platforms. These EMIs are offered mainly through three channels, *viz.*, co-branded credit cards, through credit and debit cards of banks and through the BNPL.

II.35 Smaller e-commerce startups in India are also offering embedded financial services on their platforms and their business is gaining ground (Chart II.27). These embedded financial services include BNPL, credit cards, and payments. India is among the top five nations in terms of the percentage of BNPL loans in e-commerce transactions (Chart II.28). There are dedicated BNPL applications that provide BNPL services to smaller e-commerce startups in India. These applications had a high average user rating at 4.2, as of June 2024.[10]

Chart II.28: BNPL in e-Commerce – Global Picture



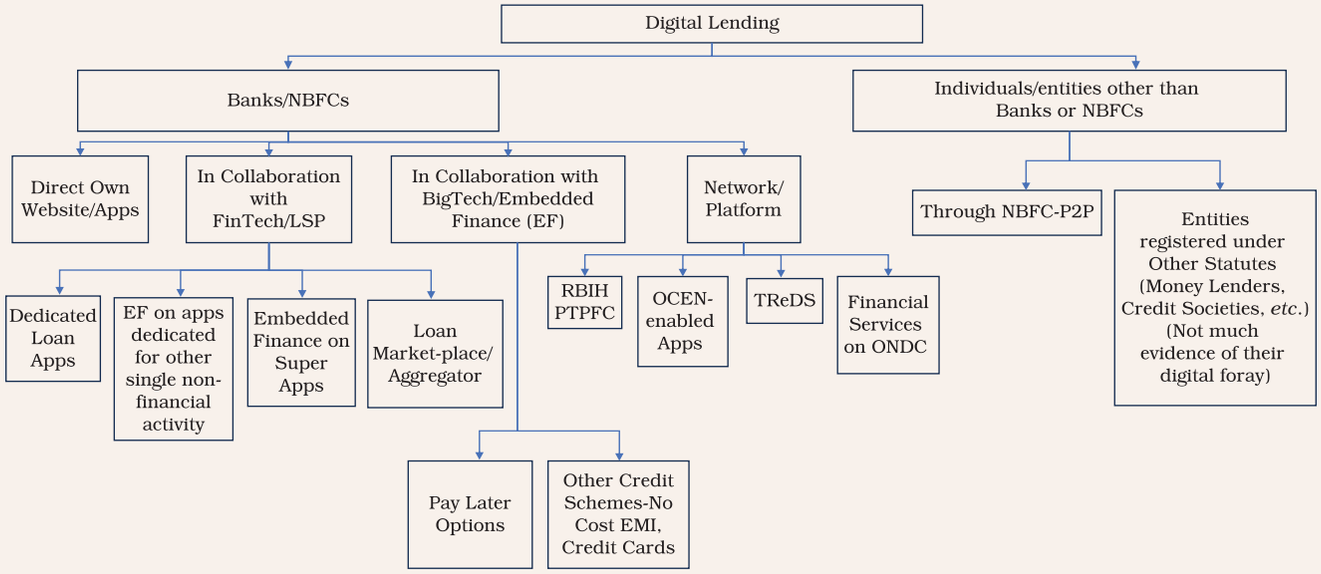
Source: Worldpay Global Payments Report, 2024.

5. Digital Lending

II.36 Digital lending is remote and automated lending process, largely by use of seamless digital technologies for customer acquisition, credit assessment, loan approval, disbursement, recovery, and associated customer service (RBI, 2022a). Three attributes that differentiate digital credit from traditional credit are speed, automation, and remote operation (Chen and Mazer, 2016). As digital lending operates

[10] User ratings of six major dedicated BNPL applications on Google Play store are considered.

Chart II.29: Digital Lending Ecosystem in India



Source: RBI staff illustration.

through an online platform, it is also known as platform-based lending. Banks, NBFCs, as well as individuals and entities other than banks and NBFCs, participate in India's digital lending ecosystem as lenders (Chart II.29). Lenders provide both secured and unsecured loans through these platforms, which are either publicly or privately owned. Loan origination and management services are also integrated in this ecosystem.

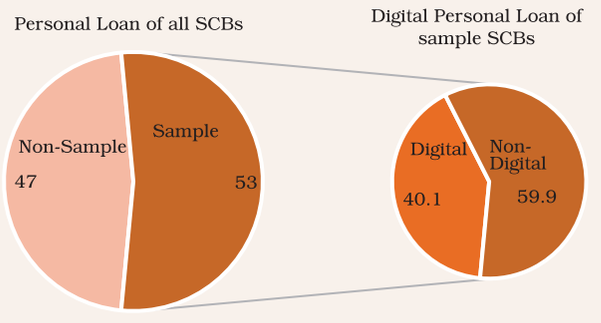
Size of the Digital Lending Market in India

II.37 At end-December, 2020, the share of digital lending was two per cent of the total amount disbursed by surveyed banks, which have an asset size of 75 per cent of the total banking sector (RBI, 2021).

II.38 SCBs are digitalising their retail portfolio, especially personal and MSME loans. Information provided by five SCBs, having 53 per cent share in the personal loan market, indicates that around 40 per cent of the personal loans by them were processed end-to-end digitally in 2022-23 (Chart II.30).

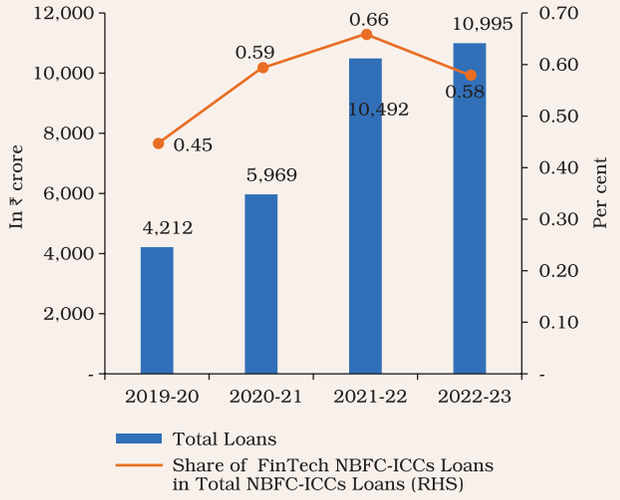
II.39 As of December 2020, surveyed NBFCs (holding 10 per cent share in total NBFCs' asset size) reported that digital lending constituted

Chart II.30: Digital Personal Loans of Select SCBs - 2022-23



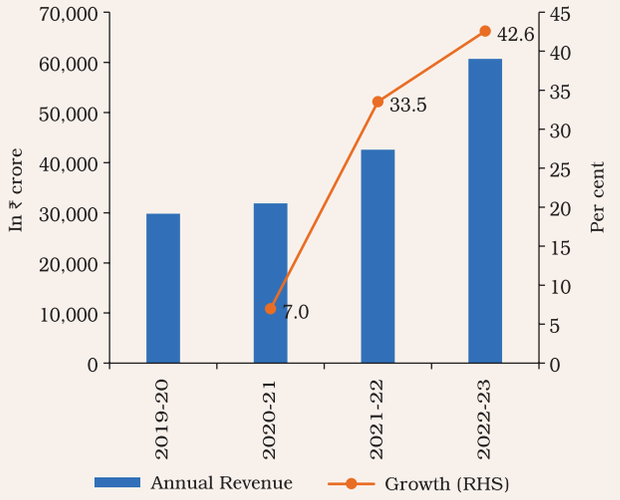
Note: Data pertain to five SCBs accounting for 53 per cent share in the total personal loans by SCBs.
Source: Annual reports of select SCBs and RBI staff estimates.

Chart II.31: Lending by FinTechs Registered as NBFC-ICCs



Note: Data on 51 NBFC-ICCs, accessed on June 12, 2024.
Source: RBI staff estimates and Tracxn.

Chart II.32: Annual Revenue of Select FinTech LSPs



Note: Data based on 40 major FinTech LSPs of upper layer NBFC-ICCs.
Source: RBI staff estimates and Tracxn, accessed as on May 13, 2024.

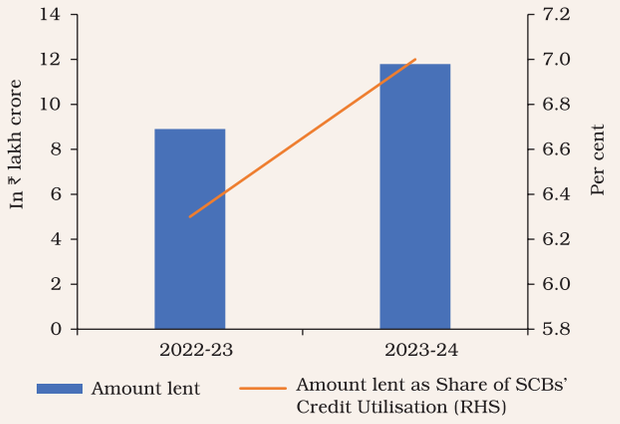
11.4 per cent of their overall lending activities (RBI, 2021). Data for 51 NBFC-ICCs, that are also shown as FinTech on Startup India portal by DPIIT, show that their lending is gaining traction at an increasing rate. The lending share of these NBFC-ICCs, however, constitutes only less than one per cent of the total lending market of NBFC-ICCs (Chart II.31).

II.40 The increasing revenue of FinTech LSPs of upper layer NBFC-ICCs, mainly from operations, in recent years indicates that their scale of activity is experiencing significant growth (Chart II.32).[11]

II.41 Lending through e-commerce platforms including BigTechs is offered *via* credit cards, debit card EMIs and BNPL. Credit extended through credit cards on the e-commerce platforms including BigTechs, encompassing both EMI plans and lumpsum credit, grew by 32.4 per cent (y-o-y) in 2023-24 to ₹11 lakh crore (Chart II.33).[12]

II.42 Crowdfunding through P2P platform, which connects individual lenders with borrowers, to facilitate unsecured loans is another form of digital lending in India (RBI, 2016). There are 26

Chart II.33: Lending through e-Commerce Platforms



Note: Lending through credit cards on e-commerce platforms including BigTechs is depicted in the chart. Data refer to loan disbursements and includes both lumpsum credit card purchases as well as purchases through credit card EMIs.
Source: RBI staff estimates.

[11] Names of the FinTech LSPs of upper layer NBFC-ICCs are collected from their respective websites.

[12] Data on credit extended through debit card EMI plans and BNPL are not available.

P2P NBFCs registered with the Reserve Bank of India as on March 31, 2024 (RBI, 2024b).

Characteristics of Loans through FinTechs

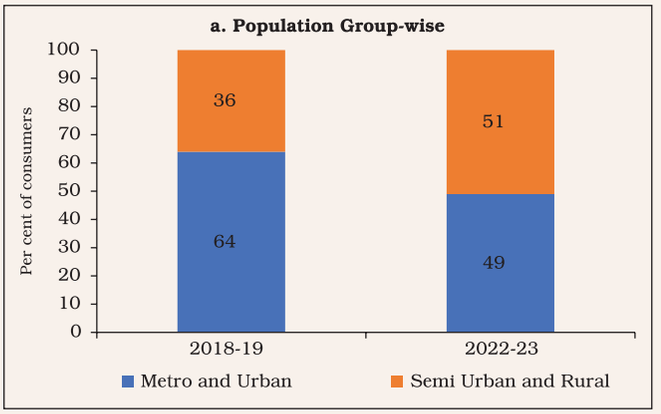
II.43 Lending through FinTechs mainly catered to semi-urban and rural areas in 2022-23 (Chart II.34a). Younger age groups (less than 25 years and 26-30 years) are the major borrower group (59 per cent of FinTechs loans) [Chart II.34b]. Delinquency rates are higher among younger age groups and are broadly similar across regions (Chart II.34c and d).

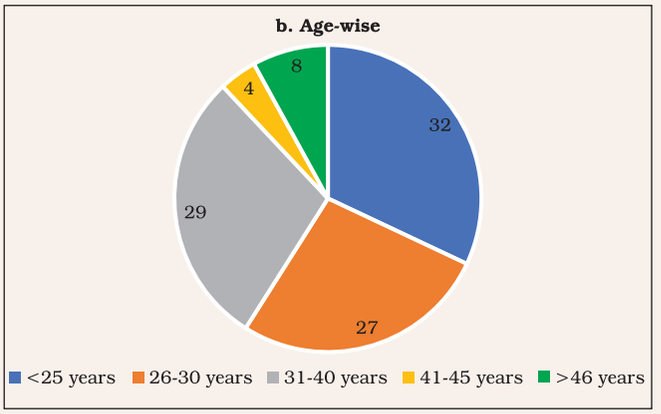
FinTech Personal Loans

II.44 FinTech loan originations mainly include personal loans followed by business and consumer loans (Chart II.35). In India, the personal loan market has seen an accelerated growth phase (Das, 2023b). FinTechs mainly cater to small-value personal loans with 68 per cent of personal loans falling in the category of less than ₹5,000 in 2022-23 (Chart II.36). The average ticket size of personal loans by FinTechs was around ₹11,000 in 2023 (Chart II.37) and these loans typically supplement or smoothen consumption (Agarwal and Chua, 2020).

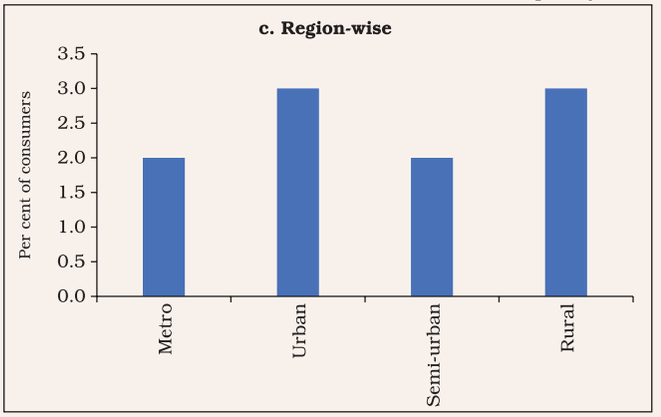
Chart II. 34: Characteristics of Loans using FinTechs

FinTech Loan Origination



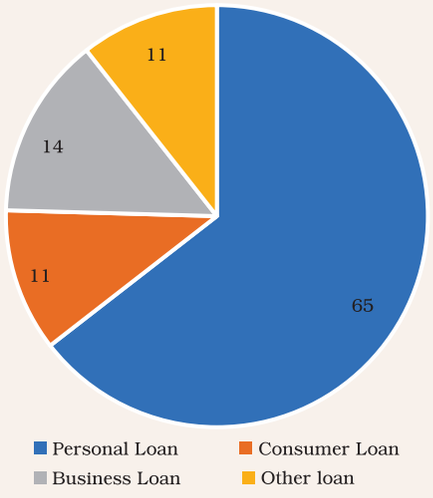


Delinquency Rates in FinTech Loans



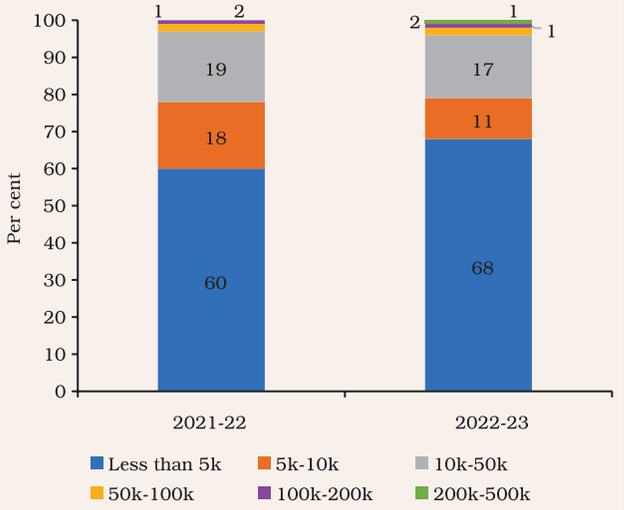
Note: Data pertain to 130 credit institutions (NBFCs).
Source: TransUnion CIBIL, 2023.

Chart II.35: FinTech Loan Origination by Value in 2022-23 (in Per cent)



Note: Data pertain to 130 credit institutions (NBFCs).
Source: TransUnion CIBIL, 2023.

Chart II.36: Distribution of FinTech Personal Loans by Ticket Size



Source: FinTech Personal Loans April 2018 – September 2023, FACE.

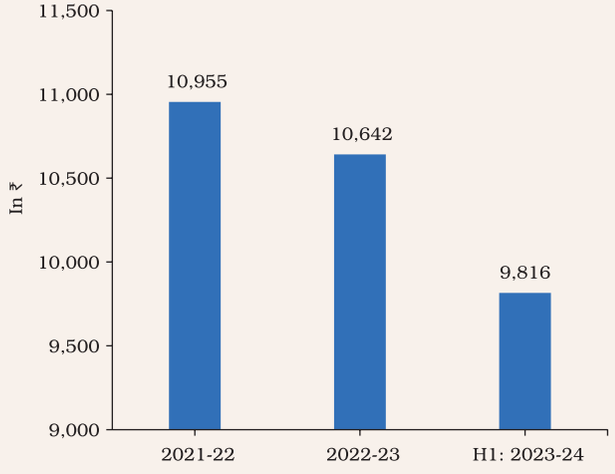
II.45 There exists vast gender-based divide in digital lending. The percentage of female borrowers of FinTech personal loans is around 14 per cent in 2022-23 (Chart II.38).

II.46 By population group, almost 31 per cent of FinTech personal loans in 2022-23 were disbursed in rural areas (Chart II.39).

Characteristics of Consumer Durable Loans through BigTechs

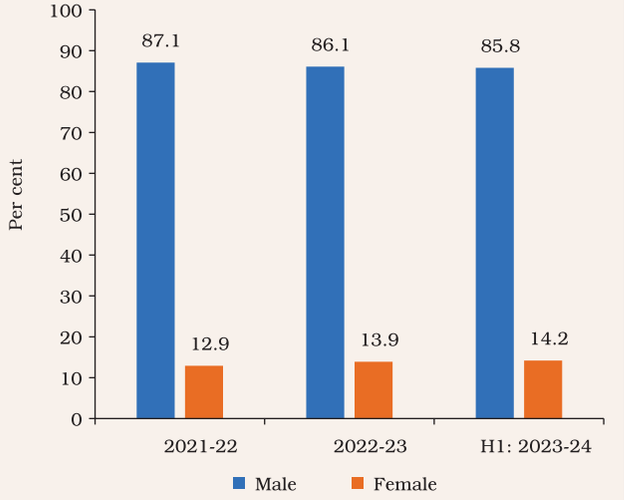
II.47 The credit options for purchasing consumer durables on BigTech platforms include purchases through credit card (without EMI), UPI (credit line and *Rupay* credit card linkage), pay later options, no cost EMI and standard EMI. Out of the total EMI

Chart II.37: FinTech Personal Loans by Average Ticket Size



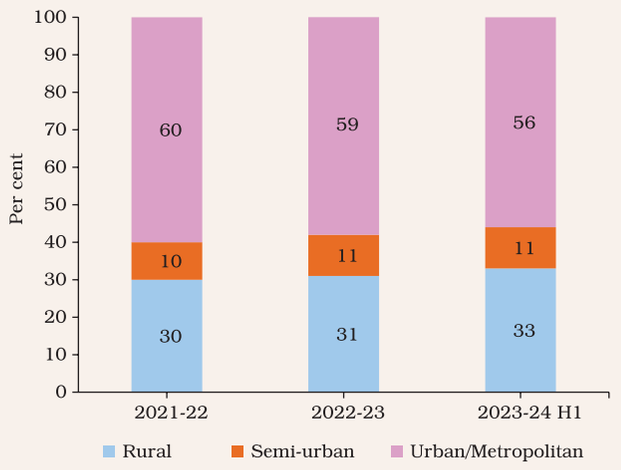
Note: Data pertain to loan disbursal of FinTechs.
Source: FinTech Personal Loans April 2018 – September 2023, FACE.

Chart II.38: FinTech Personal Loans by Gender



Note: Data pertain to loan disbursal of FinTechs.
Source: FinTech Personal Loans April 2018 – September 2023, FACE.

Chart II.39: Share of FinTech Personal Loans by Population group



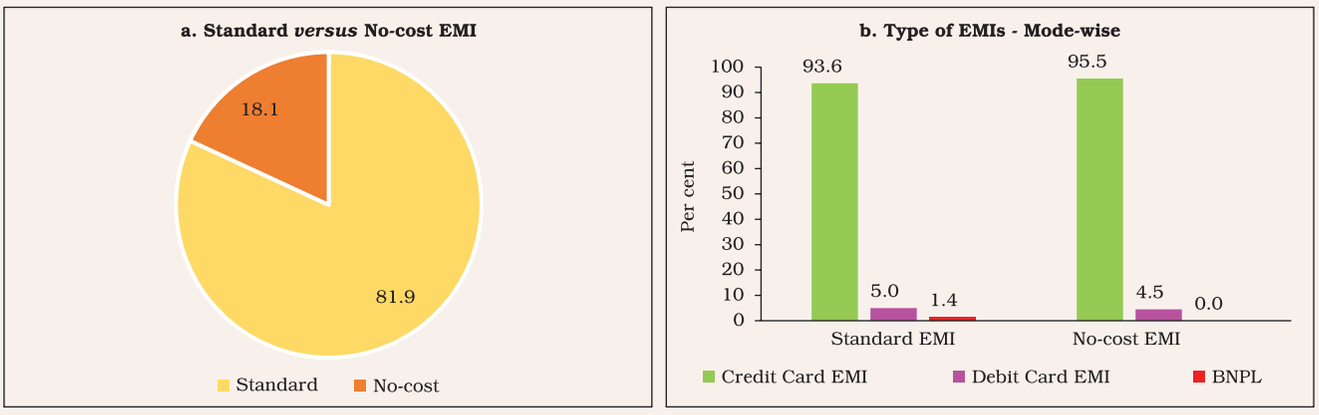
Note: Data pertain to loan disbursal of FinTechs.
Source: FinTech Personal Loans April 2018 – September 2023, FACE.

options available on the sample 150 products[13], around 82 per cent were standard EMIs, the remaining being no-cost EMIs (Chart II.40a). In both no-cost and standard EMIs, the most offered lending channel was credit card (Chart II.40b).

II.48 Under no-cost EMIs, the interest charged by the bank is offered as an upfront discount to the customer by the BigTech platforms. For 32 per cent of the total products sampled, the number of credit card no-cost EMI plans available per product was in the range of 17-108. Notably, debit card no-cost EMIs were not available on 79 per cent of the sample products.

II.49 Standard EMIs charge interest rates on loans offered through the BigTech platform. For 58 per cent of the products analysed, standard EMIs were available for more than 100 credit cards, making this as the most frequently available channel in offering credit through the BigTech platform. For only four per cent of the products analysed, credit card standard EMI was not available. For 20 per cent and 26 per cent of the products, debit card standard EMI and BNPL standard EMI, respectively, were not available.

Chart II.40: Composition of EMI Options on a BigTech Platform



Note: Data pertain to 150 products across 15 product categories.
Source: RBI staff estimates and website of a major BigTech operating in India.

[13] This sub-section is based on a case study, undertaken in July 2024, of 150 individual products randomly selected from varying price ranges across 15 product categories of consumer durables that are sold on a major BigTech platform in India. Consumer durables considered for this analysis are refrigerator, television, smart phone, almirah, sofa, stove, mixer grinder, cot, laptop, and headphone, among others.

II.50 Lending through the BigTech platform is available for durations starting from three months to 24 months. The most offered lending channel, *viz.*, credit card EMI, is available uniformly across all durations. Availabililty of debit card EMI is higher in relatively smaller durations, *viz.*, six and nine months. BNPL allows the customer to avail loans without possessing a debit or credit card. In the sample, BNPL is mostly available in medium durations such as nine and 12 months (Chart II.41a).

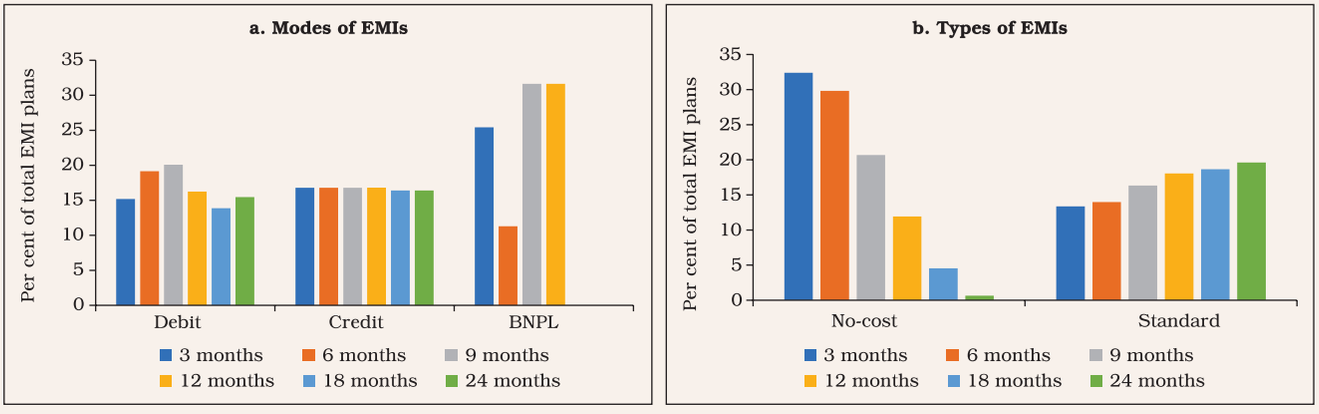
II.51 Availability of no-cost EMIs decreases as the duration of loan increases. In the sample, out of the total no-cost EMIs available, 32 per cent are for three months, 30 per cent are for six months, and 21 per cent are for nine months. Since shorter duration makes the size of EMIs bigger, the benefits of these interest-free loans are restricted to a few who can afford higher EMIs. In contrast, the standard EMIs increase with the duration of the loan, with the highest percentage of standard EMIs available for 24-month plan (Chart II.41b).

II.52 The rate of interest charged on loans offered on the BigTech platform under study vary across lending channels. The most frequently available channel, *viz.*, credit card EMIs, charges the lowest interest rates, and interest rates increase with the duration of loans. The highest interest rate is charged on BNPL loans at 24 per cent across various durations of loans. Notably, around 50 per cent of the total consumer durable loans disbursed by the SCBs are at interest rates below 13 per cent. Banks that offer loans through BigTech platforms also charge processing fees for these loans. Processing fee is applicable even if the loan is a no-cost EMI loan. An 18 per cent Goods and Services Tax (GST) is also applicable on the interest charged on these loans, which is revealed on the EMI details page of the BigTech platform. Depending on the chosen EMI plan, this varies from 0.4 per cent to 3.2 per cent of the product price in the sample and GST amount chargeable goes up with the duration of the loans.

Regulatory Innovations in Digital Lending

II.53 The initiatives of the Government of India and the Reserve Bank have been playing an important role in inculcating trust in platform-based lending by putting in place appropriate

Chart II.41: Availability of EMIs across Durations



Note: Data pertain to 150 products across 15 product categories.
Source: RBI staff estimates and website of a major BigTech operating in India.

safeguards. The major initiatives are discussed below.

Account Aggregators

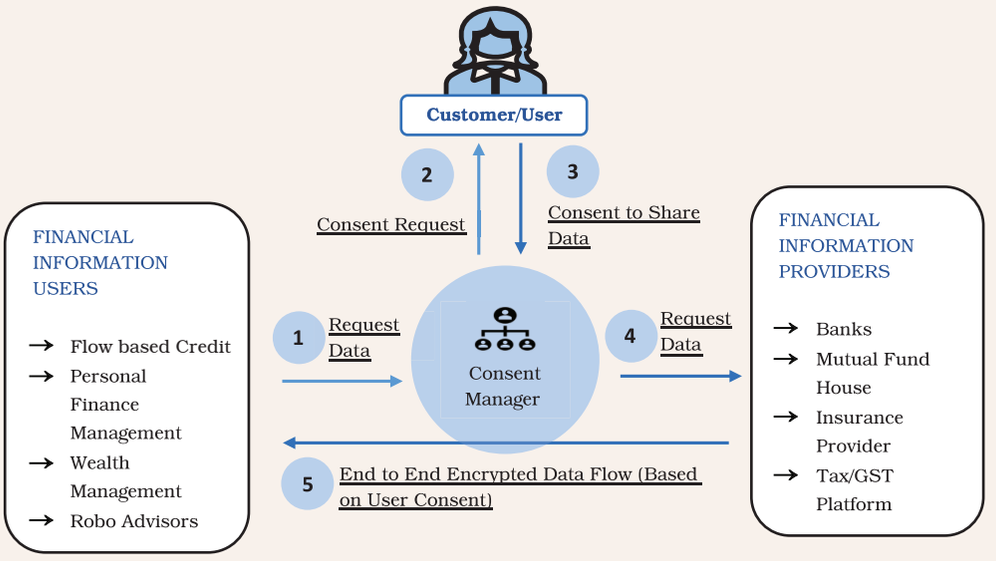
II.54 Account Aggregators (AAs) provide a technology-enabled interface based on standardised application programming interfaces (APIs) for managing customer consent and authentication, and sharing select financial information. AAs address the issue of non-standardised bank specific APIs, that are difficult for third-party applications to integrate and thus, help break down data silos in the financial sector. Financial information of consumers, with their consent, from one or more accounts held with banks, NBFCs, mutual funds, insurance companies, *etc.*, known as Financial Information Providers (FIPs) is digitally shared with other REs in the financial sector, called Financial Information Users (FIUs), who provide services such as loans or insurance to consumers (Chart II.42).

II.55 The Reserve Bank has introduced enabling regulations for NBFC-AAs in 2016. The NBFC-AA ecosystem is gaining momentum in terms of the number of accounts linked and requests fulfilled (Chart II.43a). At present, the AA system has 256 live FIUs and 71 live FIPs under the Reserve Bank. The number of successful data shares[14] stand close to 40 million. The lending through AAs is on the rise (Chart II.43b). Many RRBs are also coming live on AAs which augurs well for the flow of bank credit to the rural economy.

Open Credit Enablement Network (OCEN)

II.56 The Government of India has launched the OCEN with the goal of democratising credit and extending financial inclusion to the last mile. The OCEN is a framework of APIs which facilitates easy interaction and codified flow of credit among lenders, borrowers (especially

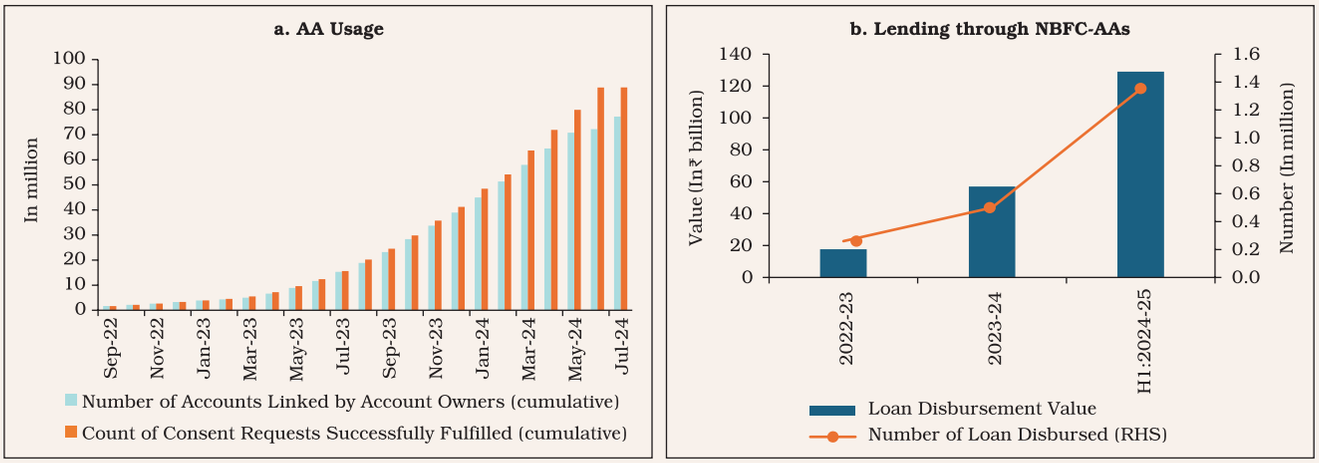
Chart II.42: Flow of Data under AA



Source: DEPA, NITI *Aayog* and RBI staff illustration.

[14] Successful data shares refer to movement of the requested data from FIPs to FIUs that has actually taken place.

Chart II.43: Progress of NBFC-AAs



Source: *Sahamati.*

small borrowers), loan agents (LAs)[15] and technology service providers (TSPs)[16] under a common set of standards. The OCEN helps LAs to effectively provide embedded finance to their customers. Borrowers get access to competing customised credit products on their preferred applications. Lenders gain from nearly zero customer acquisition costs, opportunities to serve additional customers and ease of monitoring the activities of borrowers through LAs. The OCEN helps lenders (banks and NBFCs), LAs and TSPs to create innovative financial products tailored to the needs of a range of customers and small businesses. It aims to reduce the cost of acquisition, underwriting, processing, disbursement and regulatory compliance related to loans.

II.57 Owing to the policy focus on MSME credit, several cashflow based lending platforms have been developed on the OCEN such as the GeM *Sahay* and GST *Sahay* apps. The GeM *Sahay* app provides unsecured short-term financing to sellers on the Government e-Marketplace (GeM).[17] There are 1.52 lakh GeM *Sahay* app installs on the Google Play Store[18]. As at end-May 2024, four banks and seven NBFCs were banking partners on this platform. GeM *Sahay* 1.0 has so far disbursed loans around ₹23 crore (FICCI, 2024). GST *Sahay* is an application developed under the Reserve Bank's Regulatory Sandbox (RS) that leverages the OCEN and AA framework for providing on-tap, real-time, contactless, cash-flow based financing to micro enterprises.

Trade Receivables Discounting System (TReDS)

II.58 TReDS, facilitated by the Reserve Bank, addresses the working capital and cash flow challenges faced by MSMEs arising from delayed payments. TReDS is a financing framework, harnessing technology to discount

[15] Any e-commerce company with a pre-existing user base can be a LA and act as a bridge between lenders and borrowers (users of that e-commerce company).

[16] TSPs are FinTech companies that onboard lenders, borrowers, and platforms onto the OCEN.

[17] It provides end-to-end digital loans up to a maximum of 80 per cent of loan-to-value (LTV) against GeM orders.

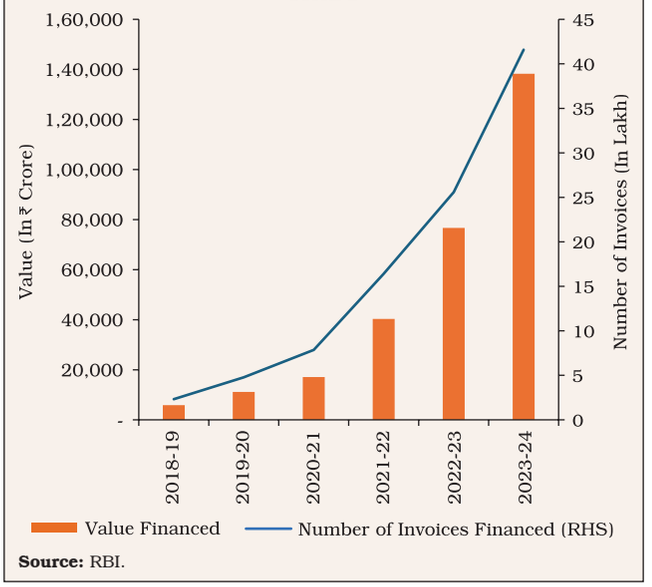
[18] The number of installs given is as on April 22, 2024.

bills and invoices. Currently, four entities are operational as TReDS platforms, with steady growth in transaction volume and value (Chart II.44).

Public Tech Platform for Frictionless Credit

II.59 In a major step towards digital financial inclusion in India, the Reserve Bank conceptualised the PTPFC. The Platform has been developed by the Reserve Bank Innovation Hub (RBIH). It leverages open APIs and standards to streamline availability of data[19] in a 'plug and play' model to enable disbursal of credit in a frictionless manner. The reduced cost of operations for lenders due to the ease of availability of data may help them offer credit at affordable rates. The PTPFC pilot, launched in 2023, focused on products such as fully digital *Kisan* Credit Card (KCC) loans up to ₹1.6 lakh per borrower, dairy loans, MSME loans, personal loans, vehicle loans, tractor loans, digital gold loans, and home loans through participating banks. Given the end-to-end digital processing, PTPFC has demonstrably reduced the turnaround time of KCC loans from a few weeks to less than an hour (RBIH, 2024).

Chart II.44: Progress in MSME Financing through TReDS



Source: RBI.

Open Network for Digital Commerce (ONDC)

II.60 The ONDC has been launched by DPIIT under the Ministry of Commerce and Industry in 2021. It aims to democratise e-commerce by building an open, interoperable network, enabling buyers and sellers to transact, without the need to be present on the same platform. The traditional model of e-commerce is constrained by dependence on specific platforms and technologies, leading to concentration risk for both buyers and sellers. Decentralisation of operations, open standards, interoperability and unbundling of e-commerce value chains on the ONDC may lead to greater competition among platforms/applications, potentially lowering costs of engaging in digital commerce.

II.61 The ONDC has onboarded over six lakh sellers/service providers from more than 607 cities[20] (ONDC, 2024a). The daily peak order volume on the ONDC platform has increased from 53,000 in October 2023 to 2,89,000 in June 2024 (ONDC, 2024b). In 2023, e-commerce constituted eight per cent of the total retail market value, indicating huge potential for the ONDC to grow (BCG and RAI, 2024). The ONDC has forayed into sectors, such as food, grocery, fashion, travel, electronics, and financial

[19] The information available includes *Aadhaar*, e-KYC, land records from the state governments (*viz.,* Tamil Nadu, Madhya Pradesh, Andhra Pradesh, Odisha, Uttar Pradesh, and Maharashtra), account aggregation by account aggregators, Permanent Account Number (PAN) validation, GST-related information, *Aadhaar* e-signing, milk-pouring data from select dairy co-operatives, and house/property search data, among others.

[20] Data accessed as on July 23, 2024.

services. Within financial services, the ONDC is concentrating on credit, insurance, investments, and gift cards. Within the credit domain, the ONDC is focusing on personal loans and GST-based loans for individuals and sole proprietors, respectively (ONDC, 2024c).

6. Financial Innovations: Implications for the Banking Sector

II.62 Financial innovations have implications for the banking sector spanning various operational aspects. According to a special survey of banks conducted in March 2024, more than 90 per cent of the respondent banks reported that their customer acquisition and transaction costs have decreased after adopting digital technologies. For 88 per cent of banks, employee costs have come down and around 76 per cent of banks reported lower premises-related costs due to the adoption of digital technologies (Chapter V).

II.63 Digitalisation enhances customer acquisition by offering convenient onboarding processes and personalised digital marketing strategies, expanding reach and engagement with different sections of consumers. Technological innovation can improve customer experience, lower costs, increase product diversity, and increase access to financial services (Elekdag *et al.,* 2024). All the banks surveyed indicated improvement in their customer acquisition and retention due to the adoption of digital technologies (Chapter V).

II.64 Digitalisation has implications for a competitive banking environment owing to new entrants like FinTechs and BigTechs (Basel Committee on Banking Supervision 2018; Dell'Arricia, 1998). Further, a competitive environment has implications for banks' market power and price discovery process (Cuadros-Solas *et al*., 2024; Jia and Liu, 2024). In the Indian context, an empirical exercise indicates that digitalisation (proxied by the volume of digital payments) is associated with a compression of banks' net interest margin (NIM)[21].

Financial Innovation and Banks' Risk Taking

II.65 Digitalisation can impact risk taking by banks in both directions. On the one hand, it can improve the risk diversification capabilities of banks through improvement in operational efficiency, risk management capabilities and better monitoring and screening of debtors (Chen *et al.,* 2023; Yang and Masron, 2024; Li *et al*., 2022). By providing more data for analysis, digital transformation helps financial institutions better identify, measure, and manage risks in real-time and take timely measures to deal with them (Yang and Masron, 2024). Reduced reliance on physical interactions with customers decreases the associated operational risks and the likelihood of human errors (Bhatia*,* 2022). On the other hand, while better and real-time monitoring of risks may foster an environment of relatively low macroeconomic risk, this may result

[21] The fixed effect panel data model using data for 31 banks for the period Q4:2014-15 – Q4:2022-23 yielded the following estimated regression:
NIM = 3.487*** – 0.018(Digitalisation(t-4)) ** - 0.081(Relative Bank size) + 0.082(CRAR)*** – 0.007(Liquid asset ratio) - 0.021(GNPA ratio)** – 0.013(cost-income ratio)*** + 0.001(GDP growth) + 0.016(Inflation) + 0.094 (COVID Dummy)* + 0.349(Bank Merger Dummy)** – 0.083 Asset Quality Review Dummy
***, ** and * indicate significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

Source : RBI staff estimates.

in an increased risk appetite of banks (Kero, 2013). Digital transformation may also increase operational risks due to excessive reliance on information and communication technology, financial crime risks (including data breaches), and privacy concerns.

II.66 Digitalisation may ameliorate certain types of risks, while exacerbating others. FinTech can increase credit and liquidity risks but may reduce insolvency risk (Wu *et al.,* 2023). The effect of FinTechs on the stability of financial institutions is market specific (Fung *et al.*, 2020). Although a stronger FinTech presence is linked to increased risk-taking by financial institutions, the presence of robust domestic institutional framework may encourage financial institutions to reduce their risk levels (Elekdag *et al.*, 2024). In the Indian context, adoption of digital technologies by banks appears to drive down risk taken by banks (Box II.2).

Financial Innovations and Impact on Liquidity

II.67 Liquidity-enhancing innovations are expected to augment stability in financial markets (O'Hara, 2004). High transaction costs, shallow markets, slow order execution, and operational risks impede liquidity in financial markets. Enhanced liquidity facilitates more effective transmission of monetary policy, enables efficient crisis management and makes financial assets more attractive (Sarr and Lybek, 2002). Historically, advancements in technology and financial innovation[22] have catalysed structural transformations within financial markets, in the process, affecting liquidity in the market (Bervas, 2008). Digital technologies expand the reach of financial markets, remove market segmentation, broaden participation, widen the set of financial instruments, and ensure fair conduct by market participants (Das, 2024). Advancements in payment and settlement systems and significant improvements in the market infrastructure have taken place, encompassing state-of-the-art primary issuance process for government securities, an efficient and completely dematerialised depository system within the central bank, electronic trading platforms, trade reporting and central counterparty settlement (Das, 2020b). Digital payment and settlement systems enhance market liquidity (Box II.3).

7. Regulatory Concerns and Policy Initiatives

II.68 Digitalisation in finance can contribute significantly to the spread and pace of financial deepening in emerging and developing economies. Such innovations cannot, however, be allowed to disrupt the financial system (Sankar, 2022). The financial stability can be safeguarded if the relationship between banks and FinTechs is appropriately balanced. Not aligning the regulation of non-bank FinTechs to that of banks offering similar services may, however, create inefficiencies, amplify risks of regulatory arbitrage, and create an uneven playing field. Notwithstanding these challenges, the imperative to regulate FinTechs remains. Taking into account these diverse perspectives, the Reserve Bank's regulation is premised on three principles – encouragement of innovation, assimilation of innovation in the financial system in a non-disruptive manner and customer protection (Sankar, 2022). The approach to regulation needs to be balanced, nuanced and reasonably anticipatory with an oversight framework

[22] Such as securitisation, introduction of new products including options, and exchange traded funds.

Box II.2
Bank Risk in the Digital Age

The impact of digital adoption on risk-taking by banks is examined for the period 2015-2023. The extent of digital adoption by 17 banks is captured through a survey conducted in 2024 by the Reserve Bank. The financial innovations that are considered for capturing digital adoption are internet banking, mobile banking, online account opening, digital KYC, investing in mutual funds, card-less cash withdrawals, payment gateways, digital lending, payment aggregator services, chatbots, online public provident fund, prepaid wallets, open banking, neo-banking, BNPL and IoT-based applications. The digital adoption variable captures "percentage of financial innovations adopted by a particular bank out of the total innovations considered". Since the variable is time-invariant, Least Square Dummy Variable specification is used to estimate the model (Baltagi, 2021).

Bank risk or financial stability risk is measured through z score defined as $z = (k+\mu)/\sigma(\mu)$, where k is equity capital plus reserves as a per cent of total assets, μ is the return on assets (RoA), and $\sigma(\mu)$ is the standard deviation of RoA for a rolling period of five years (Lepetit and Strobel, 2013). A higher z-score, therefore, implies a lower financial stability risk.

The estimation is done after controlling for relevant macro-economic, bank-specific and policy variables. The empirical estimates suggest that digital adoption is associated with lower risk-taking by banks in India (Table 1).

Table 1: Digital Adoption and Risk Taking by Banks – Empirical Estimates

Independent Variables	Dependent Variable: Z-score
Adoption of Digital Technologies	0.94*** (0.31)
Pricing Power of Banks	31.87*** (7.98)
Age	-29.48*** (10.07)
Inflation	-1.78 (1.80)
Economic Growth	2.92*** (1.11)
Ratio of Priority Sector Advances to Total Advances	-1.77*** (0.51)
Credit to Deposit Ratio	-0.92*** (0.32)
Availability of Retail Funds	0.72 (1.60)
Dependence on Long-term Loans	0.67** (0.32)
Diversification of Income	176.27** (75.2)
Net Forex Assets	5.59 (3.65)
Bank Merger Dummy	9.01 (6.15)
Public Sector Bank Dummy	2525.16*** (883.65)
COVID Dummy	-7.36 (7.30)
Asset Quality Review Dummy	-23.82** (10.60)
Constant	-5467.88*** (2091.60)
Observations	246
R-squared	0.51
Bank Fixed Effects	Yes

Note: 1. The 'Bank Merger Dummy' is defined as 1 for the year in which a bank merged with the current bank and the subsequent years, and 0 otherwise.
2. The 'AQR Dummy', representing the Asset Quality Review initiated in the financial year 2016, was set to 1 beginning from 2016 and 0 otherwise.
3. The ratio of interest income to non-interest income is used as proxy for diversification of income.
4. Bank-specific fixed effects are accounted for using cross-section dummies.
5. ***, **, and * indicate significance at 1 per cent, 5 per cent, and 10 per cent levels, respectively. Robust standard errors are provided in parentheses.
6. Net Interest Margin is used as proxy for pricing power of banks.

Source: RBI staff estimates.

References:

Baltagi, B. (2021). Econometric Analysis of Panel Data. Sixth Edition. *Springer Texts in Business and Economics.*

Lepetit, L., and Strobel, F., (2013). Bank Insolvency Risk and Time-varying Z-score Measures. *Journal of International Financial Markets, Institutions and Money, 25*, 73–87.

Box II.3
Financial Innovations and Financial Market Liquidity

Digitalisation-enabled advances in payments and settlement systems and improvements in the market infrastructure can boost liquidity of financial markets. To examine these dynamics in the Indian context, Auto-Regressive Distributed Lag (ARDL) models for select financial market segments were estimated using monthly data from January 2009 to December 2023. Although no single metric encompasses all the aspects of liquidity, stock market turnover and average daily turnover (in USD) are taken as measures of liquidity in the equity and forex markets, respectively (Sarr and Lybek, 2002). The volume of retail digital transactions is used as a proxy for digitalisation-enabled financial innovation. The regression results indicate that higher digitalisation is associated with increased liquidity in the equity and foreign exchange markets (Table 1).

Table 1: Financial Innovations and Market Liquidity - ARDL Estimates

I. Equity: Log (Stock Turnover)		**II. Foreign Exchange**: Log (Average Daily Turnover)	
Model Type:	**ARDL (2,2,0,0,0,1)**	**Model Type:**	**ARDL (1,0,0,0,1,0,0)**
I. Long run			
Digital Transactions #	0.25*** (0.03)	Digital Transactions #	0.15*** (0.05)
Index of Industrial Production (IIP) #	0.74*** (0.17)	IIP #	0.66* (0.39)
Inflation	-0.02** (0.008)	Trade #	0.23* (0.13)
Foreign Portfolio Investments (FPI; in INR trillion)	0.28** (0.12)	Exchange Rate #	-0.42 (0.55)
		Forward Premia (6 months)	0.05*** (0.01)
		FPI	-0.01 (0.12)
Constant	7.54*** (0.68)	Constant	5.41** (2.26)
II. Short Run			
Covid Stringency	0.004*** (0.001)	Covid Stringency	-0.001 (0.001)
		Taper Tantrum Dummy	-0.09 (0.06)
ECM Coefficient	-0.54*** (0.07)	ECM Coefficient	-0.54*** (0.06)

Note: 1. ***, **, * indicate significance at 1, 5 and 10 per cent levels, respectively.
2. Figures in parentheses are heteroskedasticity and autocorrelation consistent standard errors.
3. # Log values are taken.
Source: RBI staff estimates.

Reference:

Sarr, A., and Lybek, T. (2002), Measuring Liquidity in Financial Markets. IMF Working Paper No. WP/02/232.

that should be activity-based, risk-based, scale-based, and phased-in (RBI, 2024a). The recent interventions in this regard include regulation of digital lending applications, measures to address business conduct practices, such as dark patterns and the framework for self-regulation. Other initiatives to promote responsible financial innovations

include RS, hackathons, and proof of concept (PoC) for Distributed Ledger Technology (DLT) applications, and adoption of SupTech.

Regulation of Digital Lending

II.69 The boom in digital lending has raised several business conduct issues primarily related to unbridled engagement of third parties, mis-selling, breach of data privacy, charging of exorbitant interest rates, and unethical recovery practices. While there is evidence regarding the positive impact of digital credit on the financial well-being of individuals during distress (Suri *et al*., 2023), it can also result in opposite effects owing to high interest rates and poor information regarding loan conditions (Brailovskaya *et al.,* 2021). Over-reliance on technology for loan arbitration may be harmful, as AI-driven decision-making models can raise concerns associated with algorithmic bias and financial exclusion.

II.70 To address digital lending-related concerns, the Reserve Bank put in place the Guidelines on Digital Lending in September 2022 that provide detailed procedures pertaining to customer protection and conduct requirements, technology and data requirements and regulatory framework. According to these guidelines, REs' outsourcing agreements with LSPs or Digital Lending Applications (DLAs), do not lessen the REs' obligations and they must continue to adhere to the current outsourcing guidelines. Further, the REs must ensure that the LSPs they work with as well as the DLAs (whether of the RE or the LSP the RE works with) follow the guidelines. Under the guidelines dated June 08, 2023, the RE must adhere to the cap on Default Loss Guarantee (DLG)[23] cover not exceeding five per cent of the total loan portfolio, disclosure and capital requirements, specified forms of DLG, due diligence and other requirements with respect to the DLG provider.

The Insidious Nature of Dark Patterns

II.71 Dark patterns refer to deceptive practices or design patterns in user interface or user experience/interactions that are designed to mislead users to do something they originally did not intend to do, by subverting or impairing consumer autonomy, decision making or choice (CCPA, 2023). Examples include compelling users to perform unrelated actions to proceed with intended purchases, adding items to the cart without user consent, and creating a false sense of urgency to mislead users into making quick purchases, among others (Chapter I).

II.72 In India, the Central Consumer Protection Authority (CCPA) has introduced the 'Guidelines for Prevention and Regulation of Dark Patterns, 2023', applicable to advertisers, sellers and platforms. Additionally, the Digital Personal Data Protection (DPDP) Act, 2023, addresses dark patterns by requiring companies to imbibe privacy by design while collecting user data and to ensure informed consent for data processing activities. The Insurance Regulatory and Development Authority of India (IRDAI) has prohibited travel portals in India from using pre-checked boxes for selling travel insurance. The Reserve Bank has mandated card issuers to obtain explicit consent

[23] A DLG is a contractual arrangement in digital lending where an entity, such as an LSP, guarantees to compensate an RE for losses resulting from defaults on a specified percentage of the loan portfolio. LSP is an entity that offers lending services to borrowers, typically in the form of providing loans or credit facilities.

from cardholders when offering insurance through tie-ups with insurance companies (RBI, 2022b). Card issuers are mandated to provide customers the option to request closure of credit card through multiple and prominently visible channels. Unsolicited loans and enhanced credit limits shall not be offered to the credit cardholders without explicit consent. To increase transparency in digital lending, the Reserve Bank's Digital Lending Guidelines mandate that REs shall provide a Key Fact Statement (KFS) to the borrower before the execution of the contract in a standardised format for all digital lending products. All-inclusive cost in the form of Annual Percentage Rate (APR) shall be clearly communicated to the customer in the KFS. This measure can help provide the customer a clear picture of the loan product and mitigate concerns around the presence of dark patterns in any loan application.

Framework for Self-Regulation

II.73 Self-regulatory organisations (SROs) could play a pivotal role in the FinTech industry by promoting responsible practices and maintaining ethical standards (Sankar, 2023). SRO is an industry-led entity responsible for establishing and enforcing regulatory standards, promoting ethical conduct, ensuring market integrity, resolving disputes, and fostering transparency and accountability among its members. The Reserve Bank has come up with the Framework for Recognising SROs for FinTech Sector (SRO-FT framework). The Framework contains the characteristics of an SRO for the FinTech sector, and includes, *inter alia*, broad functions, governance standards, eligibility criteria and expectations for grant of recognition as an SRO-FT (RBI, 2024a).

Regulatory Sandbox

II.74 The 'Enabling Framework for Regulatory Sandbox' was announced in 2019 for facilitating responsible innovation in financial services, promoting efficiency, and benefiting consumers. Under RS, eligible domestic entities can live test their innovative products or services in a controlled environment with or without specified regulatory relaxations for the limited purpose of testing. Through this learning-by-doing approach, regulators gather empirical evidence on the benefits and risks of emerging technologies and their implications, enabling them to take a holistic view on the regulatory changes or new regulations that may be needed to support useful innovation, while containing the attendant risks. So far, four theme-based cohorts on 'Retail payments', 'Cross-border payments', 'MSME lending' and 'Prevention and mitigation of financial frauds' have been completed. Some of the products that exited successfully from these cohorts have been deployed in the market (Table II.1). A theme-neutral fifth cohort was open for application in 2023 and the shortlisted entities will commence testing in due course.

II.75 To facilitate testing of hybrid products falling within the regulatory ambit of more than one financial regulator, *viz*., the Reserve Bank, Securities and Exchange Board of India (SEBI), IRDAI, International Financial Services Centres Authority and Pension Fund Regulatory and Development Authority, a Standard Operating Procedure for Interoperable Regulatory Sandbox has been prepared by the Inter-Regulatory Technical Group on FinTech (IRTG on FinTech) constituted under the Financial Stability and

Table II.1: Products that Exited the Regulatory Sandbox and Adopted Commercially

1	'Framework for facilitating Small Value Digital Payments in Offline Mode' - 'UPI123Pay' aimed at enhancing digital financial inclusion by enabling over 40 crore feature phone users to access the benefits of UPI in a safe and secure manner.
2	'GST *Sahay*' - offering MSME loans *via* Invoice Discounting, ensuring quick cash flow and growth with a hassle-free digital process, digital cash flow-based credit underwriting process.
3	Plug and play platform for cash flow-based financing to small MSME sellers on TReDS;
4	Real-time access to working capital through digital credit lines to MSMEs
5	Application for invoice-based finance to MSMEs and end-to-end digital straight-through process (STP) journey for MSME Mudra Loan.

Source: RBI staff.

Development Council Sub-Committee (FSDC-SC). This framework has been operational since October 2022.

HaRBInger Hackathon

II.76 The Reserve Bank launched a global hackathon called '*HaRBInger* – Innovation for Transformation', open to both domestic and global FinTech companies, programmers, and students. The hackathon runs in four phases, *viz*., Screening of entries (Phase I), Shortlisting of entries for Solution Development (Phase II), Solution Development (Phase III) and Evaluation and Selection of winners (Phase IV). The first edition was launched in 2021 with the theme 'Smarter Digital Payments', and the second edition was launched in 2023 with the theme 'Inclusive Digital Services'. In June 2024, the third global hackathon was launched with two themes of 'Zero Financial Frauds' and 'Being *Divyang* Friendly'.

PoC Exercise in DLT Networks by RBIH

II.77 RBIH has successfully conducted a PoC exercise in DLT networks by taking 'inland letter of credit' as a use case. Eleven banks, three industry partners and two FinTech startups participated in the PoC. The tested DLT-based letter of credit has the potential to fix issues in the current paper-based process, such as slow speed, labour intensiveness, susceptibility to frauds, and dependence on outdated IT systems (RBIH, 2024).

G20 Tech Sprints

II.78 Given growing global economic integration, cross-border payments are a priority area for digital innovation. Under India's G20 Presidency, the Reserve Bank and the BIS Innovation Hub jointly conducted the G20 Tech Sprint, seeking innovative solutions to problem statements around cross-border payments from innovators, entrepreneurs, startups, developers, and other experts (BIS, 2023; Apix, 2023).[24]

Adoption of SupTech

II.79 Supervisory technology (Suptech) refers to the utilisation of innovative technology by regulatory bodies to enhance supervision (Broeders and Prenio, 2018). This technology increases access to more granular, diverse, timely and trustworthy data to improve operational efficiency and generate previously unattainable insights using data analytics, artificial intelligence, and machine learning (Cambridge Centre for Alternative Finance, 2022).

[24] This is the fourth edition of the G20 tech sprint. The three problem statements under this tech sprint are "AML/CFT/Sanctions technology solutions to reduce illicit finance risk", "FX and liquidity technology solutions to enable settlement in EMDE currencies" and "Technology solutions for multilateral cross-border CBDC platforms".

II.80 The Reserve Bank has been taking various measures to strengthen supervision, including adopting the latest data and analytical tools and leveraging technology for implementing more efficient and automated work processes. The Advanced Supervisory Analytics Group (ASAG) has been set up in the Department of Supervision to leverage ML models for social media analytics, KYC compliances and for gauging governance effectiveness. The establishment of an advanced off-site supervisory monitoring system—*DAKSH*—is helping to digitalise supervisory processes. An Integrated Compliance Management and Tracking System (ICMTS) and a Centralised Information Management System (CIMS) are also being implemented for seamless reporting by supervised entities for enhancing data management and data analytics capabilities, respectively (Patra, 2024). The RBI has also utilised techniques like phishing simulation and cyber reconnaissance exercises to push for enhanced IT and cyber security governance processes in banks and other supervised entities (Das, 2023a). The Platform for Regulatory Application, Validation, and Authorisation (PRAVAAH) was launched to enhance the efficiency of various processes related to the granting of regulatory approvals and clearances by the Reserve Bank.

8. Concluding Observations

II.81 Technology adoption and innovations by banks and NBFCs have increased over the last decade, especially post-pandemic. These developments have enabled financial institutions to provide a diverse bouquet of services to customers. FinTech has shown the way for providing contact-less, paper-less, and cash-less banking services in an efficient and scalable manner. FinTech firms have emerged as significant partners to banks and NBFCs, enabling them to leverage the latest technologies. Payment FinTechs feature prominently in partnerships with financial institutions, followed by lending and banking technology FinTechs. Concurrently, collaborations with BigTechs and B2C e-commerce startups have transformed the lending landscape. The digital lending models have contributed noticeably to the small ticket personal loan segment, while increasingly addressing the credit requirements of underserved segments of the society.

II.82 Policy innovations including AAs, TReDS, OCEN, PTPFC and ONDC are set to revolutionise the financial sector by enabling tailored and multifaceted financial products, including cash flow-based lending and invoice financing. Digitalisation has improved operating efficiency of Indian banks. Improved real-time monitoring, and diversification into new markets and products, facilitated by digitalisation, is mitigating risks in the banking sector. Digitalisation also has the potential to make financial markets more integrated and liquid.

II.83 Several regulatory complexities arise in the wake of emerging financial activities, given the absence of definitive regulatory frameworks governing the technologies involved. Issues pertaining to business conduct, including dark patterns and breach of data privacy, have warranted regulatory attention. Self-regulatory organisations can effectively promote responsible practices and ethical standards within the industry. Looking ahead, fostering a regulatory environment that encourages responsible innovation while prioritising financial stability and customer protection remains paramount.

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III DIGITALISATION AND THE PAYMENT REVOLUTION IN INDIA*

Payment infrastructure has made significant strides in recent years, aided by digital technologies enhancing the ease of payment delivery and reducing the cost of transactions. At the cross-country level, digital payments' adoption is supported by banking penetration, technological advancements, degree of formalisation of economy and younger cohorts. India has been at the forefront of this payment revolution with UPI transforming the retail payment landscape. India's payment architecture is influenced by a combination of factors like technological advancements, agents, institutions, and policy interventions. This transformation, while fostering financial inclusion and inclusive growth, can result in new challenges for policy makers.

1. Introduction

III.1 Over the last two decades, digitalisation has revolutionised the payment landscape, transforming the organisational structure, business practices and fundamentally the reach of the payment services fostering inclusiveness. The ease and speed of digital payments have made them a preferred choice, bringing in new players to the payments market, which hitherto was monopolised by the financial sector. From a handful of alternate methods of payments such as cash, cheques, credit/debit cards and bank transfers, currently there are over 300 alternative methods of payments worldwide, most of which ride on the digitalisation wave (Mauro and Li, 2021). The push towards a cashless society has become synonymous with modernity and efficiency.

III.2 India is a leader in development of state-of-the-art payment infrastructure and products leading to a wider adoption of digital payments (Das, 2021). India is a frontrunner in the global digital payments revolution and is an inspiration for other economies (The Economist, 2023). The unified payments interface (UPI), a flagship product of India's digital payment ecosystem, introduced in 2016, has emerged as the most preferred choice for payments in India, owing to its transactional ease and accessibility. The reach of India's payment advancements has transcended national boundaries with the internationalisation of the UPI. Emerging market economies (EMEs), in general, are leading the digital payments revolution as evident in the success of UPI of India, M-PESA of Kenya, PIX of Brazil, and PromptPay of Thailand.

III.3 The efficiency gains from harnessing digital technologies in payments are leading to significant reduction in transaction costs and ease of doing business, benefitting consumers, businesses, and economies. Along with e-commerce, digital payments through the ease and convenience of transactions have fostered entrepreneurship. Further, digital trails have enabled easy credit appraisal resulting in the reduction of information asymmetry in the credit market.

III.4 Central banks, being the fulcrum of payment architecture, have played a pivotal role in this digital payments' revolution. At the same time, advancements in digital payments

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have significant implications on central bank's objectives, operations and policy instruments, and can enhance economic growth through the productivity channel on the one hand and alter the price setting behaviour and inflation dynamics on the other. Digitalisation influences the nature, composition, and behaviour of money in the economy, with ramifications for monetary aggregates and monetary policy transmission. Digital payments can foster financial inclusion, financial deepening and instantaneous transfer of funds across financial intermediaries, with implications for financial stability and for the regulatory and supervisory role of central banks. Emerging cybersecurity risks associated with digitalisation of payments also pose challenges.

III.5 Against this backdrop, this chapter provides a detailed account of the evolution of digital payments and factors that contributed to its rapid growth, the impact of digital payments in various spheres of the economy and implications for central banks and their policies. Section II examines the evolution of digital payments in a cross-country perspective. Section III traces the stages of India's digital payments trajectory and examines the enabling forces; it also presents insights from a primary survey of merchants and consumers on the awareness, adoption and usage of digital payments. Section IV analyses the impact of digital payments on the various facets of the economy. Section V explores the challenges and way forward. Concluding observations are set out in Section VI.

2. Evolution of Digital Payment Systems: A Cross-country Analysis

2.1. Historical Context

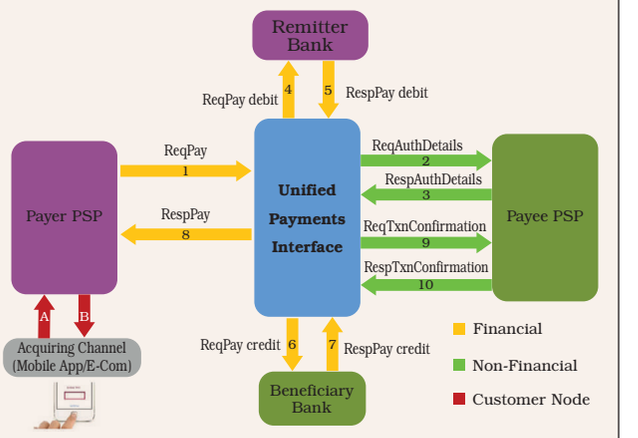
III.6 Payment systems are the lifeline of an economy (Das, 2021). By facilitating exchange of goods and services in an economy, they are imperative for the smooth conduct of economic activities. Payment infrastructure has evolved over time, with its progress mirroring the level of economic development as well as technology. The relationship between the medium of payments and technology has been deeply intertwined, with advancements in technology continuously shaping the nature and functionality of money throughout history. For example, the development of flint blades in the stone age represented a significant technological leap, which also served as a medium of exchange (Sahlins, 2013). As societies progressed into the bronze age, the discovery of metals and the development of metallurgical techniques led to metals assuming roles as currency in diverse forms (Curta, 2021). The emergence of coinage can be attributed more to social innovation than to technological advancement. Tiny pieces of metal were transformed into coins through stamping, with the stamp serving as a guarantee of authenticity. Over time, growing trust and confidence in governmental institutions paved the way for the adoption of paper and fiat currencies, which continue till date, while incorporating stronger security features to increase confidence and to prevent counterfeiting.

III.7 Continuing this tradition, the rapid advancements in information and communication technologies (ICTs) have led to the digitalisation of payments and currency. At the core of this revolution lies a profound philosophical notion that 'money is memory', and a 'superLedger' could facilitate transactions akin to traditional currency. This concept posits that a ledger not only tracks who possesses what, but also who owes and is owed what (Carstens, 2018). Within this superLedger framework, the exchange of money can be seen as being analogous to transfer of data.

III.8 While technological advancements have taken place across the globe, countries have embraced different models of digital payments, influenced by their technological readiness as well as the existing financial landscape. The global evolution of retail digital payments system can be broadly categorised into two main types: open and closed loop systems. In open loop systems, payment systems are operated by central banks or other payment system operators, allowing banks, non-bank payment service providers or third-party application providers (TPAPs) to use the system to process and settle payments. These systems link payers and payees without requiring a direct relationship between them. An example of an open loop system is UPI[1], where the National Payments Corporation of India (NPCI) owns and operates the payment system infrastructure. The TPAPs develop and maintain user-friendly mobile applications for end-users, collaborating with payment service providers[2] (PSPs) that connect to the UPI system. PSPs act as the link between TPAPs and the UPI system, facilitating transactions. Therefore, payers and payees can use different UPI apps and have accounts in different banks but can still transact seamlessly (Chart III.1). Open-loop systems are accepted across multiple merchants and locations, rather than being restricted to a single organisation or group of organisations. Despite multiple participants in a transaction, the UPI enables instant payment on its platform unlike some card networks that operate on open loop systems.

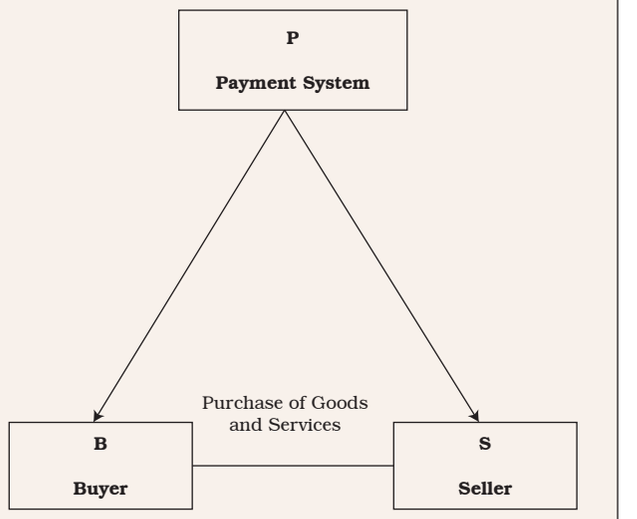
III.9 In contrast, in a closed loop system, the payment platform is managed by a single entity which is responsible for the payment and settlement of funds. These systems operate without intermediaries, establishing a direct relationship between payer and payee within the payment network[3] (Chart III.2). These payment

Chart III.1: Open Loop Payment System (UPI's case)



Note: UPI utilises a series of requests (request for payment, request for authentication details and request for transaction confirmation) and response messages (response for payment, response for authentication details, response for transaction confirmation) to facilitate secure, real-time transfer of funds.
Source: *India Stack.*

Chart III.2: Closed Loop Payment System



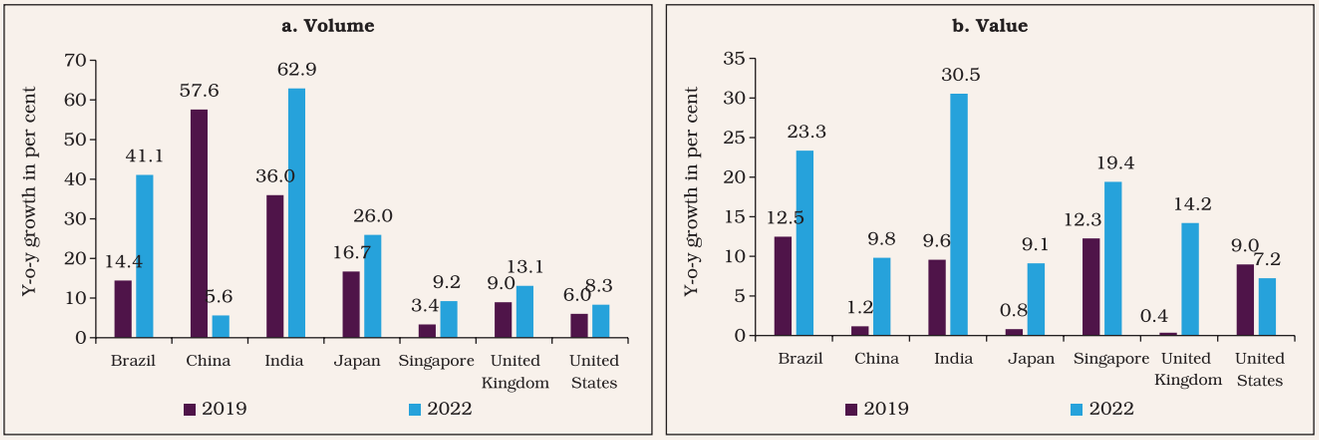
Source: Verdier, M (2006).

1 Real-time account-to-account (A2A) payment systems like PIX and card networks are also examples of open-loop payment systems.

2 PSP in the UPI system is a bank or financial institution that facilitates UPI transactions. They are like the intermediaries between UPI apps (which may be developed by TPAPs or PSPs), the UPI system managed by NPCI, and the banks handling the transactions.

3 These payment systems are also sometimes referred to as three party systems.

Chart III.3: Cross-country Trends in Retail Digital Payments



Note: Retail digital payments consist of credit transfers, direct debits, card payments and e-money and other payment modes.
Source: BIS Red Book Statistics.

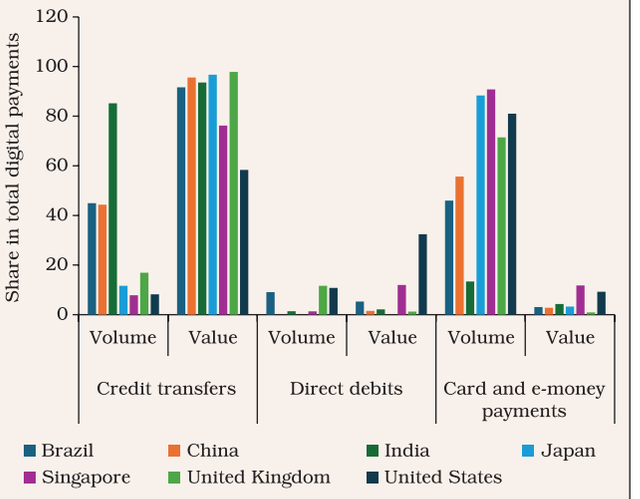
systems have limited reach and are restricted to specific networks or group of merchants, and transactions are processed internally without the need for external financial networks. Examples of closed loop payment systems include Alipay, WeChat Pay[4], transit cards, retail specific cards and gift cards. Initially, mobile money services also operated as closed loop systems, restricting money transfers only to registered consumers, and payments only to registered merchants within the system. Yet, over time, these services have evolved, and have now established connections through bilateral integrations to enable domestic interoperability and have subsequently integrated themselves into the broader financial system, expanding their outreach considerably (GSMA, 2023).

2.2. Digital Payments Revolution Across Geographies

III.10 Retail digital payments, in terms of both volume and value, have recorded significant growth across economies, led by EMEs (Chart III.3).

III.11 In both advanced economies (AEs) and EMEs, credit transfers[5] accounted for most of the retail digital payments by value (Chart III.4). The value of e-money payments made up only a small share of the total, although it has witnessed strong growth in both groups of economies.

Chart III.4: Relative Importance of Different Forms of Retail Digital Payments, 2022

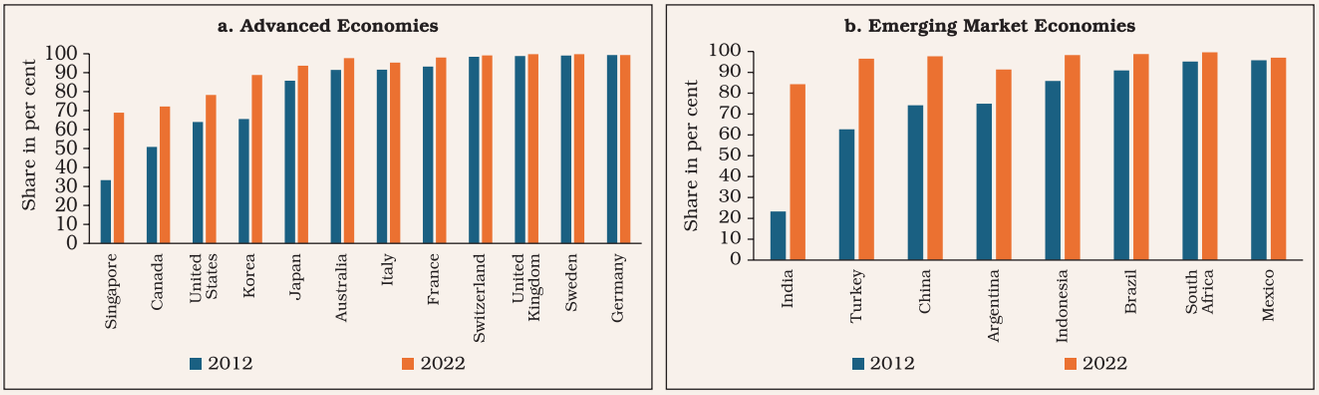


Note: Credit transfers, direct debits, card payments and e-money and other payment modes constitute retail digital payments.
Source: BIS Red Book Statistics.

[4] WeChat Pay is operated by Tencent and Alipay is affiliated with Alibaba.

[5] Credit transfers are payment instruments based on payment orders made for the purpose of placing funds at the disposal of the payee (https://www.bis.org/cpmi/publ/d168.pdf).

Chart III.5: Retail Digital Payments as Percentage of Total Retail Payments



Note: Total retail payments include retail digital payments, cheques and bank notes and coins in circulation. In the absence of information on the value of transactions made through bank notes and coins, the outstanding currency and notes in circulation are added to the rest of the instruments to arrive at total retail payments.
Source: BIS Red Book Statistics.

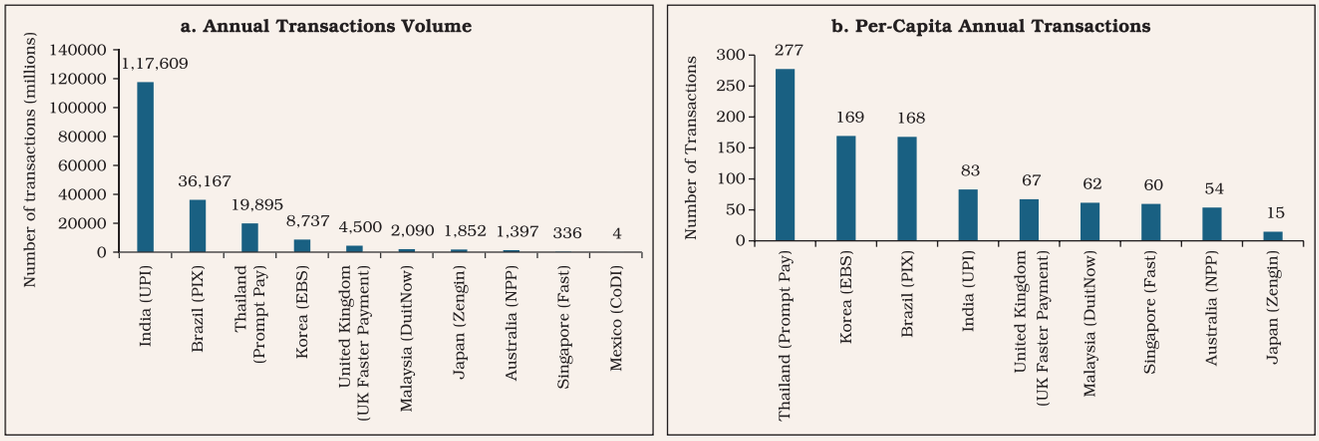
III.12 Overall, the adoption of digital payments is growing, especially in those countries where the initial share of digital payments has been low, and currently, this is the dominant mode of payment in major economies (Chart III.5).

III.13 In AEs, card-based payment systems, established prior to the internet era, are still widely used (World Bank, 2023).[6] While AEs dedicated the past decade to upgrade their bank-based magnetic striped cards with chips, EMEs embarked on a transformative shift in their retail payment landscape. Some EMEs adopted payment systems such as China's closed-loop wallet system and mobile money models prevalent in Sub-Saharan Africa. Other EMEs, including India, Brazil, Nigeria, Thailand and Malaysia, leveraged their banking systems to create account-to-account (A2A) real-time payment (RTP) rails to boost the digitalisation of payments. In major AEs and EMEs, central banks, sovereigns, and bank unions have invested in developing A2A RTP rails, which have taken the lead role in digital payment evolution. Within the A2A RTP schemes, India's UPI stands out as the leading platform in terms of the absolute number of transactions (Chart III.6). UPI crossed over a 100 billion transactions in 2023. Examples of other A2A RTP are PIX system that is being used by more than 80 per cent of the adult population in Brazil; similarly, more than 80 per cent of the Thai population uses PromptPay. The US Federal Reserve launched its own A2A RTP rail called FedNow service in July 2023 with 35 participating financial institutions, which increased to 864 as on June 28, 2024. The penetration levels of the A2A RTP systems in many EMEs are much higher than that of AEs (Chart III.7).

III.14 In this context, India's experience is notable. In 2008, India seemed an unlikely candidate for implementing an A2A RTP system, with only 1 in 25 people having formal identity, and around one in four adults holding a bank account (D'Silva *et al.*, 2019). Additionally, mobile and

[6] The Diners Club card, introduced in 1950, is often credited as the first successful charge card, allowing users to make purchases at participating merchants with the promise of payment to Diners Club later. Following the success of Diners Club, other companies began issuing their own cards (Norman, 2024).

Chart III.6: A2A RTP Transactions (2023)

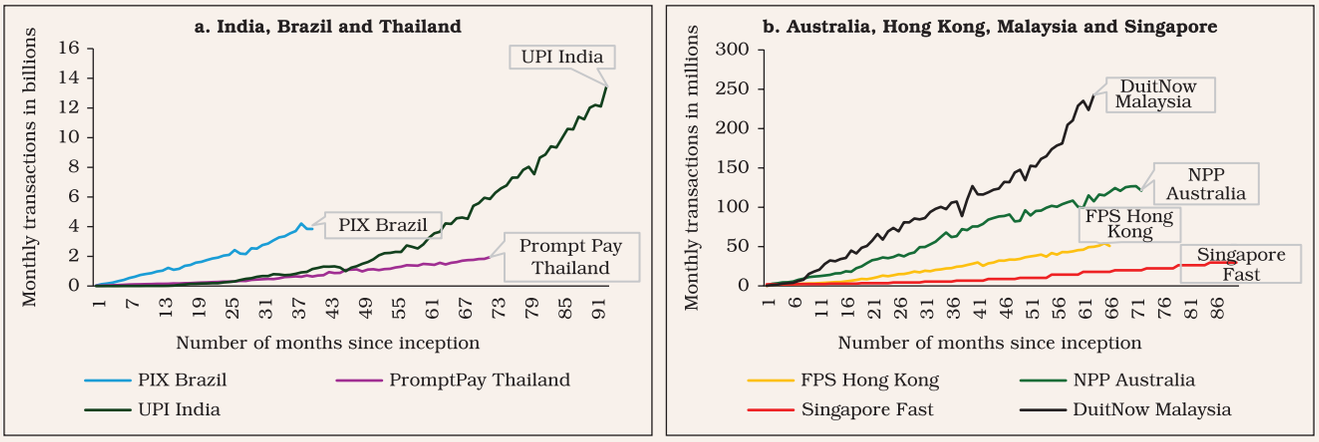


Source: Respective central bank websites; and CEIC.

internet penetration were significantly lower than global standards. The JAM trinity - *Pradhan Mantri Jan Dhan Yojana* (PMJDY), *Aadhaar*, and Mobile[7] - launched by government laid the foundation for the rapid and transformative rollout of UPI. The success of UPI has inspired other A2A RTP systems and NPCI is actively collaborating with other countries to help them develop their own systems similar to the UPI.

III.15 The mobile money model, another variant of digital payment system, has gained prominence in many developing countries, especially in Sub-Saharan Africa (Chart III.8). Under this model, a phone with an active connection and a valid government ID would help customers to open a mobile money account. The agents present in remote locations act as ATMs where people can use their services to deposit and withdraw cash

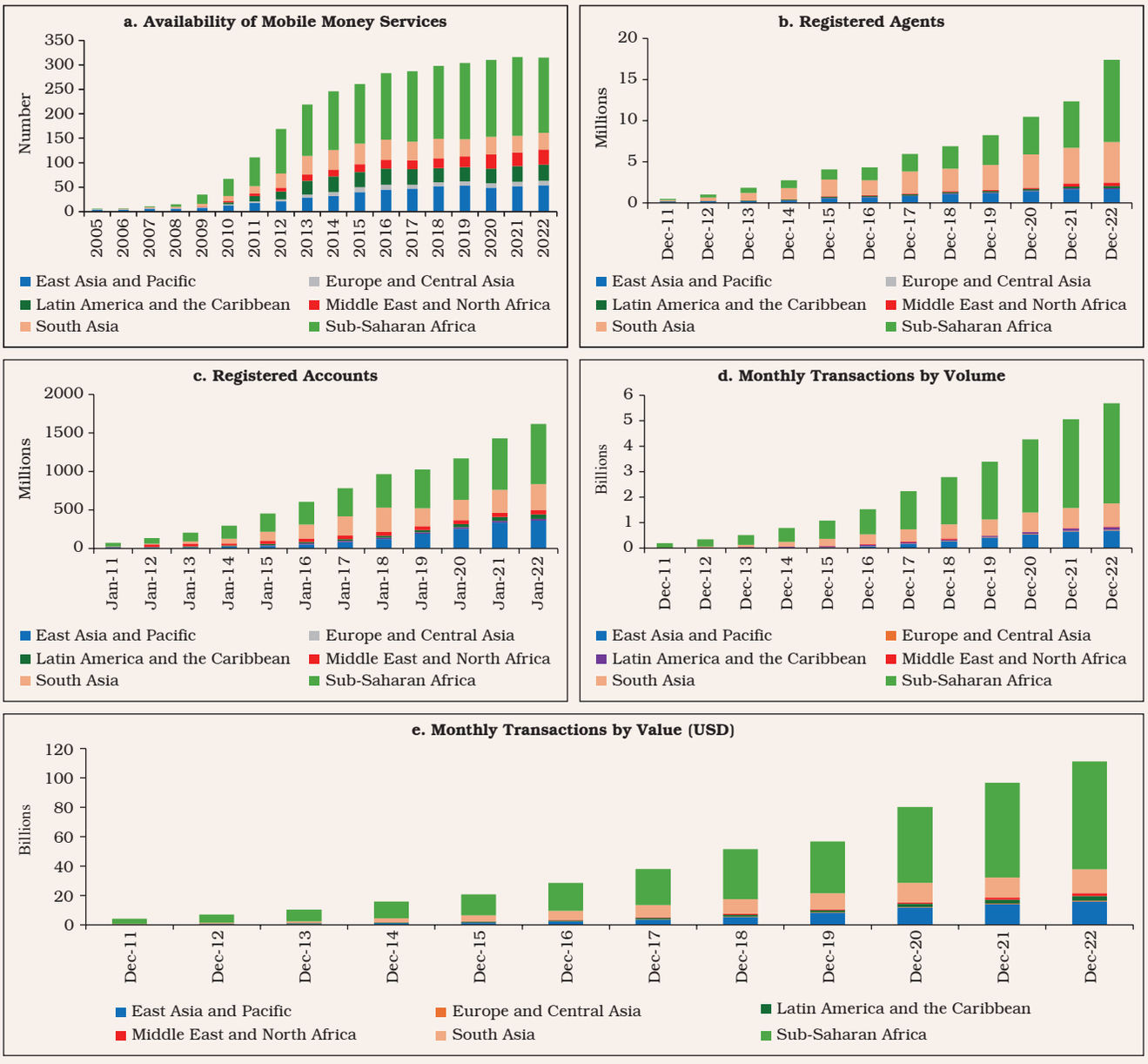
Chart III.7 - Progress in A2A RTP Payments



Source: Respective central bank websites; and CEIC.

[7] The three components of *Jan Dhan*, *Aadhaar* and Mobile (JAM) trinity are i) *Pradhan Mantri Jan Dhan Yojana* - a government scheme to expand and make available affordable access to financial services to the poor in India, ii) unique identity number, *Aadhaar,* which is nearly universal today within the country and iii) access to mobile phones.

Chart III.8: Mobile Money



Source: Global System for Mobile Communications Association (GSMA).

from their mobile money account. Initially, mobile money's focus centred on enabling consumers to conduct person-to-person (P2P) payments digitally, eliminating the necessity for bank accounts or wire transfers. As mobile money expanded its scope, it enabled the consumers to pay bills (including utilities), store money, execute person-to-business (P2B) payments, receive payments from businesses (such as wages), and receive government-to-person (G2P) payments (Suri, 2017). Globally, the mobile money ecosystem has 315 mobile money services and 1.6 billion registered mobile money accounts spread across 102 countries. In 2022, there were 17.4 million registered agents with 65 billion annual transactions totalling US$ 1.26 trillion. On

average, a mobile money provider was connected to around 18 banks and processed US$ 22 billion of international remittances in 2022 (GSMA, 2023).

III.16 The adoption of digital payments is supported by banking penetration, technological advancements, the degree of formalisation of the economy and younger cohorts (Box III.I).

Box III.I
Determinants of Adoption of Digital Payment Technology: A Cross-country Analysis

The adoption of digital payment technologies varies significantly across societies worldwide. Along with the penetration of information and communication technology (ICT), factors such as user attitudes, cultural norms, societal resistance, and institutional trust could condition the adoption of digital payments. Additionally, age demographics emerge as a pivotal factor, with younger generations often at the forefront of embracing new digital tools and platforms (Morris *et al.*, 2005). Moreover, the formalisation of the economy acts as a significant catalyst for the adoption of digital payments. The potential role of the various factors contributing to adaptation of digital payments is examined in a panel framework for 24 countries for the period 2012 to 2022 (equation 1).[8]

$$DigPay_{it} = \beta 1.IntPen_{it} + \beta 2.Pop65_{it} + \beta 3.BankBr_{it} + \beta 4.TaxGdp_{it} + \beta 5.IncLev_{it} + \alpha_t + \varepsilon_{it} \quad (1)$$

where the dependent variable is retail digital payments as a percentage of total retail payments of country i at time t. $IntPen_{it}$ represents the percentage of population using internet while $Pop65_{it}$ indicates the share of people above 65 years of age in total population. The variables $BankBr_{it}$ and $TaxGdp_{it}$ represent bank branches per lakh adults and tax to GDP ratio, respectively. The tax to GDP ratio is taken as a proxy for the size of formal economy. $IncLev_{it}$ is a dummy variable with zero for developed countries and 1 for developing nations to assess the relative speed of adoption in these groups. α_t represents time fixed effects.

The empirical analysis indicates that digital payments are boosted by internet penetration, formalisation of the economy, availability of bank branches and younger generations. Furthermore, within the sample economies, the developing countries have a higher rate of digital payment adoption than the advanced economies.

Table 1: Drivers of Digital Payments Adoption-Regression Results

Dependent Variable: Digital payments as a percentage of total payments

Explanatory variable	Coefficient
Percentage of population using internet	0.215 *** (0.056)
Share of people above 65 years	-0.102** (0.045)
Tax to GDP ratio	0.162*** (.043)
Dummy emerging economy	0.144*** (.049)
Bank branches per lakh adults	0.059* (0.033)
Observations	264
Number of countries	24
Number of developing countries	8

Note: Figures in parentheses indicate standard errors; ***,**,*: indicate significance at 1, 5 and 10 per cent level, respectively.

Source: RBI staff estimates.

Reference:

Morris, M. G., Venkatesh, V., and Ackerman, P. L. (2005). Gender and Age Differences in Employee Decisions About New Technology: An Extension to the Theory of Planned Behavior. *IEEE Transactions on Engineering Management*, 52(1), 69-84.

[8] Data Sources: BIS in its Redbook statistics publishes retail payments data which includes credit transfers; direct debits; cheques; card payments and e-money; other payment modes and currency and bank notes in circulation. Credit transfers, direct debits, card payments and e-money and other payment modes are considered to constitute retail digital payments. Data on internet penetration and age demography have been taken from World Telecommunication/ICT Indicators Database and World Bank, respectively. Tax to GDP ratio has been sourced from CEIC database while the classification of countries into AEs and EMEs is from the World Bank.

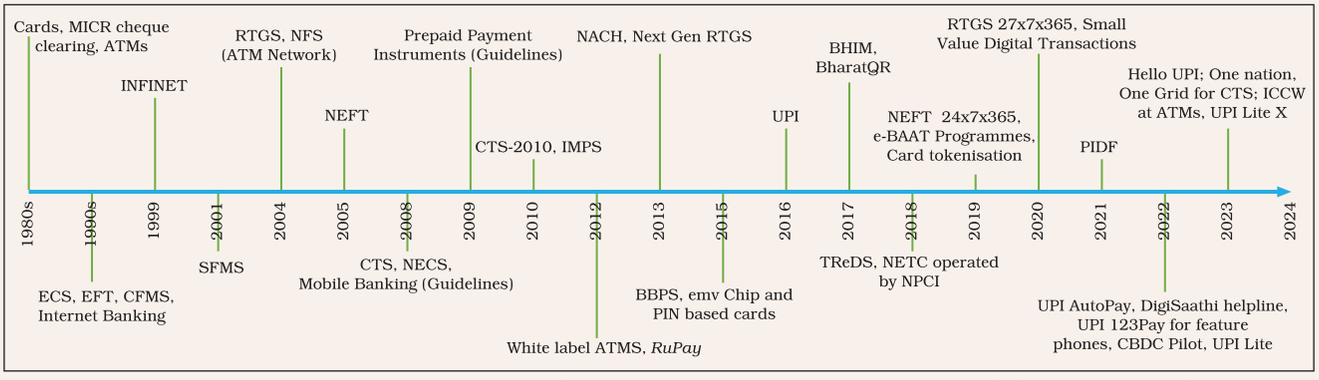
3. The Digital Payment Revolution in India

III.17 India has witnessed a revolution in its digital payments journey, without so realising, to become a leader in the digital payments landscape (Gandhi, 2016; Ramasastri, 2018). Underscored by the Reserve Bank's commitment to move towards a "less-cash" society, India's journey to become a global leader in the payments' space has witnessed many global firsts – a low cost, interoperable, mobile-based acceptance solution like Bharat QR Code; Two Factor Authentication; *Aadhaar* enabled payment systems (AePS); and the UPI (Gandhi, 2017). This journey began in relative obscurity in the 1980s, and the strong retail payments framework in the country today is comparable to that of any advanced country, and perhaps even surpassing some in terms of the variety and efficiency (Gandhi, 2016; RBI, 2022b). The payments revolution in India offers critical lessons for cooperation between a central bank and private firms in bringing about technological progress (Kearns and Mathew, 2022; D'Silva *et al.*, 2019). Payment systems in India have not only navigated through the fast-evolving technological innovations but also developed into one of the most modern and diverse systems with a whole gamut of bill payments, merchant payments, vendor payments, transit payments, and recurring payments (Das, 2024). The flexibility of interoperability among payment systems has brought in unparalleled ease of transactions while robust customer protection measures have made India's retail payment system one of the safest in the world (BRICS, 2021).

3.1. Evolution of Digital Payments in India

III.18 The foundation of an efficient digital payment system was laid down in the 1990s when the modernisation of the payment and settlement systems was accorded high priority in the agenda of financial sector reforms to improve the efficiency of financial intermediation and financial system stability. The reform in payment and settlement systems were facilitated by advancements in computerisation and technology. The payment systems evolution in India can be roughly categorised in two distinct waves: a) digitalisation of existing systems to improve efficiency, and b) changes in payment space brought about by the digital revolution (Chart III.9).

Chart III.9: Evolution of Payment System Landscape in India



Note: MICR: Magnetic Ink Character Recognition; ATM: Automated Teller Machines; ECS: Electronic Clearing Services; EFT: Electronic Funds Transfer; CFMS: Centralised Funds Management System; INFINET: INdian FInancial NETwork; SFMS: Structured Financial Messaging System; RTGS: Real Time Gross Settlement; NFS: National Financial Switch; NEFT: National Electronic Funds Transfer; CTS: Cheque Truncation System; NECS: National Electronic Clearing Service; IMPS: Immediate Payment Service; NACH: National Automated Clearing House; BBPS: Bharat Bill Payment System, UPI: Unified Payment Interface; BHIM: Bharat Interface for Money; TReDS: Trade Receivables electronic Discounting System; NETC: National Electronic Toll Collection; e-BAAT: electronic Banking Awareness and Training; PIDF: Payment Infrastructure Development Fund; CBDC: Central Bank Digital Currency; ICCW: Interoperable Card-less Cash Withdrawal.
Source: RBI staff illustration.

3.1.1. Digitalisation of Existing Payment Systems to Improve Efficiency

III.19 In the 1980s, ICT revolution brought significant changes in operating systems at the bank level, beginning from back-office automation of cheques to the front desk total branch automation. Under changes in the banking methods, in the first phase, a three-pronged approach of consolidation, development and integration was adopted (RBI, 2002). Connectivity of bank branches through networking of computers and inter-connectivity of banks were the earliest objectives for the modernisation of the payment and settlement systems.[9] The operationalisation of the INdian FInancial NETwork (INFINET), a Closed User Group, in June 1999, was a major step forward in providing a robust communication network for the exclusive use of banks and financial institutions. Until the 1990s, the major alternative to cash was the cheque clearing system. The switchover from physical currency to paper-based payment instruments and to electronic media warranted technological upgradation in clearing arrangements. The evolution of cheque clearing systems progressed from manual to Magnetic Ink Character Recognition (MICR) clearing in the mid-1980s, introducing automation and standardisation. MICR instruments enabled electronic clearing while physically exchanging cheques. The Cheque Truncation System (CTS), introduced in 2008, allowed digital processing of cheques and eliminated the need for their physical movement. Standardised under CTS-2010, with enhanced security features, it replaced MICR completely, starting 2014. To promote efficient cheque processing, the Reserve Bank decided to migrate CTS from an architecture of three regional grids to one national grid. The merger was completed on October 13, 2023, and the merged grid has been named as National Grid Clearing House (NGCH). The merger has improved liquidity and efficiency of the system and enabled rationalisation of cheque clearing infrastructure. After the merger, all cheques presented through the CTS are being processed as local cheques.

III.20 The introduction of Central Bank Digital Currency (CBDC) on a pilot basis in 2022 is the latest innovation which would entail a 'more efficient and cheaper currency management system' (GOI, 2022; RBI, 2022c). Digital currency is expected to complement cash and current payment systems. "Digital Rupee", is the digital form of India's currency, the Rupee, and is a legal tender issued by the Reserve Bank of India. It can be held as a store of value or used to carry out transactions. In May 2024, India was among the 36 countries where CBDC was in pilot stage.[10] Based on usage, CBDCs can be classified into wholesale (CBDC-W) and retail (CBDC-R). While wholesale CBDC (CBDC-W) caters to institutional participants of the financial markets, retail CBDC (CBDC-R) is a risk-free digital medium of exchange for the retail consumers. The initial use cases for the pilot of CBDC-R included Person to Person (P2P) and Person to Merchant (P2M) transactions. The pilot has also introduced additional use cases using programmable and offline functionalities. As of June 2024, 50 lakh users and 4.2 lakh merchants were participating in the CBDC retail pilot.

3.1.2. Changes in Payment Space brought about by the Digital Revolution

III.21 In the second wave, significant innovations in the payment and settlement landscape were

[9] Branch level computerisation and the establishment of connectivity between branches were recommended by the Committee on Computerisation in Banks (1988), chaired by Dr. C. Rangarajan, then Deputy Governor, Reserve Bank of India.

[10] Retrieved from https://www.atlanticcouncil.org/cbdctrack on July 20, 2024.

driven by technology-based solutions. Early initiatives in this regard were the introduction of credit cards and ATM networks in the late 1980s. The current wave of innovations in payments system began with the rationalisation of decentralised electronic products like ECS and EFT into centralised pan-India payment solutions like the NACH and NEFT which enabled servicing customers spread throughout the country with settlement at a central location. This phase was facilitated by the adoption of Core Banking Solutions (CBS)/centralised liquidity management solutions in banks which enabled straight-through-processing of payments. In 2012, *RuPay* card was introduced as the first of its kind global card payment network of India with lower transaction fees and wider acceptance at ATMs, Point of Sale devices, and e-commerce platforms across the country. Mass adoption of e-banking and newer delivery channels for the customers – such as internet banking (the primary mode of e-banking in India) and mobile banking – evolved. As internet connectivity and mobile phone penetration surged, payment mechanism shifted from cards and ATM networks to mobile phones as a convenient alternative for small value transactions.

III.22 In recent years, new dimensions have been added to the payment systems, such as the Immediate Payment Service (IMPS) and the UPI, which provide instant credit to the beneficiary, and are available round the clock for undertaking fund transfers. The Real Time Gross Settlement (RTGS) has been developed as a Financial Market Infrastructure, which processes large payment transactions. Initiatives like Bharat Bill Payment System (BBPS) and Pre-paid Payment Instruments (PPIs) (which facilitate payment of bills and purchase of goods and services), and the National Electronic Toll Collection (NETC) which allows for electronic toll payments have further enhanced convenience. Innovations like the Bharat Interface for Money (BHIM) App, interoperable QR code, and 24×7×365 of NEFT and RTGS enhanced the convenience of these payment systems and ensured their rapid acceptance. The facilitation of non-bank FinTech firms in the payment ecosystem as PPI issuers offering stored value services to customers, and in payment gateway and aggregation services like Bharat Bill Payment Operating Units (BBPOUs) and TPAPs in the UPI platform have furthered the adoption of digital payments in the country (RBI, 2021a). Leveraging increasing mobile density, PSPs, both banks and non-banks, have started services using mobile as an access device as well as an access channel.[11]

III.23 The introduction of UPI in 2016 brought twin benefits for mobile banking - convenience of operations for customers, and merchant 'pull' payments. Prior to this, mobile banking applications were largely operating in silos, particularly for merchant payments and were generally not interoperable across merchants and customers of different banks (Das, 2024). In 2022, the interlinking of *RuPay* credit cards with the UPI platform offered more convenience to users and expanded the reach of digital payments.

III.24 To broaden access to digital payments in areas of low internet connectivity, a pilot scheme was launched in August 2020 to enable small value digital transactions in offline mode. In 2022, the framework was formalised with offline payments allowed using any channel or instrument like cards, wallets and mobile devices in proximity (face-to-face) mode without mandatory Additional Factor of Authentication (AFA). UPI Lite was

[11] Banks provide mobile banking services through three channels – SMS, Unstructured Supplementary Services Data (USSD) and applications.

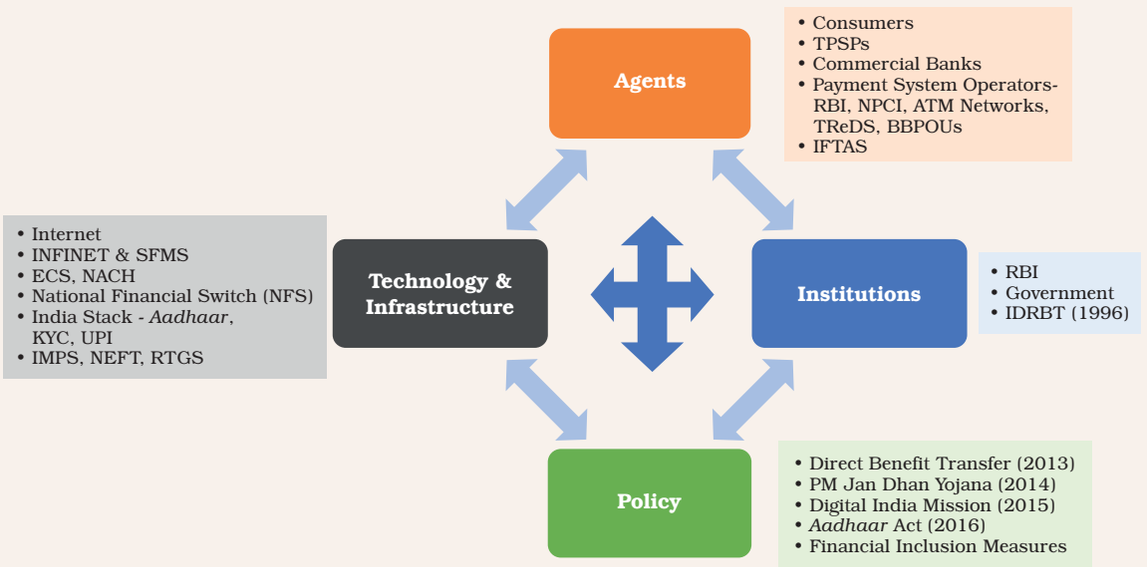
introduced in this framework in September 2022 as a simplified version of the UPI payment system. Using the same account, payments of up to ₹ 500 can be made without pin authentication, making payments faster and more convenient. In September 2023, UPI Lite X was introduced for offline payments where transactions are carried out using the Near Field Communication (NFC) technology. UPI Tap & Pay, introduced at the same time, allows tapping NFC-enabled QR codes at merchant locations and aids in faster digital transactions.

3.2. Factors Contributing to Digitalisation of Payments in India

III.25 The evolution of retail payment landscape in India can be analysed using the innovation systems approach, which was first introduced in the late 1980s as a framework to understand technological innovations at the national level. It has been defined as *"the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies"* (Freeman, 1987), and "*the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state*" (Lundvall, 1992). The concept rests on the premise that understanding the interactions among the actors involved in innovation is crucial for enhancing technology performance (OECD, 1997). Nations excel in specific industries because their domestic environment is exceptionally forward-looking, dynamic, and challenging (Porter, 1998).

III.26 Through the lens of the National Innovation Systems (NIS) framework, the payment landscape in India can be seen as influenced by the interaction of various factors including technological advancements, agents, institutions and policy prescription (Chart III.10). The pace and sequencing of payment system

Chart III.10: Payment System in India in a National Innovation Systems (NIS) Framework



Note: TPSPs: Third Party Service Providers; NPCI: National Payments Corporation of India; TReDS: Trade Receivables electronic Discounting System; BBPOUs: Bharat Bill Payment Operating Units; IFTAS: Indian Financial Technology Application Services; IDRBT: Institute for Development and Research in Banking Technology; INFINET: INdian FInancial NETwork; SFMS: Structured Financial Messaging System; ECS: Electronic Clearing Service; NACH: National Automated Clearing House; KYC: Know Your Customer; UPI: Unified Payments Interface; IMPS: Immediate Payment Services; NEFT: National Electronic Funds Transfer RTGS: Real Time Gross Settlement.
Source: RBI staff illustration.

reform has been impacted by several factors, *viz.,* (i) the different degrees of computerisation in the financial system; (ii) geographical spread of the banking sector; (iii) the regulatory role of the Reserve Bank in relation to the payment systems; (iv) systemic risks in payment and settlement systems; (v) legal infrastructure; and (vi) impact of payment and settlement system reforms on the conduct of monetary policy (RBI, 2001).

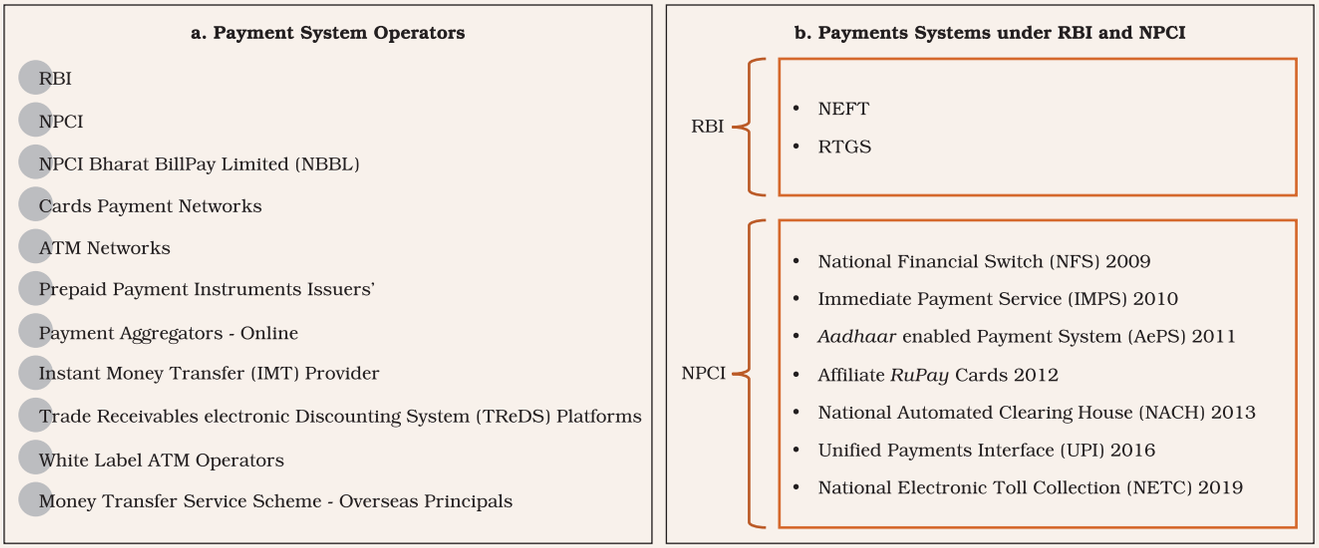
III.27 The public sector's pioneering role in the evolution of payments systems included a four-pronged strategy: treating digital financial infrastructure as a public good, fostering private innovation with open access, ensuring a fair regulatory environment, and empowering individuals through a consensual data-sharing framework. The top-down strategising fostered an open loop digital payments system, which enabled banks to take centre stage in the evolution and integrate themselves in the payment infrastructure. These strategies led to innovative digital platforms that served specific needs like identity verification, payments, and data sharing and collectively form a powerful integrated system known as the Digital Public Infrastructure or the "*India Stack*" (D'Silva *et al*., 2019). The multidimensionality of the stack and the open loop system (where settlement happens in the fiat currency), facilitated interoperability and mass adoption, and enhanced financial inclusion.

III.28 The Reserve Bank is vested with the power to regulate payment and settlement systems in the country under the Payment and Settlement Systems Act, 2007 (PSS Act). The Board for Regulation and Supervision of Payment and Settlement Systems (BPSS), a Committee of the Central Board of the Reserve Bank of India oversees the payment and settlement systems in India. It is instrumental in prescribing policies and setting standards for regulating and supervising all the payment and settlement systems in the country.

III.29 The continuous establishment and development of several institutions by the Reserve Bank played an immense role in the evolution and regulation of payment systems. The Institute for Development and Research in Banking Technology (IDRBT) was established in 1996 with a focus on sculpting the technological infrastructure of the banking sector. It pioneered vital technological infrastructure systems like the INFINET and the Structured Financial Messaging System (SFMS). The IDRBT also developed the National Financial Switch (NFS) in 2004, which is currently under the NPCI. The NPCI was established in 2008 by the Reserve Bank of India and the Indian Banks' Association exclusively for promoting payment systems. In 2015, the Indian Financial Technology Application Services (IFTAS) was created as a subsidiary of the Reserve Bank which took over key services like INFINET, SFMS, Indian Banking Community Cloud (IBCC), and Global Interchange for Financial Transactions (GIFT), offering uninterrupted 24x7 IT services to the banking sector, including as a communication backbone, messaging platform, and community cloud. In April 2020, NPCI International Payments Limited (NIPL) was established as a subsidiary dedicated to globalising NPCI's payment systems, focusing initially on the internationalisation of *RuPay* and UPI. The IDRBT has expanded its focus to research centres, addressing areas like analytics, cyber security, mobile banking, affordable technologies, cloud computing, and payment systems. The setting up of the Reserve Bank Innovation Hub in March 2022 is another step taken to encourage and nurture financial innovation in a sustainable manner through an institutional set-up.

III.30 With institutions in place, the Reserve Bank authorised various agents like Payment System Operators (PSOs) such as NPCI (retail payments organisation), card payment networks, cross-

Chart III.11: Payment System Operators and Systems



Note: In Chart III.11b, the year of authorisation is reported at the end.
Source: RBI staff illustration.

border inbound money transfers entities, ATM networks, PPI issuers, Instant Money Transfer operators, TReDS platform providers and NPCI Bharat BillPay Limited (NBBL) to operate payment systems in the country (Chart III.11a). Of all the operators, the Reserve Bank and the NPCI are the major ones entrusted with overseeing vital payment systems like RTGS, NEFT and UPI; IMPS and NACH respectively (Chart III.11b).

III.31 Concurrently, changes in the payment landscape were brought from the perspective of government payments. As noted earlier, the trifecta of JAM trinity revolutionised the retail payment landscape. Bulk and repetitive government benefit and subsidy payments to *Aadhaar*-seeded bank accounts of identified beneficiaries were facilitated by the *Aadhaar* Payments Bridge System (APBS). *Aadhaar* Enabled Payment System, operational since 2011, uses *Aadhaar* authentication for online transactions and offers cash withdrawal, balance enquiry, and fund transfers. Nearly 352 million *RuPay* cards have been issued under *Jan Dhan Yojana* accounts (PMJDY, 2024). Mobile based banking developed as fast payments systems like IMPS and UPI accorded multi-channel access including internet and mobile banking. Amidst this evolution, a universe of Third-Party Service Providers (TPSPs) developed simultaneously, which includes, payment gateways (PGs), payment aggregators (PAs), and TPAPs. These TPSPs play a significant role in furthering public-private partnership in the FinTech sphere.

III.32 To further expand the digital payment ecosystem in India, the Reserve Bank in 2019 introduced the 'Expanding and Deepening of Digital Payment Ecosystem' (EDDPE) programme. Under this programme, State Level Bankers' Committees (SLBCs)/Union Territory Level Bankers' Committees (UTLBCs) of respective states and union territories (UTs) provide every eligible individual in the identified district with at least one mode of digital payments *viz*., debit/*RuPay* cards, net banking, mobile banking, UPI, USSD, AePS, to facilitate him/her to make/

receive payments digitally in a safe, secure, quick, affordable, and convenient manner. As on March 31, 2024, all districts across the country (except two districts from the UT of Andaman and Nicobar Islands) have been identified for the purpose, and 179 districts were 100 per cent digitally enabled.

III.33 The Payments Infrastructure Development Fund (PIDF) operationalised by the Reserve Bank in January 2021 provided a further fillip to the digital payments revolution. The PIDF Scheme, initially implemented for a period of three years was extended further for a period of two years, *i.e.,* up to December 31, 2025. It encourages deployment of payment acceptance infrastructure such as physical Point of Sale (PoS) terminals and Quick Response (QR) codes in tier-3 to tier-6 centres, north-eastern states and UTs of Jammu & Kashmir and Ladakh, and beneficiaries of Street Vendor's *AtmaNirbhar Nidhi* (PM *SVANidhi* Scheme) and PM *Vishwakarma* scheme in tier-1 and tier-2 centres (Table III.1). The PIDF had a corpus of ₹1,239 crore in May 2024.

III.34 Apart from these factors, digital payments were boosted by the demonetisation of banknotes of ₹500 and ₹1000 denominations in 2016. The year-on-year growth in retail electronic payments jumped from around 37 per cent during April to October 2016 to nearly 70 per cent in November and 123 per cent in December 2016. There appears to be a structural break in the volume and value of retail electronic payments, coinciding with the onset of demonetisation (RBI, 2017). The COVID-19 pandemic also hastened the adoption of digital payments in India with consumers and businesses increasingly choosing contactless transactions amidst social distancing norms and lockdowns. Realising the importance of financial literacy in digital payments' adoption, the Reserve Bank, along with several non-governmental organisations and financial institutions, has initiated various programmes to educate the underserved segments about the benefits of digital payments. The Reserve Bank has been conducting electronic banking awareness and training (e-BAAT) programmes regularly to educate the masses to move their focus of payments from physical presence of money to electronic money payments.

III.35 Overall, the evolution of the retail payment landscape in India within the context of the NIS reflects a dynamic ecosystem characterised by policy support, technological innovation, stakeholder collaboration, and consumer-driven

Table III.1: Payments Infrastructure Development Fund (PIDF)
(As on May 31, 2024)

Location	Physical devices*	Digital devices**	*Aadhaar* enabled biometric devices
Tier 3 & 4 Centres	5,15,476	1,05,70,839	1,775
Tier 5 & 6 Centres	4,00,945	1,68,59,577	3,670
Special Focus Areas (North-eastern States and UTs of J&K and Ladakh)	1,30,450	24,45,204	191
Tier 1 & 2 Centres (PM *SVANidhi* and PM *Vishwakarma* Schemes)	335	14,68,901	0
Total	10,47,206	3,13,44,521	5,636

Note: 1. *Physical devices include PoS, mPoS (mobile PoS), GPRS (General Packet Radio Service), PSTN (Public Switched Telephone Network), *etc.*

2. **Digital devices include inter-operable QR code-based payments such as UPI QR, Bharat QR, *etc.*

Source: RBI.

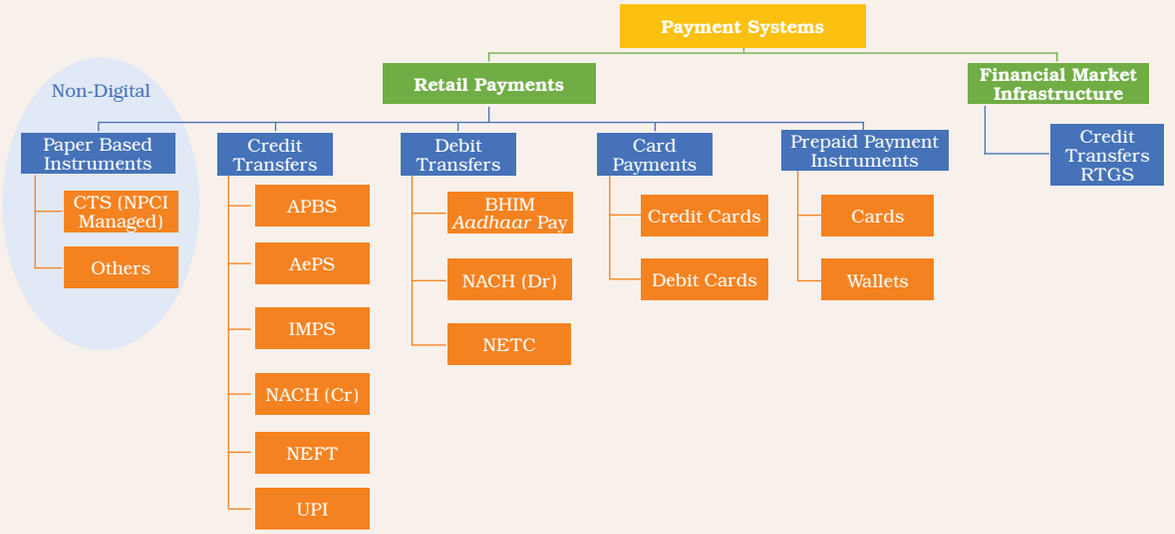
demand. These efforts were a part of a broader strategy to promote financial inclusion, enhance the efficiency of the payment system, and boost the digital economy. Going forward, the Payments Vision Document 2025 (RBI, 2022a) further builds upon the five pillars of integrity, inclusion, innovation, institutionalisation and internationalisation and is indicative of the future evolution of payment systems in India.

3.3. Trends in Digital Payments

III.36 Payment transactions in India currently comprise bulk payment transfers (RTGS), which include both customer and inter-bank transactions; and retail payment transfers[12] (Chart III.12). Except paper-based instruments, all other payments constitute digital transactions. The digital payments system has been developed to offer a bouquet of products to cater to diverse needs. While the UPI has facilitated digital payments to merchants such as retail outlets/vendors across the country, the BBPS has ensured migration of bill payments from cash/cheques to digital mode. Likewise, the NETC system aided migration of toll payments to digital mode, and the NACH facilitated digital direct benefit transfers (DBT).

III.37 The transition to digital modes of payment is borne out by the phenomenal growth witnessed across all facets of digital transactions over the past decade. The volume of digital transactions recorded a compound annual growth rate (CAGR) of 52 per cent during 2013-14 to 2023-24 while the value of these transactions exhibited a 12 per cent CAGR (Chart III.13a). The intensity of digital payment usage has shot up multi-fold: the number of transactions per lakh of GDP increased from 0.8 in 2005-06 to 56 in 2023-24, and the number of transactions per capita from 0.2 in 2005-06 to

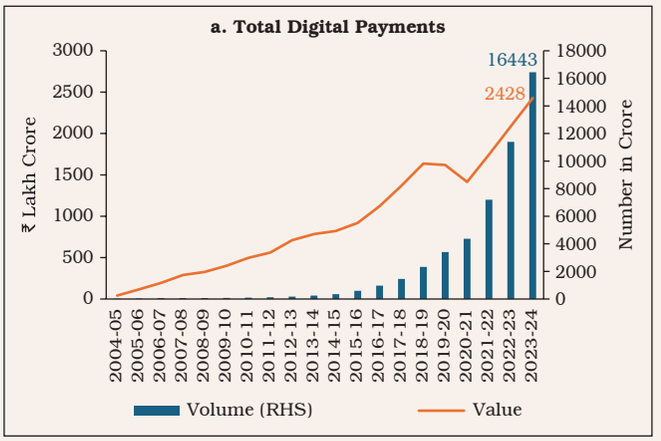
Chart III.12: Payment Systems Landscape in India

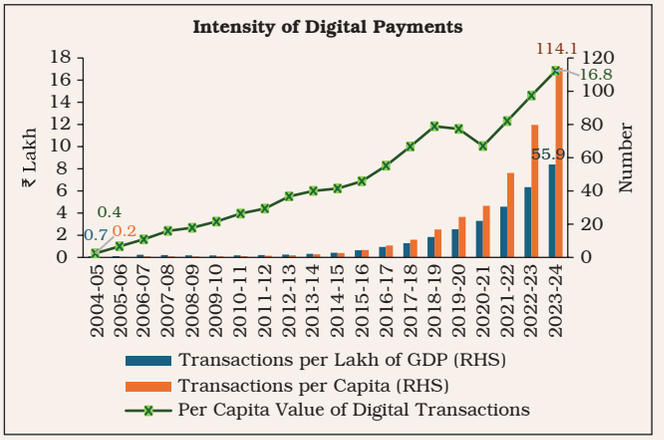


Note: CTS: Cheque Truncation System; NPCI: National Payments Corporation of India; APBS: *Aadhaar* Payment Bridge System; AePS: *Aadhaar* enabled Payment System; IMPS: Immediate Payment Services; NACH(Cr): National Automated Clearing House (Credit); NEFT: National Electronic Funds Transfer; UPI: Unified Payments Interface; BHIM: Bharat Interface for Money; NACH(Dr): National Automated Clearing House (Debit); NETC: National Electronic Toll Collection; RTGS: Real Time Gross Settlement.
Source: RBI staff illustration.

[12] The classification between retail and non-retail segments is at Payment System/Instrument level and does not *per se* capture individual transaction values. For instance, NEFT is called as retail payment system, even though it allows for high value transactions. Contrastingly, for RTGS there is a lower limit of value defined, and is classified as wholesale/large value payment system.

Chart III.13: Intensity of Digital Payments Adoption





Source: RBI; NSO; UN World Population Prospects; and RBI staff estimates.

114 in 2023-24. The average value of transaction per capita for total digital payments surged from ₹0.4 lakhs to ₹16.8 lakhs over the same period (Chart III.13b).

III.38 The share of the volume of paper clearing plummeted to 0.4 per cent in 2023-24 in total retail payments from 81.9 per cent in 2005-06. Further, the share of digital retail transactions in total value of retail payments increased to 90.9 per cent in 2023-24 from 1.3 per cent in 2005-06 (Chart III.14a and b). UPI has emerged as the preferred method of retail payments, with a share of 79.6 per cent in total volumes of retail payments made in 2023-24 (Chart III.14c). In value terms, NEFT transactions had the highest share (49.4 per cent) in total retail payments in 2023-24, followed by UPI (25.3 per cent share in 2023-24 as compared to only 2.4 per cent in 2018-19) [Chart III.14d]. Within card payments, the usage of credit cards has increased over the years. In 2023-24, credit cards accounted for 61 per cent of total volume and 76 per cent of total value of card payments (Chart III.14e). The integration of functionality of UPI with *RuPay* credit cards increased credit card usage further in 2023. Consequently, the market share of outstanding *RuPay* credit cards in circulation also increased from 3 per cent in 2022-23 to 10 per cent in 2023-24.[13]

III.39 UPI is now the most popular and preferred payment mode in India revolutionising the P2P as well as P2M transactions (Das, 2023a). Apart from being a user-friendly interface and facilitating QR code-based payments, the UPI has evolved to include advanced functionalities such as offline payments through NFC technology (UPI Lite X), payments through feature phones (UPI 123Pay) and AI based conversational payments (hello! UPI) [Chart III.15]. The volume of UPI transactions has increased multi-fold from 539 crore in 2018-19 to 13,113 crore in 2023-24 and their value from ₹8.8 lakh crore to ₹200 lakh crore during the same period. Currently, UPI is processing close to 45 crore transactions in a day (June 2024).

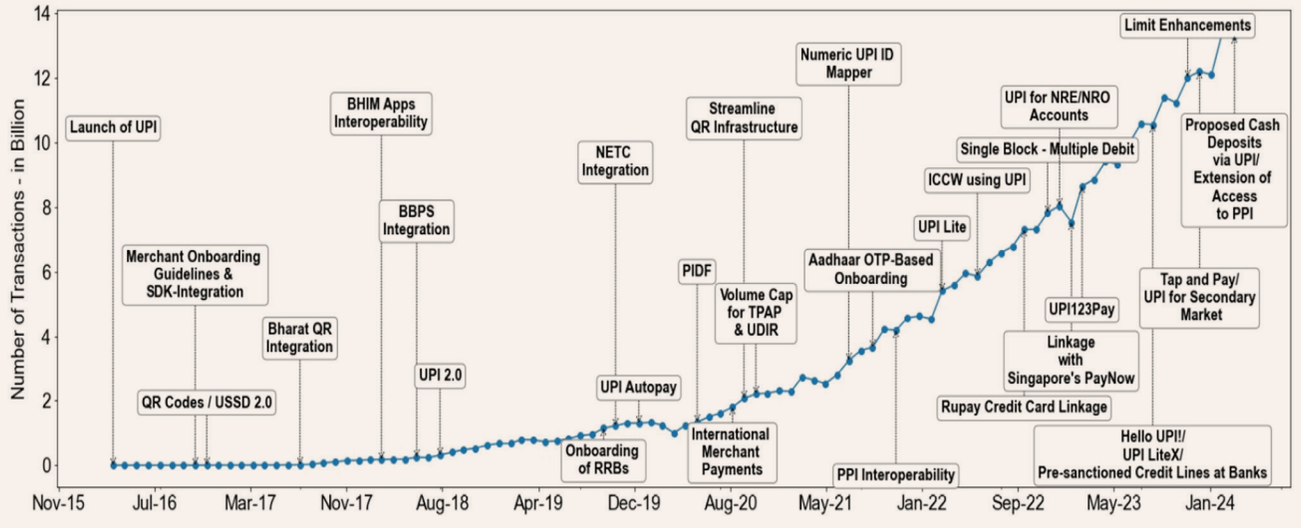
[13] In December 2023, *RuPay* credit card spending on UPI platform crossed ₹ 5,000 crore - almost 50 per cent of overall *RuPay* credit card spending.

Chart III.14: Retail Payments Trend

Note: Aadhaar based payment methods include AePS, APBS and BHIM *Aadhaar* Pay.
Source: RBI; and RBI staff estimates.

III.40 The Digital Payments Index (DPI), constructed by the Reserve Bank of India with March 2018 as the base year, captures the extent of digitisation of payments across the country. It comprises of five broad parameters that capture demand and supply side factors to measure deepening and penetration of digital payments: (i) payment enablers, (ii) payment infrastructure – demand-side factors, (iii) payment infrastructure – supply-side factors, (iv) payment performance and (v) consumer centricity. Each of these parameters have sub-parameters that consist of various measurable indicators (Chart III.16).

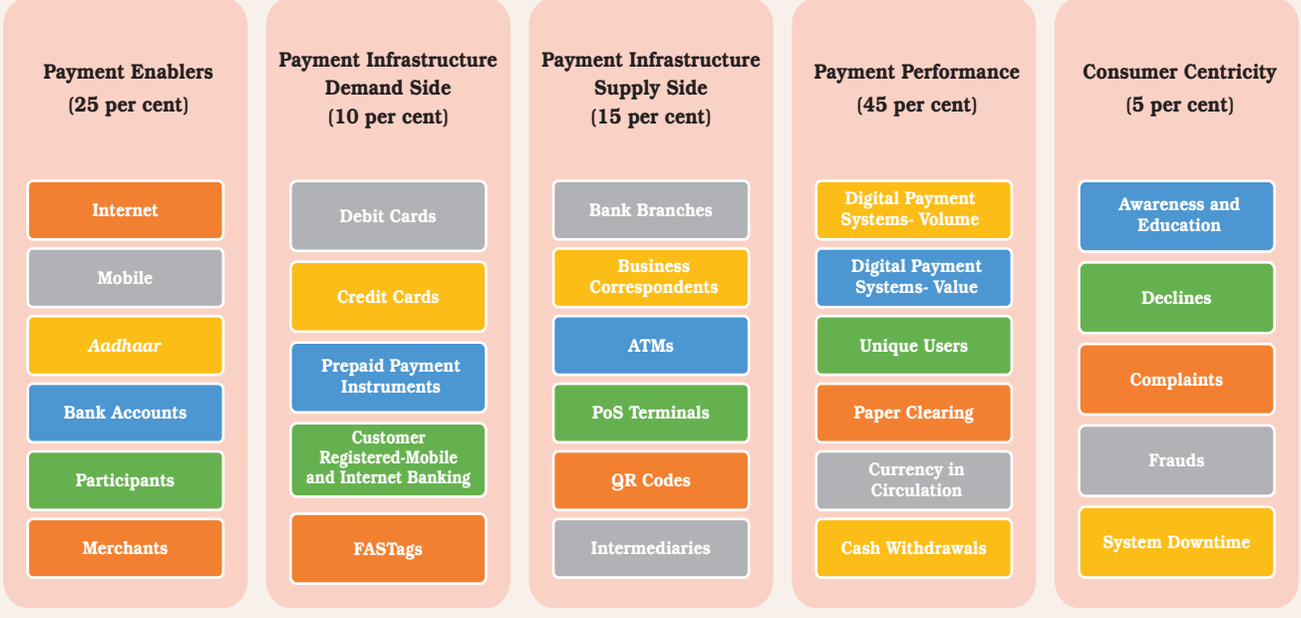
Chart III.15: Timeline of UPI Evolution and Adoption



Source: RBI staff illustration.

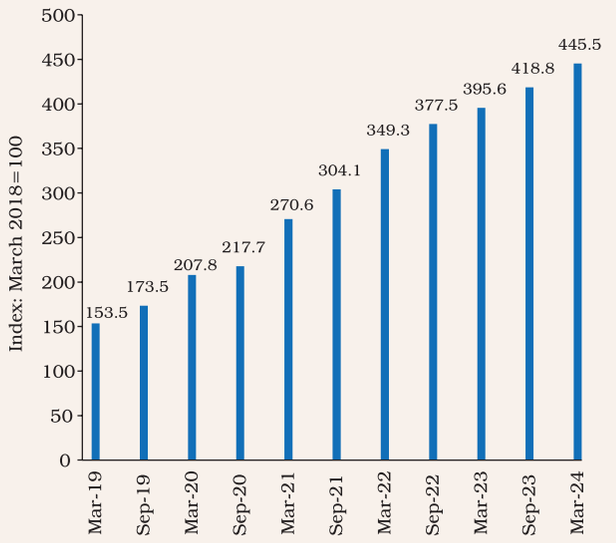
III.41 Since March 2018, the DPI has increased more than four-fold to reach 445.5 in March 2024 (Chart III.17). The increase has been recorded across all parameters and driven particularly by payment performance and payment infrastructure across the country, over the period.

Chart III.16: Parameters (Weight in Parentheses) and Sub-parameters of RBI's Digital Payments Index (DPI)



Source: RBI staff illustration.

Chart III.17: RBI- Digital Payments Index



Source: RBI.

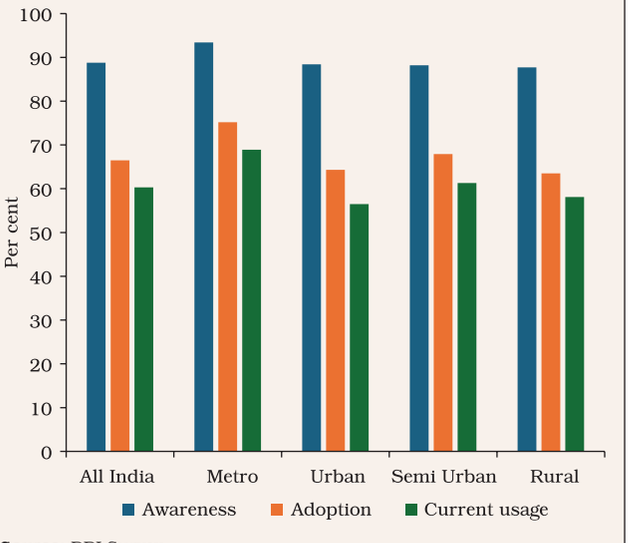
3.4. Awareness and Adoption of Digital Payments in India: Evidence from User Survey

III.42 Even as there has been significant progress in digital payments adoption in India as captured by the broad aggregates discussed above, micro level evaluation from the users' perspective is crucial to extract important policy lessons regarding the degree of penetration of digital payments as well as gaps, if any, which need focused attention. Accordingly, the Reserve Bank conducted a nationwide survey of merchants and consumers with approximately 90,000 participants from both the rural as well as urban areas in all States and Union Territories (UTs), ensuring a proportionate representation according to population size and geographies in 2022.[14] The major survey results are set out below.

3.4.1. Merchants

III.43 As per the survey, familiarity with digital payments is widespread across geographical locations with 88.8 per cent of the merchants being aware of digital payments (the highest in metro areas at 93.4 per cent). About two-third of the survey respondents had tried digital payments at least once.[15] The adoption levels were, however, lower than the awareness levels suggesting scope for expanding the usage of digital payments. In metro areas, the percentage of merchants who had adopted digital payments was higher at 75.2 per cent, along with higher current usage (Chart III.18). At an all-India level, about one-fifth of the merchants had never used digital payments despite being aware of it, while another 11.2 per cent had never used digital payments because of the lack of awareness. Around 60 per cent of

Chart III.18: Merchant Digital Payments – Awareness, Adoption and Usage in 2022



Source: RBI Survey.

[14] The survey's execution was delegated to National Payments Corporation of India (NPCI), and the field work for the survey was conducted from September 2022 to December 2022.

[15] If the respondent has used digital payments at least once in his/her life time, it is considered as 'adoption of digital payments' and if she/he continues to use digital payments at the time of survey, it is considered as 'usage of digital payments'.

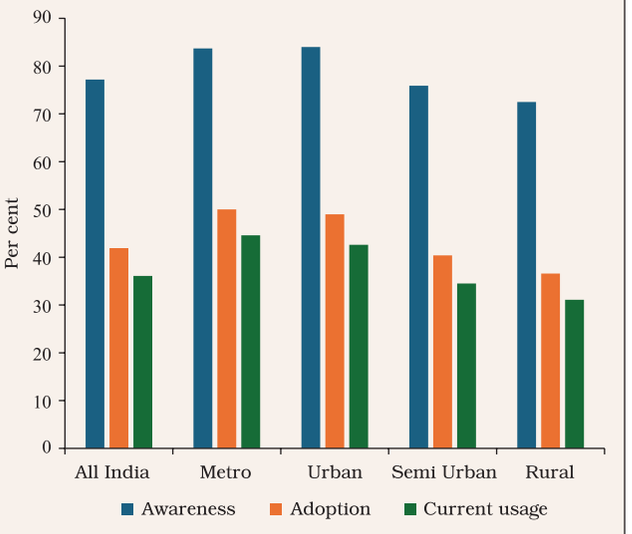
merchants observed an uptick in digital payments usage following the COVID-19 pandemic. This pattern was consistent across different groups, with a notably higher increase among merchants in metro areas.

3.4.2. Consumers

III.44 The pattern of digital payment awareness among consumers was like that of merchants, although the awareness levels were somewhat lower. As in the case of merchants, the awareness among metro and urban consumers was higher and the awareness in semi-urban and rural areas did not see a significant drop from the all-India average. The adoption levels among consumers were lower compared to merchants, with only 41.9 per cent consumers having used any of the digital payment modes at least once in their lifetime. The adoption of digital payment modes was higher in metros and urban areas. The conversion from awareness to trial was 54.3 per cent, suggesting scope for further penetration.

III.45 According to the survey, about 36.1 per cent consumers were current users of any of the digital payment modes in India. When compared to 41.9 per cent of users who have tried digital payments at least once, this translates to a conversion rate of 86.1 per cent, implying that most people having once used, continue to use digital payments regularly. This also indicates that efforts towards initiating consumers to digital payments on a trial basis could result in long term adoption. The current usage of digital payments was also found to be higher among metro and urban residents (Chart III.19). Approximately 4 in every 10 consumers reported that they started using digital payments post the pandemic. Among the remaining 59.9 per cent who had been using

Chart III.19: Consumer Digital Payments - Awareness, Adoption and Usage in 2022

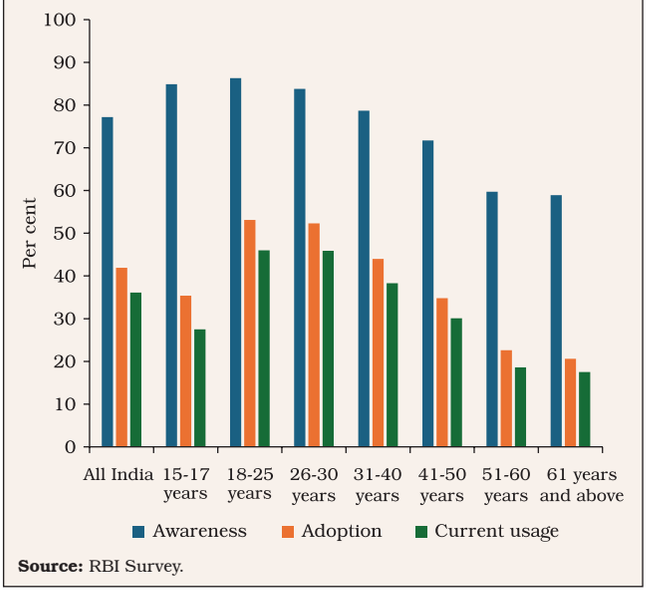


Source: RBI Survey.

digital payments pre-Covid, 64.7 per cent reported an increase in their usage post-Covid.

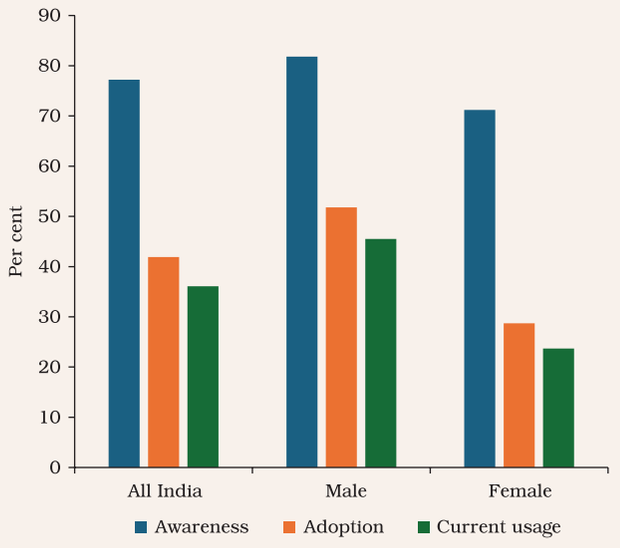
III.46 By age groups, the awareness of digital payments was high among the younger age groups. Adoption and current usage followed similar trends, with the age group 18-30 years using digital payments the most (Chart III.20).

Chart III.20: Consumer Digital Payments - by Age Group



Source: RBI Survey.

Chart III.21: Consumer Digital Payments - by Gender



Source: RBI Survey.

III.47 Awareness and usage levels among males were higher than females. While 51.8 per cent of the males had used digital payment mode at least once in their lifetime, the number was 28.7 per cent for females, according to the survey (Chart III.21).

III.48 Across states, the overall awareness was in the range of 60-93 per cent, with twelve states/UTs exhibiting awareness levels equal to or higher than the all-India average (Table III.2).

3.4.3. Key Drivers of Adoption of Digital Payments

III.49 The survey also elucidated information on what facilitated the adoption of digital payments ecosystem from the consumers' perspective. Ease and convenience were cited as key reasons, with 61.8 per cent consumers quoting the same. Amongst users of digital payments in the country, 86.6 per cent respondents did not face any difficulty while using digital payment methods. Among the small set of customers who did face difficulty while using digital payments, server being down/not working was reported as the key issue (59.1 per cent). Other challenges were

Table III.2: Consumer Digital Payments Awareness - by States

State/UT	Awareness (per cent)	State/UT	Awareness (per cent)
Andaman Nicobar Islands	81.6	Lakshadweep	84.4
Andhra Pradesh	73.5	Madhya Pradesh	69.2
Arunachal Pradesh	81.4	Maharashtra	74.8
Assam	75.8	Manipur	87.4
Bihar	84.4	Meghalaya	83.2
Chandigarh	73.7	Mizoram	80.6
Chhattisgarh	60.8	Nagaland	91.5
Dadra and Nagar Haveli	80.6	Odisha	82.7
Daman and Diu	92.1	Puducherry	78.8
Delhi	93.7	Punjab	77.2
Goa	86.4	Rajasthan	77.6
Gujarat	75.7	Sikkim	83.7
Haryana	93.3	Tamil Nadu	79.3
Himachal Pradesh	77.6	Telangana	70.5
Jammu and Kashmir	76.6	Tripura	66.7
Jharkhand	67.4	Uttar Pradesh	72.3
Karnataka	80.5	Uttarakhand	89.9
Kerala	85.1	West Bengal	78.8
All India	**77.2**		

Source: RBI Survey.

consumers' habituality with cash (30.7 per cent) and unacceptability of digital payments (19.7 per cent).

4. Impact of Digital Payments

III.50 Through their fast, convenient, cost-effective, and transparent nature, digital payments offer significant advantages to consumers as well as producers – they foster financial inclusion and inclusive growth and boost productivity and incomes. In a panel of 90 economies over 2014-19, a one percentage point increase in digital payments use was associated with 0.04 percentage point and 0.10 percentage point growth in total factor productivity and GDP per capita, respectively (Aguilar *et al.*, 2024). The study also found that digital payments facilitated greater access to credit and resulted in 0.06 percentage point decline in the share of informal

employment. Digital payments enhance the well-being of households by reducing the risk from economic shocks; they also facilitate informal-risk-sharing networks by facilitating timely transfer of small amounts of money, enabling mitigation of negative shocks, and more efficient investment decisions (Jack and Suri, 2014; Jack and Suri, 2011).

4.1 Financial Inclusion and Inclusive Growth

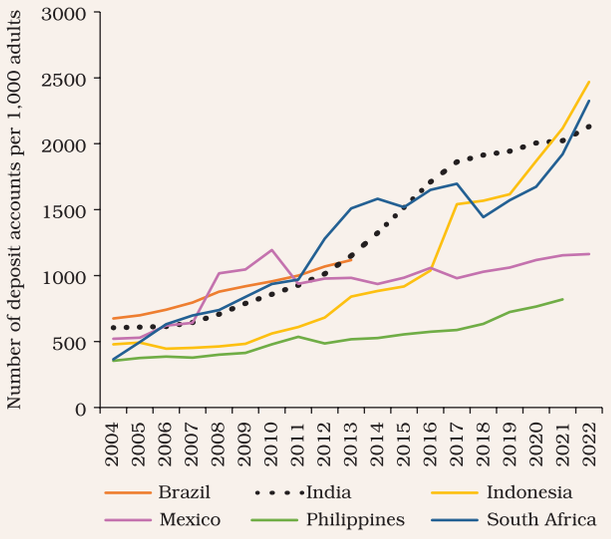
III.51 The emergence of digital payments has quickened the pace of financial inclusion by breaking many of the obstacles faced by traditional financial inclusion channels, like cost, geographical barriers, and information asymmetry (Khera *et al.*, 2022). Digital finance complements traditional finance in areas where formal finance is already engraved and supplements in places where traditional financial modes have limited reach. Inclusive digital financial services, including online accounts, mobile money services, electronic payments, combinations of insurance and credit as well as FinTech applications have the capacity to reach individuals and firms which were hitherto excluded. Digital financial services (DFS), by virtue of being faster, more efficient, and typically cheaper than traditional financial services, are becoming increasingly capable of reaching lower-income households as well as micro, small, and medium enterprises (MSMEs) [Khera, 2023]. The advent of digital innovations and payments has the potential to be an enabler for the next level of financial inclusion where the quality of inclusion takes precedence over just the availability of financial services (Rao, 2022).

III.52 By widening the reach of financial payments to poor households and micro enterprises, digital payments enhance their opportunities for participating in formal economic activities, fostering growth and bringing down poverty and inequality. Higher access to payment services is associated with a reduction in income inequality, particularly for those at the lower end of the income distribution, and when female financial inclusion is high (Čihák and Sahay, 2020). Additionally, DFS reduce gender gap in financial inclusion by addressing constraints that affect women in particular, such as mobility and time constraints (Khera, 2023). DFS also holds promise for reducing costs, improving speed, security, and transparency, and facilitating more tailored financial services that cater to the disadvantaged and underserved populations (Thomas and Hedrick-Wong, 2019; Pazarbasioglu *et al.,* 2020).

III.53 Digital payments help in consumption-smoothing and increasing savings for households, while helping in stabilising income and increasing sales for firms in the informal sector. In Bangladesh, mobile banking increased urban-to-rural remittances; rural households receiving digital payments borrowed less, saved more, and consumed more in the lean season (Lee *et al.,* 2021). Based on a study of 400 million mobile money users in India, Patnam and Yao (2020) found that mobile money use increased the resilience of households to shocks by dampening the impact of rainfall shocks on economic activity and household consumption. The study also indicated that firms adopting mobile payments improved their sales after six-months of use, had lower subjective uncertainty and greater sales optimism.

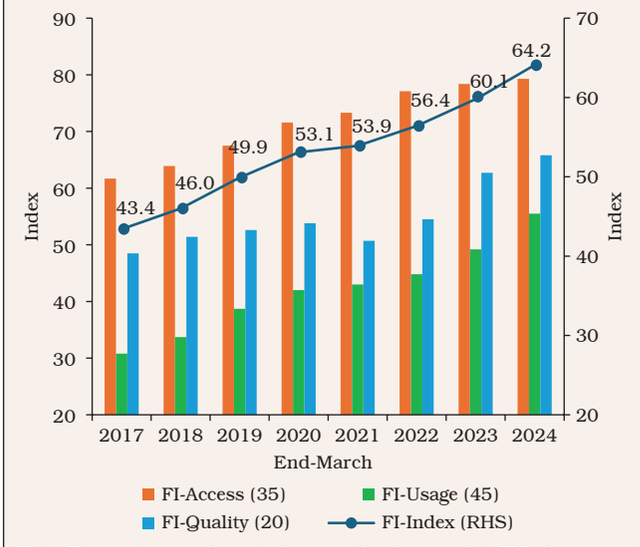
III.54 India's financial inclusion initiatives received a fillip when PMJDY was launched in 2014 (Chart III.22). The digital technological revolution widened the usability of bank accounts from a traditional deposit or credit account to a payment intermediary. As per the World Bank's Findex database, 78 per cent of Indian adults (population with 15 years or more of age) had a

Chart III.22: Deposit Accounts with Commercial Banks



Source: Financial Access Survey, IMF.

Chart III.23: Progress in Financial Inclusion (FI Index)



Note: Figures in parentheses indicate weights (per cent) in FI-Index.
Source: RBI.

bank account in 2021 as compared to 53 per cent in 2014.

III.55 The strides in furthering financial inclusion are captured by the Reserve Bank's Financial Inclusion Index (FI-Index), a comprehensive index incorporating details of banking, investments, insurance, pension as well as the postal sector. The FI-Index, on a scale of 0 to 100, comprises of three broad parameters, *viz.*, access (35 per cent), usage (45 per cent) and quality (20 per cent), with each of these consisting of various dimensions. The index improved to 64.2 in March 2024 from 43.4 in March 2017, with growth across all sub-indices (Chart III.23).

4.2 Improving Credit Assessment and Availability

III.56 Digital payments generate real-time data on sellers' businesses, timing of cash flows, and buyers' purchasing habits, allowing payment providers to offer credit, savings, wealth management, collections, insurance, and other financial services. Ouyang (2021) found that cashless payment adoption in China increased credit access by 56.3 per cent, and a 1 per cent rise in payment flow increased credit line by 0.4 per cent. These effects were found to be more pronounced among individuals with lower levels of education, and the older population. Digital payments also simplify the transaction process, making it faster and more efficient and eliminate manual cash handling and record-keeping. In India, internet adoption by small businesses has increased over the years, though the usage remains low. As per the Annual Survey of Unincorporated Sector Enterprises (ASUSE) 2022-23 (October-September), 21.1 per cent of unincorporated establishments used internet for entrepreneurial purposes during the year compared to 4.0 per cent in 2015-16[16]. A major share of these establishments with internet used internet banking (61.5 per cent) for business purposes during 2022-23.

[16] Estimated using microdata of National Sample Survey Office (NSSO) 73rd round - Survey on Unincorporated Non-Agricultural Enterprises (Excluding Construction) - July 2015- June 2016.

III.57 Digital payment history enables lenders to gauge cash flow, revenue patterns, and repayment habits of borrowers, enhancing their ability to obtain credit at more favourable lending terms and opportunities for expansion. This data-driven approach bridges the gap that often hampers credit access for smaller businesses. For India, Dubey and Purnanandam (2023) found that digital payments alleviated credit constraints and transaction cost frictions, especially in areas where the presence of conventional banking infrastructure was limited. Digital payment infrastructure helped reduce impediments faced by marginal self-employed households, such as hawkers and small traders; and small entrepreneurs' borrowing from formal sources of financing increased with digital payments. Additionally, digital payments help small businesses to innovate and explore new business models such as subscription services, online marketplaces, and digital platforms, enabling them to transcend geographical boundaries and reach a wider customer base both domestically and internationally.

4.3 Better Targeting of Government Support Schemes

III.58 Digital payment systems facilitate a cost-effective expansion of government-to-persons social assistance programmes, given their ability to reach far-flung and remote areas (Yawe *et al*., 2022). In India, one of the most significant impacts of digital payments on under-served populations has been through the implementation of DBTs. The *Aadhaar* Payment Bridge (Digital ID and Digital Payment) allowed the government to make direct transfers of subsidies, wages, and other

Table III.3: Gains from DBT and Other Governance Reforms of the Union Government
(Cumulative savings up to March 2023)

S. No	Ministry/ Department	Scheme Category	Estimated Savings / Benefits (in ₹ Cr)	Remarks
1	Ministry of Petroleum and Natural Gas	PAHAL	73,443	Elimination of 4.15 crore duplicate, fake/ non-existent, inactive LPG connections.
2	Department of Food and Public Distribution	PDS	185,573	Deletion of 5.04 crore duplicate and fake/ non-existent ration cards.
3	Department of Rural Development	MGNREGS	42,534	Deletion of 7.10 lakh fake job cards (2022-23).
4	Department of Rural Development	NSAP	537	Deletion of 11.05 lakh duplicate, fake/ non-existent, ineligible beneficiaries.
5	Ministry of Minority Affairs	Scholarship Scheme	1,917	Deletion of 30.92 lakh duplicate, fake/ non-existent beneficiaries.
6	Department of Social Justice and Empowerment	Scholarship Scheme	1,055	Deletion of 12.28 lakh duplicate, fake/non-existent beneficiaries.
7	Ministry of Women and Child Development	Others	1,524	Reduction of 98.8 lakh duplicate, fake/non-existent beneficiaries.
8	Department of Fertilizers	Fertilizer	18,700	Reduction of 158.06 lakh metric tonnes of fertilizer sale to retailers.
9	Department of Agriculture and Farmers Welfare	PM-KISAN	22,106	Deletion of 2.12 crore ineligible beneficiaries.
10	Others	Others	1,176	
	Total		348,565	

Note: PAHAL: *Pratyaksh Hanstantrit Labh*; PDS: Public Distribution System; MGNREGS: Mahatma Gandhi National Rural Employment Guarantee Scheme; NSAP: National Social Assistance Programme; PM-KISAN: *Pradhan Mantri Kisan Samman Nidhi Yojana.*

Source: Direct Benefit Transfer Mission, Government of India.

benefits into beneficiaries' bank accounts in an efficient, transparent, and speedy manner, while reducing leakage and corruption. The number of transfers as well as the total amount transferred under DBTs have witnessed a significant rise in recent years (See Chapter I, Chart I.19). DBTs and other governance reforms have led to an estimated savings of ₹3.49 lakh crore till March 2023 (Table III.3). During 2023-24, 1006 crore DBT transactions were made by the Central Government amounting to ₹ 6.9 lakh crore.[17]

4.4 *Impact on Central Banking Operations*

III.59 The rapid pace of technological advancements in digital payments could have a significant bearing on monetary transmission mechanism and central banks' operational frameworks and instruments. This would require them to adapt their policies and frameworks to navigate the realities of the new financial landscape efficiently and effectively to maintain their key objectives of price and financial stability (BIS, 2020).

4.4.1. Money Demand

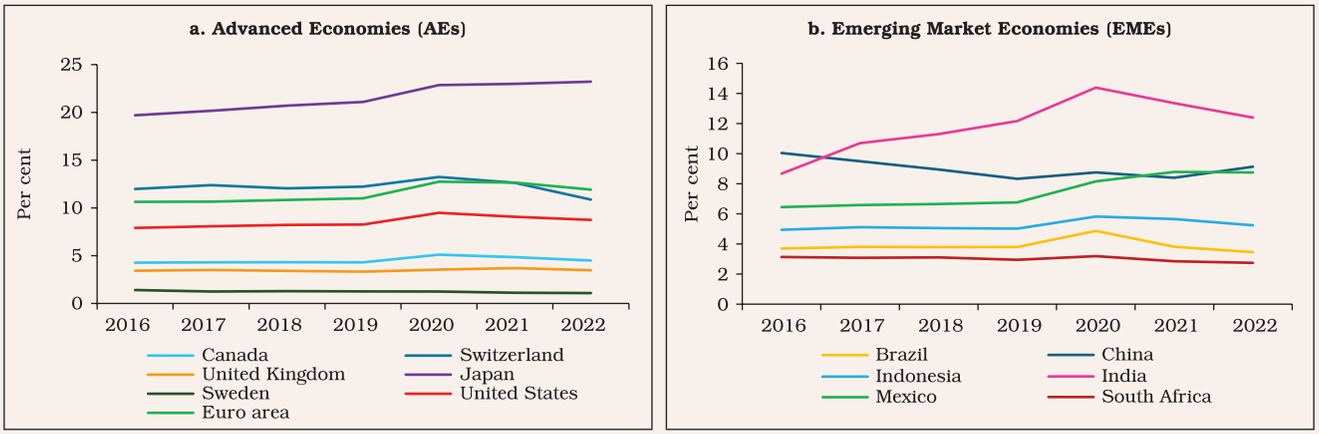
III.60 Even as digital payments are growing rapidly, demand for cash still remains generally high. Cash continues to be used as a store of value and a preferred choice during periods of heightened uncertainty, as seen during the COVID-19 pandemic (Ashworth and Goodhart, 2021; Awasthy *et al.*, 2022). It is also the dominant mode of payment for certain segments of population, like older people (Khiaonarong and Humphrey, 2022). These developments and country-specific factors are reflected in divergent currency to GDP ratios and trends across the world. For instance, among the major AEs, Japan has the highest currency in circulation (CiC) to GDP ratio, which is even higher than major EMEs (Chart III.24). Sweden's payments market, on the other hand, has digitalised at a rapid pace, with its CiC to GDP ratio at 1.1 per cent in 2022, among the lowest in the world.

III.61 In India, currency/GDP ratio has been broadly range-bound in recent years, with variations due to events such as demonetisation in 2016 (and subsequent remonetisation), a temporary jump in precautionary demand due to uncertainties induced by the COVID-19 pandemic and the withdrawal of ₹2000 banknotes in May 2023 (Chart III.25a). CiC growth has recorded some moderation amidst strong expansion in digital payments (Chart III.25b). The negative and statistically significant substitution effect between cash and digital modes can, however, be outweighed by the combination of positive income and precautionary effects depending upon the prevailing circumstances (Awasthy *et al.*, 2022).

III.62 Digital payments influence monetary aggregates – both narrow money (M1) by influencing CiC and demand deposits (Columba, 2009) and broad money (M3) by affecting levels of saving and deposits (Demirgüç-Kunt *et al.*, 2022). Further, as transactions become faster and more seamless in the digital mode, money can change hands faster, thereby affecting the velocity of money. Digital payments can also make it easier to respond to changes in interest rates, with implications for interest rate sensitivity of money and monetary policy transmission (Kahn *et al.*, 2022). In several countries, like the US, Canada, China, Kenya, Singapore, and Sweden, the digitalisation of payments was accompanied by a structural shift and instability in money velocity. The effect was, however, dampened

[17] As on July 12, 2024.

Chart III.24: Currency in Circulation (CiC) to GDP Ratios



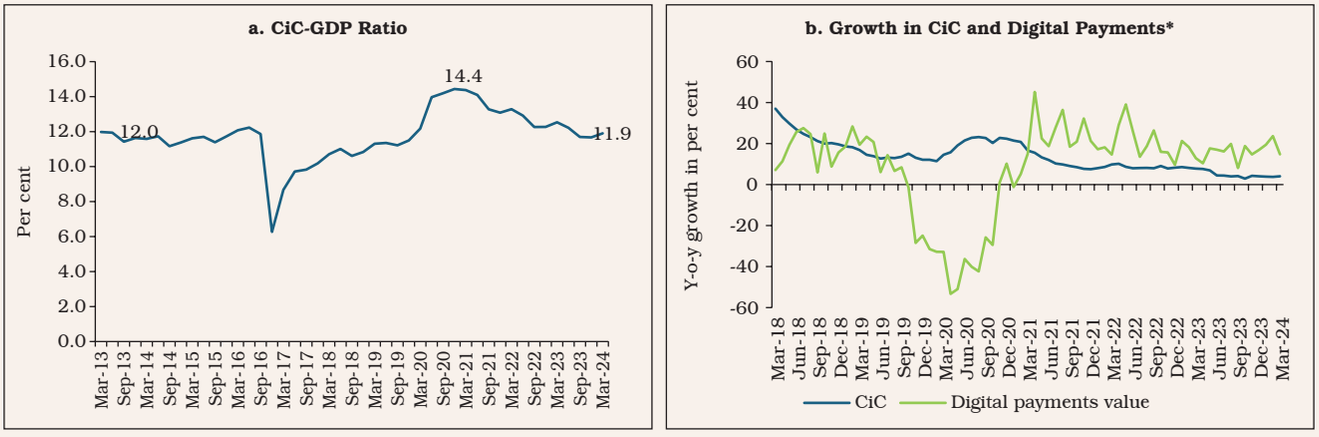
Source: BIS Red Book Statistics.

by other macroeconomic factors. In the US, important innovations in the payment space were accompanied by an increase in income velocity of M1, while a decline of the same was registered in the aftermath of the GFC and the COVID-19 pandemic. Canada experienced a similar uptick in money velocity for narrow money, coinciding with the introduction of credit cards. In the case of China, expansion in mobile money around 2002 led to an increase in volatility of money velocity (Lukonga, 2023).

III.63 In India, in the aftermath of the COVID-19 pandemic, M3 growth accelerated transiently, as its largest component, aggregate deposits, grew sharply owing to COVID-19 induced uncertainties and the lack of avenues to spend (Chart III.26). This also led to a sharp drop in the velocity of money (RBI, 2021b). The velocity of money returned to its long run trend in 2022-23 (RBI, 2023).

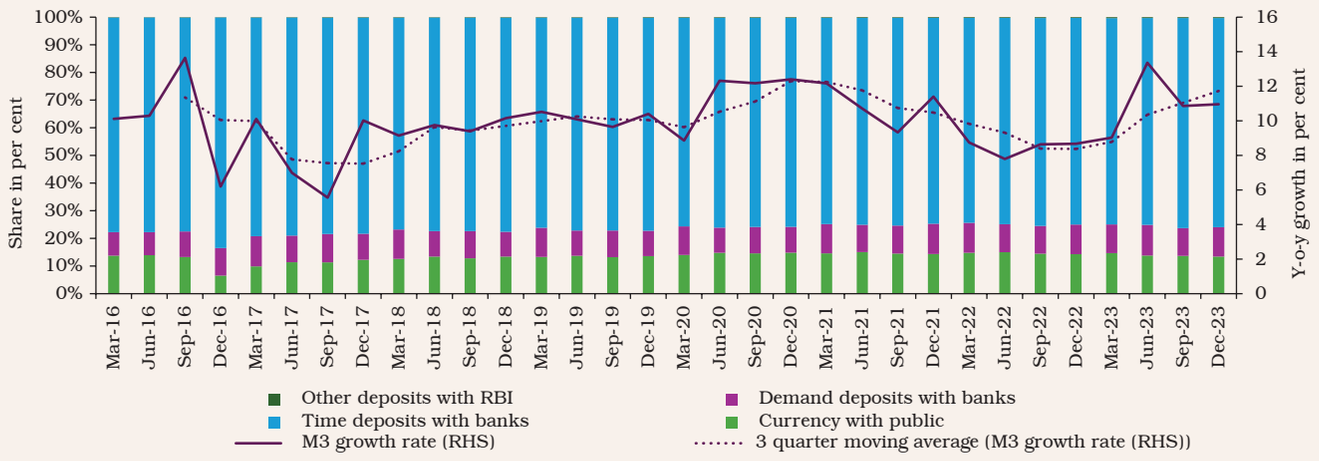
III.64 In India, financial innovations (cards and mobile banking, among others) are important determinants of real money balances (Adil *et al.*,

Chart III.25: CiC and Digital Payments in India



Note: *Total digital payments.
Source: RBI.

Chart III.26: India's Broad Money (M3) and its Components



Source: RBI.

2020). In China, digital finance impacts stability of money demand differently across monetary aggregates: it leaves M0 unaltered, has no effect on the volatile M1, but disrupts the previously stable M2 (Zhan *et al.*, 2023). In Italy, the diffusion of ATMs and PoS had a negative impact on CiC, but a positive impact on M1, as payment innovations lead to a shift away from cash towards demand deposits (Columba, 2009). In the Indian context, digitalisation appears to reduce money demand (Box III.2).

4.4.2. Impact of CBDC

III.65 CBDCs are being introduced in different economies in pilot mode, including India. While CBDCs offer a range of benefits like reduced dependency on cash, lower currency management cost and reduced settlement risk, these also have implications for financial stability, monetary policy, financial market structure, and cost and availability of credit (RBI, 2022b). Conceptually, CBDCs can induce changes in public's demand for currency; banking system deposits and credit; retail, wholesale and cross-border payments; and monetary policy implementation and transmission. CBDC can reduce transaction demand in deposits, as it brings down settlement risk, reducing the liquidity needs for settlement of transactions (Sankar, 2021). At the same time, it can also reduce bank deposits affecting the credit creating capacity of commercial banks. As deposits are a cheap and stable source of funding for banks, substitution of bank deposits with CBDCs could impact banks' overall funding, and ability to lend (Chang *et al.,* 2023). Bank disintermediation due to introduction of CBDCs would depend, *inter alia*, upon the design features of the CBDC (for example, whether remunerative or not). CBDCs could also impact the commercial bank reserves at the central bank and open market operations. Countries with banking systems dominated by small retail deposits and a high share of non-interest-bearing demand deposits could be more vulnerable to deposit disintermediation (Lukonga, 2023). The implications of CBDC for central banking operations and monetary policy essentially depend on the way it is designed and its degree of usage. If the CBDCs get a positive remuneration, higher usage and adoption of CBDCs could weaken monetary policy transmission. A reduction in availability, and/or an increase in the cost

Box III.2
Impact of Digital Payments on Money Demand

With digitalisation gaining traction, digital payments have emerged as an attractive alternative to cash, with potential implications for demand for money and monetary aggregates. Using quarterly data from June 2013 to March 2023, an Autoregressive Distributed Lag (ARDL) model (Pesaran *et al.,* 2001) is deployed to examine the dynamic relationship between money demand (Broad money M3) and digitalisation in payments. Based on Adil *et al.* (2020), money demand is postulated to depend upon nominal income (income effect, represented by gross domestic product (GDP) at market price, 10-year G-Sec yield (opportunity cost of holding money balances) and total value of digital payments. Further, to capture wealth/ substitution effects, stock price (closing values of BSE Sensex) is included in the model. GDP, M3, Sensex and digital payments are seasonally adjusted using X-13 ARIMA filter and log-transformed. The effect of demonetisation and the COVID-19 pandemic are controlled through dummy variables. All variables considered in the regression are either I(0) or I(1), as is the requirement of ARDL model which takes the following general long run form:

$$LM3_t = c + \sum_{i=1}^{p} \varphi_i \, LM3_{t-i} + \sum_{i=0}^{q} \beta_i X_{t-i} + \sum_{t=0}^{n} D_t + \varepsilon_t$$

where, $LM3$ is log of broad money (M3), X_i are the explanatory variables (nominal GDP, 10-year G-Sec yield and value of digital payments). D_t are the dummy variables, as noted above. ε_t is the white noise error term and p and q are the optimal lag lengths.

The corresponding error correction model (ECM) form is given by the following equation:

$$\Delta \mathrm{LM3}_t = c_0 + \sum_{i=1}^{p-1} \alpha_i \Delta LM3_{t-i} + \sum_{i=0}^{q-1} \delta_i \Delta X_{t-i} + \sum_{t=0}^{n} D_t + \gamma ECM_{t-1} + \varepsilon_t$$

where, Δ is the first difference operator and ECM_{t-1} is the error correction term which measures the deviations from long-run equilibrium relationship. The Akaike Information Criterion (AIC) suggests an ARDL (4,2,0,1,3) model. The bounds test establishes the existence of a long-run equilibrating relationship between the variables (Table 1).

Table 1: Bounds Test Results

Test Statistic	Value
F-statistic	8.419***

Note: *** denotes significance at 1 per cent.
Source: RBI staff estimates.

Table 2: Long-run and short-run ARDL Results

Dependent variable: *Log_M3*		
Sample period: June 2013 - March 2023		
Variable	**Coefficient**	**Standard Error**
Long-run equation		
log_Nominal GDP(-1)	1.25***	0.26
log_Digital Payments (-1)	-0.33**	0.13
G-Sec_Yield	-0.08**	0.03
Sensex (-1)	-0.10	0.19
Constant	4.66**	1.92
ECM term		
Gamma	-0.14***	0.02
Short-run equation		
D(log_M3(-1))	-0.52***	0.09
D(log_M3(-2))	0.41***	0.09
D(log_M3(-3))	0.23**	0.09
D(log_NGDP)	-0.085*	0.04
D(log_NGDP(-1))	-0.072**	0.03
D(log_DIGI_S)	0.02	0.02
D(log_SENSEX)	0.06***	0.02
D(log_SENSEX(-1))	0.02	0.02
D(log_SENSEX(-2))	-0.07***	0.02
Demonetisation Dummy	-0.04***	0.00
Covid-19 Dummy	-0.03**	0.01
Observations	40	
Adjusted R-squared	0.73	
Log-likelihood	154.01	

Note: 1. ***,**,*: indicate significance at 1, 5 and 10 per cent level, respectively.
2. D denotes first difference operator.
3. Data pertains to all digital payments.
Source: RBI staff estimates.

The long-run coefficients and the short run dynamics are presented in Table 2. In the long-run, money demand is positively associated with income and negatively with digital payments and G-sec yield. Thus, growth in digital payments can dampen the demand for money. The error correction coefficient is negative and significant, and about 14 per cent of any deviation from the long run equilibrium path is corrected within one quarter.

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Pesaran, M. H., Shin, Y., and Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics, 16(3)*, 289-326.

of credit from the banking sector could impact aggregate demand and supply in the economy and weaken the bank lending channel of monetary policy transmission; alternatively, positively remunerated CBDCs could lead to more effective monetary policy transmission as banks will need to compete for more deposits, and thereby maintain competitive deposit rates. Further, interest bearing CBDCs could transmit monetary policy actions directly to economic agents improving efficacy of transmission (RBI, 2022c).

5. Challenges in the Digital Payments Landscape and Way Forward

III.66 India has made significant strides in digital payments. Small value transactions majorly account for digital payments, and there is immense scope for a further jump in their usage. Ensuring that digital payment systems are accessible and affordable for all segments of society, including those without access to smartphones or the internet, is an ongoing challenge. While many individuals may technically have access to digital financial services, regular and meaningful use could be impeded by barriers like financial literacy, mistrust in digital systems, insufficient network infrastructure, and the complexity or inaccessibility of digital financial products.

Financial Literacy

III.67 Financial literacy (FL) is a precondition for promoting digital financial inclusion. Barriers in FL explain some of the variation in usage of digital financial services and financial inclusion across countries (Sahay *et al.,* 2020). As per the financial literacy and inclusion survey carried out by the National Centre for Financial Education (NCFE) in 2019, only 27 per cent of the respondents had achieved minimum required FL levels.[18] Furthermore, heterogeneity exists between the components of FL within the socio-economic groups with urban respondents as well as salaried class/retired persons reporting higher level of FL (Jangili *et. al.,* 2023).

Digital Divide

III.68 Although there has been a consistent increase in the availability of digital infrastructure in the country, as of April 2024, internet penetration[19] in the country at 55.3 per cent is below the worldwide average of 67.1 per cent.[20] Moreover, there is geographical and regional divide in the availability: internet subscriptions per 100 population in urban areas were more than 2 times higher (111.8) compared to rural India (44.2) with an all-India average of 68.2 (TRAI, 2024). Among the rural households, only 9.9 per cent have access to a computer, while the proportion is 32.4 per cent among the urban households (NSO, 2019). On the positive side, internet costs in India are among the lowest in the world, with 1GB data costing on average US$ 0.17 in 2022.[21] Tele-density at the all-India level was at 85.2 per

[18] OECD/INFE (International Network for Financial Education) guidelines were followed, wherein a person is regarded financial literate if he/she has a combined score of at least 15 out of 22 with a minimum of 3 in financial attitude, 6 in financial behaviour and 6 in financial knowledge. If a respondent continues to use digital payments at the time of survey, it is considered as 'usage of digital payments'.

[19] Percentage of population using the internet.

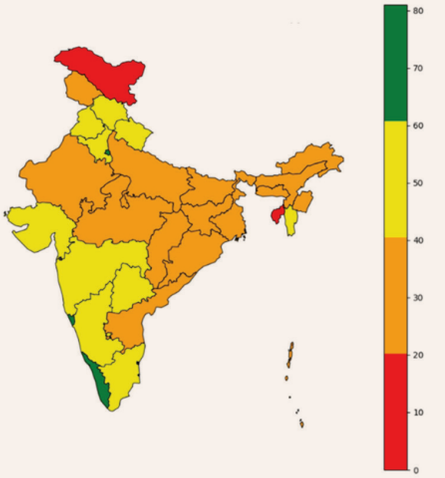
[20] Retrieved from https://www.meltwater.com/en/resources/digital-2024-april-global-statshot-report on July 24, 2024.

[21] Statista.

cent, with urban areas and rural areas being at 133.8 per cent and 58.6 per cent, respectively.[22] Similarly, in case of digital literacy, wide diversity exists across states (Chart III.27).

III.69 Improved tele-density in rural areas and increased internet access could contribute to further penetration of digital payments in the country. Service providers can ensure availability through community networks and public WiFi/ internet access points. Innovative solutions, such as NFC-enabled QR codes, could address these concerns related to digital access to some extent and scaling up the infrastructure requirements, particularly in rural areas, would hasten seamless adoption of digital payments in the country.

Chart III.27: Digital Literacy across States and UTs, Rural and Urban Areas Combined



Note: Percentage here indicates percentage of digitally literate households among total households. Map is for illustrative purpose only.
Source: Mothkoor and Mumtaz (2021).

Consumer Protection: Concerns Emanating from Digital Payments

III.70 A pre-requisite for wider use of digital payments is ensuring security of payments. Cybersecurity threats in the digital payments ecosystem not only pose risks to the integrity and availability of payment systems but also undermine consumer trust and financial stability. Key cybersecurity threats in digital payments include phishing, card skimming, man-in-the-middle attacks, malware, ransomware, among others, and a focused arttention is required to ensure that risks arising from such threats are mitigated and customers' interests are protected. As per the Reserve Bank's survey regarding awareness and use of digital payments, 94.5 per cent users reported that they have not experienced any fraud. The incidence of an encounter with fraud or attempted fraud was lower in metros (4.1 per cent) relative to semi-urban areas (6.4 per cent). Vishing emerged as the most prevalent method in frauds or attempted frauds (54.2 per cent), followed by phishing (37.2 per cent), misuse of 'collect request' (28.7 per cent), and remote access (25.5 per cent).[23] Additionally, approximately 11 per cent of digital frauds or fraud attempts involved the use of fake numbers associated with e-wallets or banks. While at the aggregate level, the incidence of fraud is low, digital payments can attract more users by ensuring safer, reliable, and trustworthy digital payment ecosystem.

III.71 The gamut of cybersecurity threats in digital payments is complex and constantly evolving, requiring a multifaceted approach to risk management. Financial institutions, PSPs, and consumers must collaborate to enhance the security of digital payment systems. Adopting advanced technological solutions, promoting cybersecurity awareness, and adhering to best practices and regulatory standards will ensure that the risks are minimised.

[22] The Indian Telecom Services Performance Indicators, Telecom Regulatory Authority of India, October-December 2023.

[23] The total may add up to more than 100 as same individual can select more than one response.

Scalability Issues

III.72 Digital payment solutions need to be scaled up to handle the growing number of transactions without compromising performance or security. Scalability issues can lead to system outages, slow transaction processing, and customer dissatisfaction. As the digital economy continues to expand, the ability to scale efficiently will be a crucial factor for the success and resilience of payment systems worldwide. It will require a combination of technological innovation, strategic planning, and collaboration across the financial ecosystem. By investing in scalable infrastructure, embracing modern architectural approaches, and leveraging new technologies, payment providers can enhance their capacity to support growth, maintain performance, and ensure the security and reliability of digital transactions.

Dark Patterns

III.73 As discussed in Chapter I, digital platforms often employ "dark patterns" in their user interfaces - design choices that manipulate users into making decisions that may not be in their best interest, such as subscribing to services they do not need or sharing more personal data than necessary. These practices can undermine trust and raise ethical concerns. These tactics exploit psychological biases and can significantly impact user trust and financial well-being. Some common dark patterns encountered in the realm of digital payments are hidden fees, forced recurring subscriptions, complicated cancellation process, bait and switch[24], sneak into basket[25], incomplete payment disclosures, and false urgency[26]. The challenge is to ensure that the payment systems remain one step ahead of the malicious agents and safeguard customers from these threats to retain and strengthen their trust (Rao, 2023).

III.74 Laws and guidelines protecting consumers from deceptive practices and consumer awareness can go a long way in combating dark patterns. Digital literacy programmes that cater to the specific needs and capabilities of different demographic groups could increase awareness through hands-on training on how to use digital financial services, navigate online platforms, and protect against cyber risks (Swaminathan, 2024).

6. Concluding Observations

III.75 Countries have embraced diverse models of digital payment methods, shaped by their technological preparedness, financial environment and demography. Unlike the other major technological advancements where AEs had taken a lead in adaptation and EMEs have had to catch-up, the ongoing digital payment revolution is spearheaded by EMEs. India is heralded as a global leader whose experience holds important policy lessons for other countries. The evolution of India's digital payments landscape has been driven by concerted efforts to modernise the existing systems as well as bring in new forms of payments in a proactive manner. The Government, the Reserve Bank and other public institutions aided infrastructure building which helped consumers and other agents in adoption as well as ensuring that the growth is inclusive. The intersection

[24] Promotions or offers that catch a user's attention may lead them towards initiating a transaction. However, at the last moment, the conditions change, or the offer is no longer available, and users are steered towards making a more expensive purchase.

[25] During the checkout process, additional products or services (such as warranties or donations) are automatically added to the user's basket. Users may not notice these additions and may inadvertently purchase them.

[26] A countdown shown to nudge users into hasty purchases.

of technology, regulation, and collaboration supplemented innovation by providing a robust feedback loop that expanded financial access and deepened digital infrastructure, making India a global leader in digital payments.

III.76 The Reserve Bank's survey shows that both consumers and merchants exhibit high levels of awareness of digital payments. Certain aspects, however, require policy focus, such as the gap between awareness and adoption rates. The conversion rates for those who have at least once tried digital payments to a regular user is high. This underscores the importance of initiatives aimed at introducing users to digital payments for long-term usage. Younger age groups have a definitive advantage over the older cohorts in adopting digital payments. Increasing the awareness levels across the age groups would reduce the risk of vulnerable sections being subject to potential frauds and other cyber malpractices.

III.77 India's experience further shows that digital payments play a pivotal role in promoting financial inclusion by overcoming obstacles such as distance, cost, and accessibility, thereby broadening the availability of formal financial services. Moreover, they facilitate enhanced credit availability and accessibility for businesses, offering several advantages for small enterprises. Through enabling direct transfer of subsidies, wages, and other benefits into recipients' bank accounts, digital payments have enhanced the efficiency, transparency, and swiftness of such programmes. Finally, innovations in payments systems, including CBDCs, alter the environment in which the central bank operates and could have far reaching implications on monetary policy transmission, its own operational framework and objectives of price and financial stability.

III.78 Overall, India stands ready to further harness the benefits of the digital payments revolution, leveraging on a rapidly growing economy, a large and young population, increasing internet and smartphone penetration, and supportive government policies. These factors create a fertile ground for further innovation, investment, and growth in digital payments. India's rich and successful experience in digital identity and payments offers fine guidance on pathways to improving the lives of the common man (Das, 2023b).

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IV OPEN ECONOMY DIGITALISATION: CHALLENGES AND OPPORTUNITIES*

Open economy digitalisation[1] *offers unique opportunities for India to reap dividends from cross-border digital trade. India's state-of-the-art digital public infrastructure (DPI) has enormous potential for enhancing cross-border trade across sectors like finance, health, education, agriculture and MSMEs and boosting India's productivity and growth potential. The rising digitalisation share in cross-border remittance flows would help reduce the cost of sending remittances, increase their volume and improve income of the recipients. The internationalisation of the INR is benefitting from the comprehensive and integrated approach and would impart vibrancy to India's external sector. India's DPI resilience can be augmented by strengthening self-reliance in sea cables, expanding satellite internet connectivity, making UPI global, and providing pro-active policy support to data localisation. There exists immense potential in building cross-border interoperable fast payment systems and CBDCs to leverage open economy digitalisation.*

1. Introduction

IV.1 India has embarked on a transformative journey to become a developed nation by 2047. This aspiration will get a boost from the significant progress that has been achieved in India's digital public infrastructure (DPI) and the potential to scale it up manifold. The "India Stack" is well recognised as a world-class DPI which has fostered innovation and competition, promoted financial inclusion, improved efficiency of public expenditure, facilitated direct transfers of social safety payments, and reduced leakages and corruption (Alonso *et al.,* 2023). There exists enormous potential to leverage India's DPI in an open economy setting to expand and diversify digital merchandise and services trade, promote cost-effective remittances, and increase FDI into digital sectors. By enabling its emergence as a preferred currency for cross-border payments, digitalisation also presents opportunities for hastening internationalisation of the rupee. The DPI can be easily exported due to its open and modular architecture. In this context, this chapter provides an in-depth assessment of the opportunities and challenges related to open economy digitalisation.

IV.2 Digitalisation is set to break the *'iron laws'* of cross-border trade and bring about a fundamental structural shift in global production processes, trade, and investment flows *via* the re-allocation of tasks through the use of robotics, automation and artificial intelligence (AI), servicification of the production processes and the rise in e-commerce (Bekkers *et al.,* 2021). Geographically, digital trade has been gradually shifting from advanced economies (AEs) to emerging market economies (EMEs) [IMF, OECD, UN, and WTO, 2023].[2] India's digital trade is projected to increase to US$ 2.4

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1 Open economy digitalisation refers to the use of digitally-enabled products/services in trade, income and investment in a cross-border setting.

2 In 1995, OECD countries represented 82 per cent of estimated global digital trade (exports). Their share fell to 73 per cent by 2018 (González *et al.,* 2023).

trillion in 2047 - more than 13 times its level in 2020. India's fast adoption of frontier technologies and its state-of-the-art DPI encompassing an array of critical sectors in the economy such as finance, health, education, industry and governance are expected to expand economic opportunities while strengthening its linkages with the rest of the world. Cross-border digital ordering and delivery of goods and services have picked up at an accelerated pace since the pandemic.[3] During the pandemic, digital trade enhanced economic resilience across geographies by maintaining business operations and delivering goods and services amidst physical restrictions.

IV.3 Digitalisation is also rapidly transforming cross-border migrant remittances and global capital flows by lowering costs, increasing transparency and efficiency, fostering financial inclusion, and aiding coordination and risk management. Given considerations of financial stability and global coordination, the shift towards open economy digitalisation is expected to be gradual and measured, which has been India's approach. The internationalisation of the UPI is a pertinent example of this approach. The initial steps were aimed to enable Indian travellers and diaspora to make merchant payments using UPI abroad. The next upgradation was the ability to make person-to-person remittances using UPI with the same efficiency as of domestic transactions. Going forward, the goal is to globalise the UPI such that every other country will have some fast payment system (FPS), either its own or the UPI (Sankar, 2023). Such a network would ensure that all cross-border payments can happen on a FPS, which augurs well for global trade and payments. Central bank initiatives such as interlinkage of FPSs across economies and central bank digital currencies (CBDCs) are expected to support seamless international transactions, reduce foreign exchange risks and effectively manage global liquidity.

IV.4 While digitalisation in an open economy brings immense benefits, it is not devoid of challenges. These include, *inter alia*, ensuring interoperability and adoption of standards; cross-border digital governance and accountability; rising technological dependency and disruption risks; digital monopolies and market concentration; and safeguarding intellectual property. Policies on data security and privacy need to strike a delicate balance between global harmonisation and country-specific preferences. Moreover, digital trade policies may be needed to prevent digital trade wars. The volume and types of cross-border transactions and exchanges have increased significantly. This necessitates measurement of digitalisation in the System of National Accounts (SNA) and Balance of Payments (BoP) statistics. Moreover, the adoption of digital supply and use tables (DSUTs) could improve the measurement of the digital economy (OECD, 2024a). To be future ready, there is also a need to enhance India's DPI resilience by building self-reliance in sea cables, expanding satellite internet connectivity, ramping up cybersecurity, and providing pro-active policy support to data localisation.

IV.5 Against this backdrop, this chapter discusses digital trade in goods and services,

[3] As per IMF (2018a), digital trade is defined as all cross-border transactions that are either digitally ordered (*i.e.*, cross-border e-commerce), digitally facilitated (by platforms) or digitally delivered. While digital trade forms a part of the conventional cross-border trade statistics, non-monetary digital flows, which comprise cross-border non-monetary information and data flows, are not included.

digital remittances, and digital capital flows, while also focussing on supply-side enablers such as DPIs, cross-border FPSs, CBDCs, and data embassies. Section 2 delves into the existing landscape, significance, and prospects of digitalisation within India's external macroeconomic framework. Digitalisation of trade, services and remittances is discussed along with the implications for the internationalisation of the INR. Section 3 explores the supply-side dimensions, such as the expanded influence of India's DPIs on the global stage, with a special focus on the internationalisation of the UPI and global prospects stemming from CBDCs. Section 4 elucidates opportunities for India from data localisation in the realm of data centre infrastructure. Section 5 discusses the potential challenges due to rapid advancements in digitalisation. Section 6 provides concluding remarks.

2. India's Journey Towards Open Economy Digitalisation

IV.6 The digital economy encompasses all activities that use digitised data and can be measured as the contribution of economic transactions, that involve both digital products and digital industries, to output (IMF, 2018b; ADB, 2021). Digital products are goods and services that primarily generate, process, and/or store digitised data, while digital industries are producers that primarily produce such products. Within digital economy, 'core' digital economy includes economic activity from core information and communications technology (ICT) goods and digital services producers in the following five product groups: hardware, software publishing, web publishing, telecommunications services, and specialised and support services. The broader concept of 'digitally dependent economy' is the combined output from the core digital sector and ten digitally disrupted sectors[4], with the latter as defined by the UN Advisory Expert Group on National Accounts, 2019. In 2019, the size of the core global digital economy was estimated at 8.8 per cent of world output, and the corresponding figure for India was 8.5 per cent[5]. India's overall digitally dependent economy was estimated at around 22 per cent of GVA in 2019 (Gajbhiye *et al.,* 2022).[6] India's performance on various indicators of the digital economy compares well against many of its peer EMEs (Chart IV.1).

IV.7 Within a digital economy, cross-border digital trade constitutes a key component. While traditional trade statistics make a distinction between cross-border trade in goods and services and further classify services based on the four modes of supply[7], digital trade entails new dimensions. The growth of cross-border e-commerce has helped in identifying the ordering and delivery process (both of which

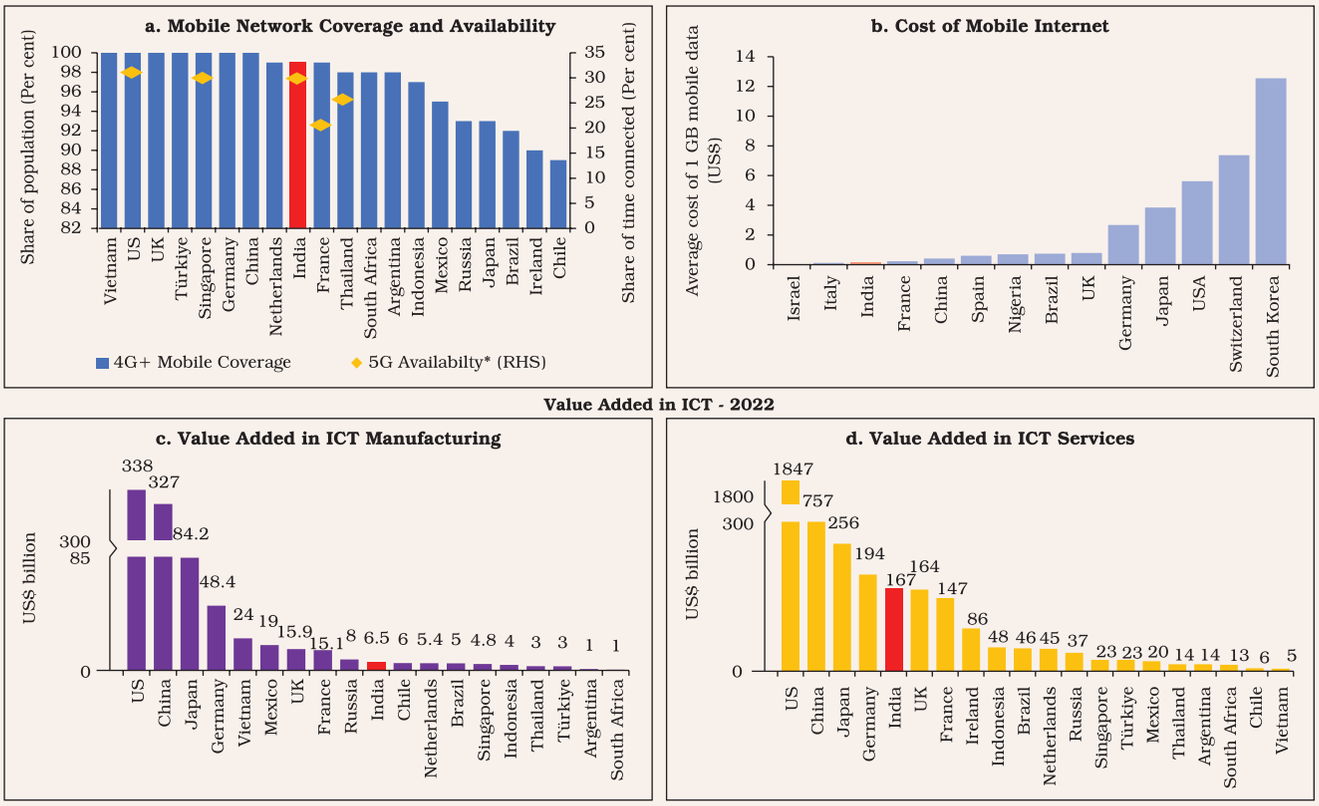
[4] These 10 digitally disrupted sectors include: land transport services and transport services *via* pipelines; accommodation services; food and beverage serving services; publishing services; motion picture, video and television programme production services; sound recording and music publishing services; financial and insurance services; advertising and market research services; travel agency, tour operator and other reservation services; education services; and gambling and betting services.

[5] Estimate for the global digital economy is from ADB (2021) and for the Indian digital economy is from Gajbhiye *et al.,* (2022).

[6] Gajbhiye *et al.,* (2022) follow the Asian Development Bank (ADB) approach that uses national Input-Output Tables (IOTs) to measure the size of the digital economy.

[7] The General Agreement on Trade in Services (GATS) distinguishes between four modes of supplying services: cross-border trade, consumption abroad, commercial presence and presence of natural persons.

Chart IV.1: Cross-Country Indicators on Digital Infrastructure and Value Added in ICT Digital Infrastructure - 2022

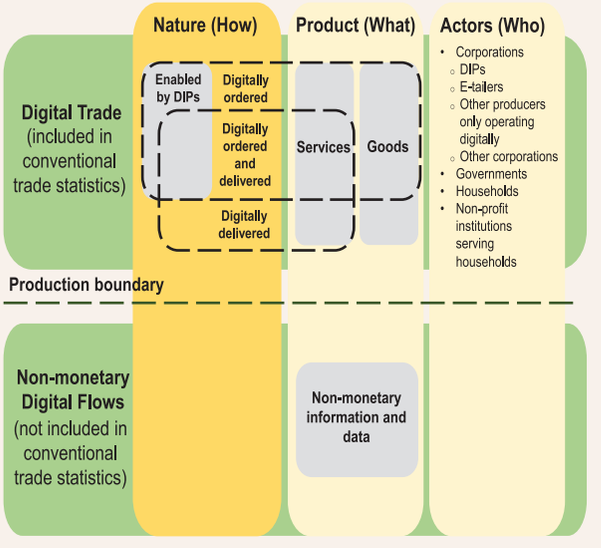


Note: Per cent share of time connected in Chart (a) indicates availability expressed as the share of time users spend connected to 5G. *: Data pertain to 2023.
Source: World Bank (2024a) and Statista (2023).

can be digital), and has also brought attention to the different (institutional) nature of partners involved in international trade. The literature identifies three key dimensions of digital trade [Chart IV.2] – the nature of the transaction ('how'), the product ('what') and the partners involved ('who') – and suggests a close relationship between digitalisation, internet connectivity and international trade (Choi, 2010; Lin, 2015; González and Sorescu, 2021; Herman and Oliver, 2023).

IV.8 Digitalisation matters for trade, and more so for services trade, because the trade in modern services may not be conditional upon the geographical proximity between trading partners. Bivariate Granger causality analysis using world digital trade estimates following González *et al.* (2023), and fixed

Chart IV.2: Conceptual Framework for Digital Trade



Note: DIP stands for digital intermediation platform.
Source: Reproduced from OECD (2023a).

Table IV.1: Granger Causality Test Results between Digitalisation and Cross-Border Digital Trade in Services

1	2
A. Bivariate Granger Causality Test	
Fixed broadband usage does not Granger-cause global digital trade	F-Statistic: 2.95 Probability-value: 0.09
Global digital trade does not Granger-cause fixed broadband usage	F-Statistic: 0.24 Probability-value: 0.79
B. Panel Granger Causality Test	
Internet usage does not Granger-cause digitally delivered services exports	HPJ Wald test: 47.82 Probability-value: 0.00
Internet usage does not Granger-cause digitally delivered services imports	HPJ Wald test: 773.82 Probability-value: 0.00

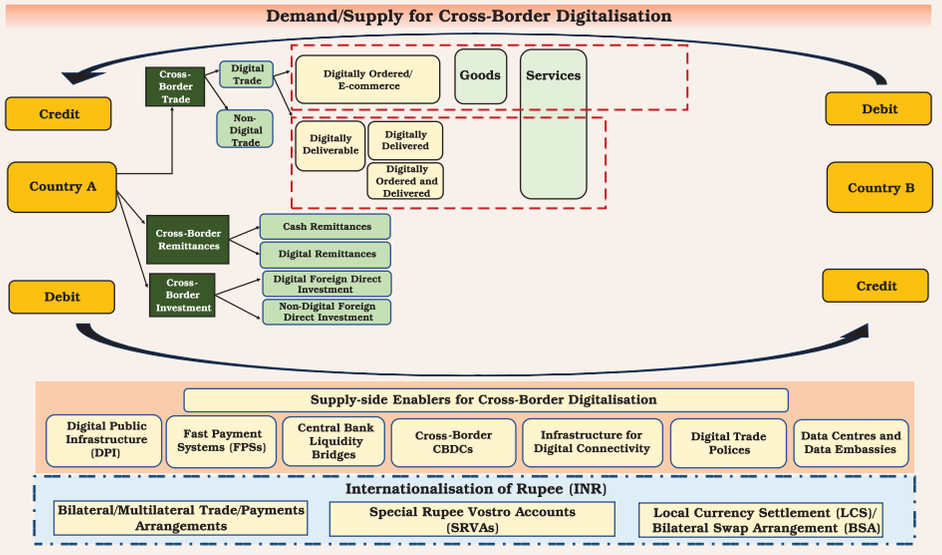
Note: Juodis *et al.* (2021) Panel Granger non-causality test was used for the cross-country panel dataset.
Source: WTO, OECD Tiva Database, World Bank and RBI staff estimates.

broadband usage per 100 people during 2001 to 2020 suggests unidirectional causality from digitalisation to global digital trade. These results are corroborated by Granger causality tests on a panel dataset for 58 economies (both AEs and EMDEs) and a sample period from 2015 to 2021 which indicate unidirectional causality from digitalisation (proxied by share of internet users in the population) to trade in digitally delivered services (Table IV.1).

Goods and Services in the Digital Age

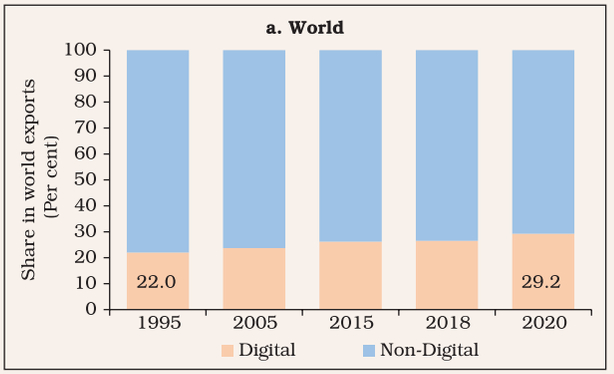
IV.9 Digital trade in goods refers to digitally ordered goods comprising international e-commerce transactions (Chart IV.3). Digital trade in services constitutes digitally ordered and/or delivered services (IMF, OECD, UN and WTO, 2023). Globally, the share of digital exports in total world exports has risen from around 22 per cent to around 29 per cent during 1995 to 2020 (Chart IV.4a).

Chart IV.3: Open Economy Digitalisation – A Schematic Presentation

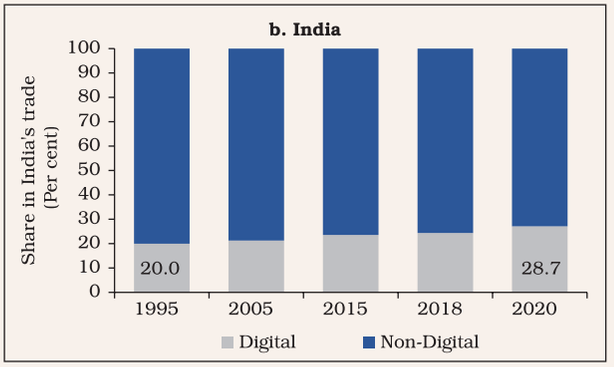


Source: RBI staff illustration.

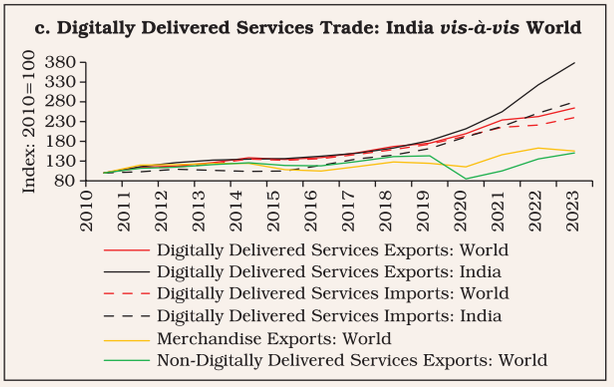
Chart IV.4: Cross-Border Digital and Non-Digital Trade: India *vis-à-vis* World



Note: Based on González *et al.* (2023) methodology.
Source: OECD TiVA Database and RBI staff estimates.



Note: Based on González *et al.* (2023) methodology.
Source: OECD TiVA Database and RBI staff estimates.



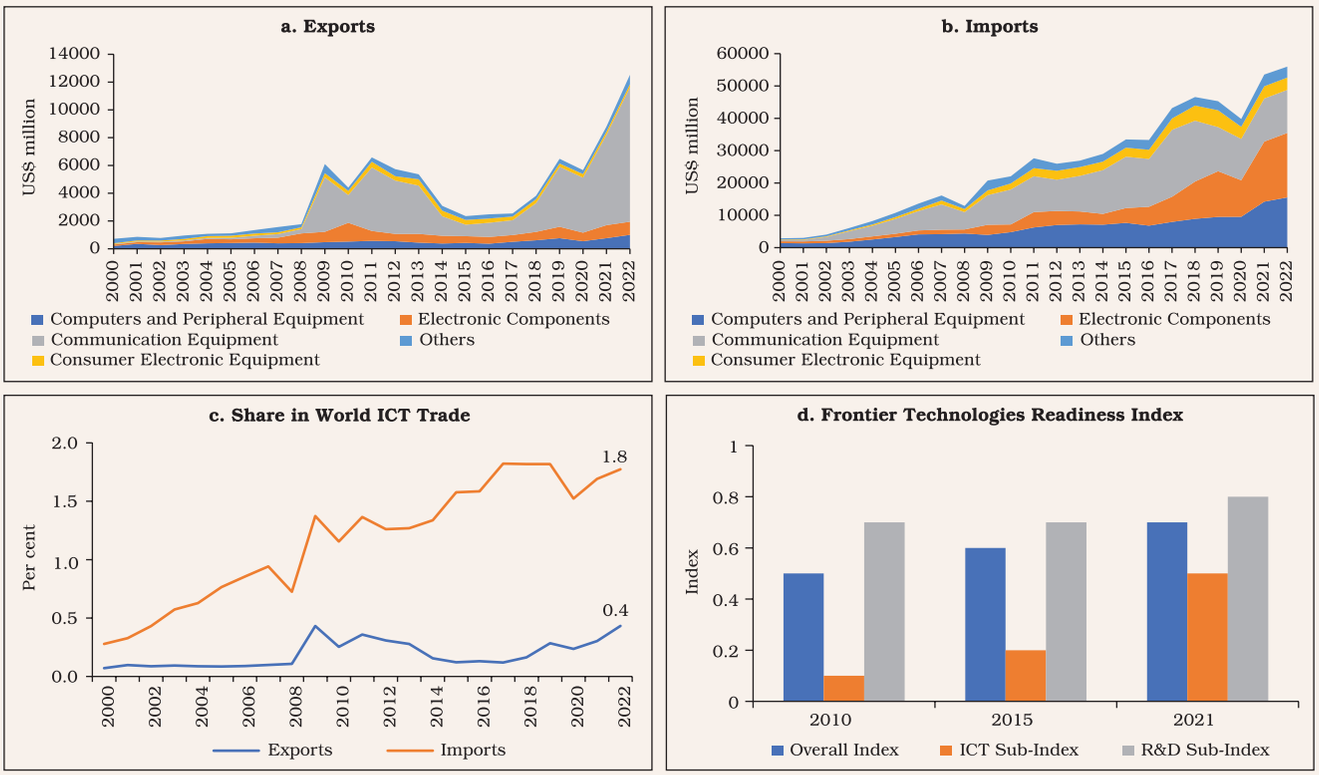
Source: WTO and RBI staff estimates.

IV.10 Goods account for over three quarters of global trade, and the limited evidence available on digitally ordered goods suggests that around two-third of e-commerce sales relate to goods. For India, the share of digital trade in total trade is estimated to have risen from around 20 per cent in 1995 to around 29 per cent in 2020 (Chart IV.4b). Digitally delivered services have recorded a significant surge globally and India has outperformed global trends (Chart IV.4c).

IV.11 India is a net importer of ICT products (Charts IV.5a and IV.5b). ICT products, the backbone of the global digital economy, are primarily intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display (OECD, 2008). In line with the needs of its growing digital economy, India's share in global ICT goods imports has increased from 0.3 per cent in 2000 to 1.8 per cent in 2022 (Chart IV.5c). India is set to become a major adopter of the frontier technologies on ICT, which would in turn further increase the demand for ICT goods (Chart IV.5d). On the export side, communication equipment dominates exports of ICT products. The ongoing efforts to onshore their production through the production linked incentive (PLI) scheme are helping India's exports of these products and as a result, the trade deficit in electronics may moderate going forward.

IV.12 Across major services exporting economies, digitally deliverable services dominate exports, gaining in share especially after the pandemic (Charts IV.6a and IV.6b). With an average annual growth rate of 8.2 per cent between 2005 and 2023, global exports of digitally delivered services have outpaced other services and goods (WTO, 2024). Growth has accelerated in recent years (10.9 per cent annually between 2020 and 2023), due to the pandemic-induced surge in remote work. AEs have generally dominated the exports of digitally delivered services, and only around 21 per cent of digitally delivered services exports in 2023 originated from EMDEs.

Chart IV.5: India's Trade in ICT Goods

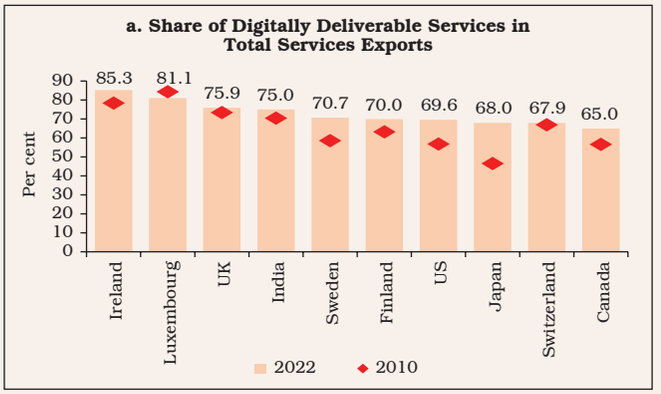


Note: ICT goods as defined in the OECD Guide on Measuring the Information Society 2011. The Frontier Technologies Readiness Index includes technological capacities related to physical investment, human capital and technological effort, and covers national capacities to use, adopt and adapt these technologies.
Source: UNCTAD and RBI staff estimates.

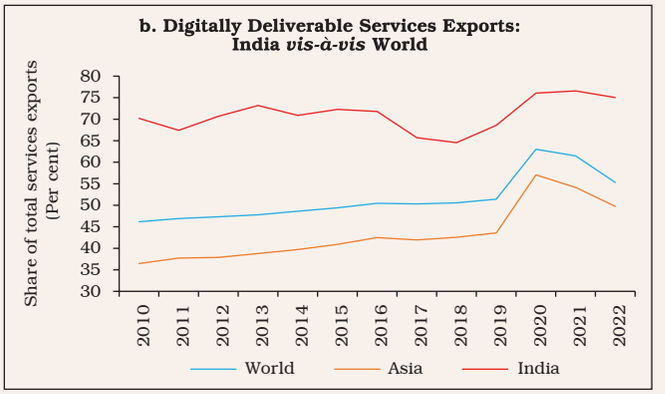
IV.13 India's services exports in US dollar terms recorded a compound annual growth rate (CAGR) of 10.3 per cent over the recent two decades (between 2005 and 2023), significantly higher than India's merchandise export growth (7.9 per cent) as well as world services export growth (5.9 per cent). Over the same period, India's digitally delivered services exports grew by more than 8 times (from US$ 31 billion to US$ 257 billion), whereas digitally delivered services imports rose by more than 6 times (from US$ 18 billion to US$ 111 billion) [Charts IV.6c and IV.6d]. During this period, the expansion in India's digitally delivered services exports (CAGR of 11.9 per cent) was well above that in world digitally delivered services exports (7.7 per cent CAGR). As a result, the share of India's digitally delivered services exports in world digitally delivered services exports doubled from 3.0 per cent in 2005 to 6.0 per cent in 2023. In the case of imports, the shares have risen from 1.9 per cent in 2005 to 3.1 per cent in 2023.

IV.14 India's digitally delivered services trade (exports plus imports) comprised 10.5 per cent of India's nominal GDP in 2023, up from 6.0 per cent in 2005. Whereas, the share of India's digitally delivered services exports in India's GDP went up from 3.8 per cent in 2005 to 7.4 per cent in 2023. India's services exports exhibited resilience during the pandemic primarily on account of a larger share of telecommunication,

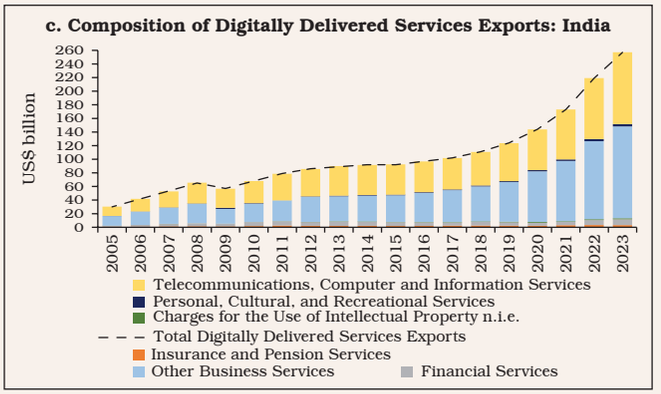
Chart IV.6: Cross-Border Digital Trade in Services: India *vis-à-vis* World



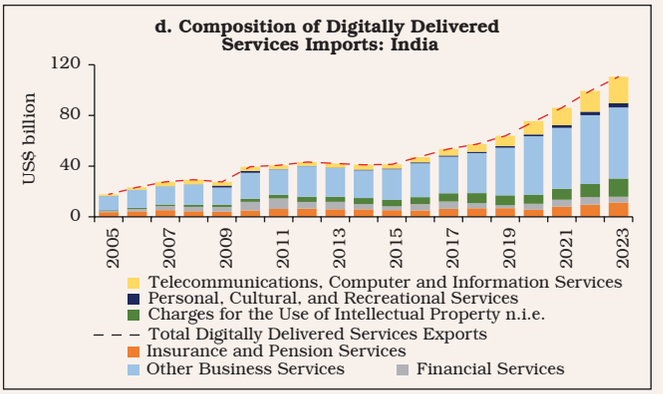
Source: UNCTAD.



Source: UNCTAD.



Source: WTO and RBI staff estimates.

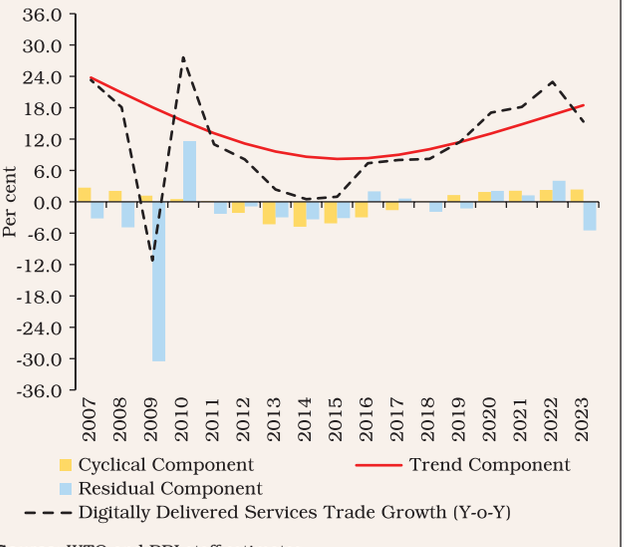


Source: WTO and RBI staff estimates.

computer and information services and business services in its export basket (Gajbhiye *et al.*, 2024).

IV.15 India's rise as a preferred destination for global capability centres (GCCs) has raised the trend growth of digitally delivered services trade (Chart IV.7). The number of GCCs housed in India has increased by around 60 per cent since 2015-16 to reach more than 1580 in 2022-23, and the number is expected to reach 2400 by 2030 (EY, 2023). The wave of big data, artificial intelligence (AI), machine learning (ML), internet of things (IoT) and advancements in compatible hardware, generative AI and spatial computing has opened up new opportunities to expand India's services exports, especially in business services, and may improve India's participation in global value chains (GVCs). Generative AI is projected to become

Chart IV.7: Decomposition of India's Digitally Delivered Services Trade Growth



Source: WTO and RBI staff estimates.

a US$ 1.3 trillion market by 2032 (Bloomberg, 2023). India is also experiencing the generative AI boom with currently around 100 start-ups (as on July 2024) and a projected market size of US$ 17 billion in 2030 (Inc42, 2024).

IV.16 Cross-border e-commerce offers a more affordable point of entry compared to conventional businesses, demands fewer personnel, and enables firms to directly connect with customers, thereby reducing reliance on intermediaries to access global markets (Majumdar *et al.,* 2020). Cross-border e-commerce transactions are mainly classified into four types depending upon the sector involved – business-to-business (B2B), business-to-consumer (B2C), consumer-to-consumer (C2C) and government-to-business (G2B). The Indian e-commerce market is also gradually gaining ground.

IV.17 Following González *et al.* (2023) and assuming India's annual nominal GDP growth during 2024-2047 is at the same pace as recorded during 2001-19 (10.1 per cent in US$ terms), India's digital trade is projected to increase to around US$ 0.5 trillion in 2030, and US$ 2.4 trillion in 2047 from around US$ 0.2 trillion in 2020 (Table IV.2)[8]. Scenario analysis suggests that if the annual nominal GDP growth were to be 3.5 percentage points above its historical pace (2001-19), India's digital trade could go up to US$ 0.7 trillion in 2030 and US$ 5.8 trillion in 2047

Table IV.2: Scenario Assumptions for India's Digital Trade Estimates

1	2	3
Variable	**Baseline Scenario**	**Higher Growth Scenario**
Nominal GDP growth (in US$ terms): India	10.1 per cent (realised during 2001-19) during 2024-47	13.6 per cent during 2024-47[9]
Digital trade to GDP ratio: India	6.6 per cent (realised during 2011-19 for digitally delivered services trade)	7.6 per cent (realised during 2015-23 for digitally delivered services trade)
Nominal GDP growth (in US$ terms): World	5.2 per cent (realised during 2001-19) during 2024-47	8.1 per cent during 2024-47[10]
Digital trade to GDP ratio: World	5.8 per cent (realised during 2011-19)	6.0 per cent (realised during 2015-20)

Source: RBI staff estimates.

(Chart IV.8a). India's share in world digital trade is projected to increase from 5.6 per cent in 2020 to around 12 per cent by 2047 in the baseline scenario and around 14 per cent in the higher growth scenario (Chart IV.8b).

IV.18 With the advent of digitalisation and technological advancements, India is witnessing growing servicification of its manufacturing exports. India's domestic services value-added share in gross manufacturing exports rose to 17.7 per cent in 2020 from 13.4 per cent in 2011.[11] Moreover, India has a revealed comparative advantage (RCA) in modern services exports, particularly in computer services exports (Gajbhiye *et al.,* 2024). Further, its RCA has improved in the

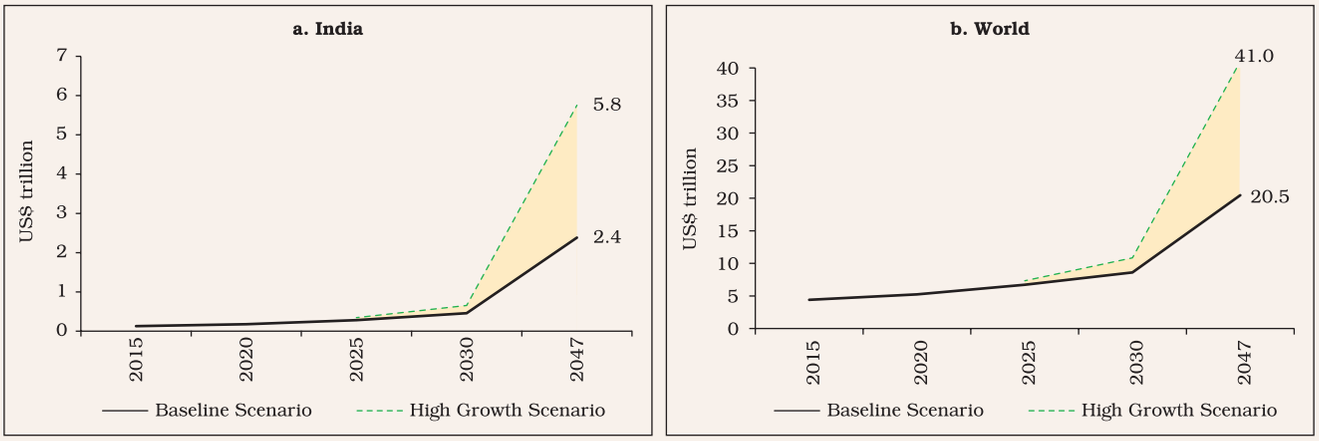
[8] Based on the assumption of 10.1 per cent growth in India's nominal GDP (in US$ terms) during 2001-2019; and the annual average share of India's digitally delivered services trade in India's GDP of 6.6 per cent – the value realised during 2011-2019, a period of significant advances in digitalisation in India.

[9] Assuming real GDP growth to be 9.6 per cent (RBI, 2023a), and inflation to be around 4 per cent, as envisaged in the current target of India's flexible inflation targeting monetary policy framework.

[10] Assuming world real GDP growth to be 2.6 per cent (PWC, 2017), and inflation of around 5.5 per cent, which is the historical average from 1993-2023.

[11] Trade in Value Added (TiVA) 2023 ed. Principal Indicators, OECD.Stat.

Chart IV.8: Digital Trade Estimates: India *vis-à-vis* World



Source: IMF, OECD TiVA, WTO and RBI staff estimates.

case of business services exports. Digitalisation is expected to support the exports of Indian services (Box IV.1).

IV.19 Recent developments in AI and Large Language Models (LLMs) provide an additional avenue to boost India's digital trade. Due to rising

Box IV.1
Do India's Services Exports Defy the Gravity Model?

The gravity model, the workhorse model for bilateral trade between economies, posits that countries trade in proportion to their economic size (measured as their share in world GDP), and a set of trade costs, some of which are bilateral, such as geographical proximity or distance (Tinbergen, 1962; Gurevich, *et al.,* 2018; Herman, 2023). While GDP size is expected to impact trade positively, bilateral distance between the economies dampens trade on account of an increase in trade costs. Given the growing importance of digitalisation in cross-border trade flows, recent literature has used augmented gravity equations to analyse the impact of digitalisation and internet connectivity on global trade (Herman and Oliver, 2023).

Against this backdrop, the following gravity equation is estimated for India's merchandise and services exports for the period 2015-2021 and a sample of 56 countries, which comprise around 90 per cent of India's total trade.

$$log(exports)_{i,j,t} = \alpha_t + log(distance)_{ij} + log(GDP)_{i,t} + log\ (GDP)_{j,t} + region\ dummy_j + common\ legal\ origin_{ij} + common\ language_{ij} + internet\ usage_{j,t} \quad \ldots (1)$$

where, *i* represents India, *j* represents the importer and *t* represents year. In the case of services exports, alternate specifications using total services exports (Specification 2) and modern services exports (Specifications 3[12] and 4[13]) have been estimated, given India's revealed comparative advantage in the latter. Variables, other than distance, such as region dummy, common legal origin of the economies and common language are also used as controls.[14] The regression results indicate that the gravity model holds in the case of India's merchandise exports and total services exports (Table 1), *albeit* with a lower coefficient in the latter. However, in the case of modern services exports, the distance variable turns out to be statistically

(Contd...)

[12] Services exports-Category 1 includes insurance and pension services, financial services, telecommunication, computer and information services and other business services.

[13] Services exports-Category 2 includes telecommunication, computer and information services and other business services.

[14] Standard gravity models include controls such as distance, contiguity/common region, common language and former colony/common legal origin.

Table 1: Gravity Model Results[15]

	Specification (1)		Specification (2)		Specification (3)		Specification (4)	
Variables	**Merchandise Exports**		**Services Exports-Total**		**Services Exports -Category 1**		**Services Exports-Category 2**	
$log(distance)_{i,j}$	-1.01***	-0.98***	-0.58***	-0.63***	-0.18	-0.26	-0.16	-0.25
	(0.22)	(0.22)	(0.17)	(0.17)	(0.23)	(0.25)	(0.23)	(0.25)
$log(GDP)_{i,t}$	1.32***	1.15***	0.52*	0.78***	0.33	1.00***	0.37	1.04***
	(0.26)	(0.20)	(0.30)	(0.16)	(0.42)	(0.21)	(0.41)	(0.22)
$log(GDP)_{j,t}$	0.81***	0.82***	0.76***	0.75***	0.79***	0.79***	0.79***	0.79***
	(0.22)	(0.07)	(0.07)	(0.06)	(0.08)	(0.09)	(0.08)	(0.08)
$region\ dummy_{j}$	0.22	0.25	-0.22	-0.27	-0.13	-0.31	-0.10	-0.27
	(0.29)	(0.30)	(0.34)	(0.31)	(0.42)	(0.43)	(0.42)	(0.43)
$common\ legal\ origin_{i,j}$	0.63**	0.67***	0.46**	0.41**	0.59**	0.48*	0.59**	0.48*
	(0.26)	(0.24)	(0.20)	(0.20)	(0.27)	(0.29)	(0.27)	(0.29)
$common\ language_{i,j}$	0.49**	0.43**	0.70***	0.81***	0.73***	0.90***	0.73***	0.90***
	(0.21)	(0.21)	(0.22)	(0.23)	(0.27)	(0.29)	(0.28)	(0.31)
$internet\ usage_{j,t}$	-0.01	-	0.01*	-	0.02***	-	0.02***	-
	(0.003)	-	(0.004)	-	(0.01)	-	(0.01)	-
$broadband\ usage_{j,t}$	-	-0.01	-	0.02**	-	0.03***	-	0.03***
	-	(0.01)	-	(0.01)	-	(0.01)	-	(0.01)
$constant$	-43.09***	-38.65***	-24.62***	-31.11***	-24.84**	-42.51***	-25.89**	-43.45***
	(8.36)	(6.78)	(8.60)	(4.88)	(11.74)	(7.05)	(11.68)	(7.20)
Observations	392	392	385	385	392	392	392	392
F-Statistic	57.70***	56.31	46.62***	66.23***	28.30***	37.88***	29.65***	40.50***
R-squared	0.78	0.78	0.79	0.80	0.74	0.73	0.73	0.72

Note: Standard errors (clustered by distance) in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Source: RBI staff estimates.

insignificant, suggesting that the cross-border trade in modern services may not be impacted by transport costs. For total services exports by India, distance remains a key factor as indicated by the statistically significant negative coefficient, as traditional services exports (such as travel and transportation) depend upon the distance between the economies. The results also indicate the positive impact of digitalisation (proxied by percentage of internet usage in the economy and fixed broadband subscriptions per 100 people in alternate specifications) in services exports, suggesting that digitalisation may help moderate the impact of trade costs arising due to geographical distance.

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digitalisation, AI is expected to increase India's annual GVA growth rate by 1.3 percentage points to 7.1 per cent in 2035 (Statista, 2023). India has the highest relative AI-skill penetration rate[16], and it has shown the largest increase in AI talent between 2016 and 2023 (Maslej *et al.,* 2024). This

[15] Similar results are obtained under panel fixed effects with year dummies. Further, similar results were obtained when the sample period was restricted to pre-pandemic years, *i.e.*, 2015-19.

[16] A measure of the intensity with which LinkedIn members use AI skills in their jobs.

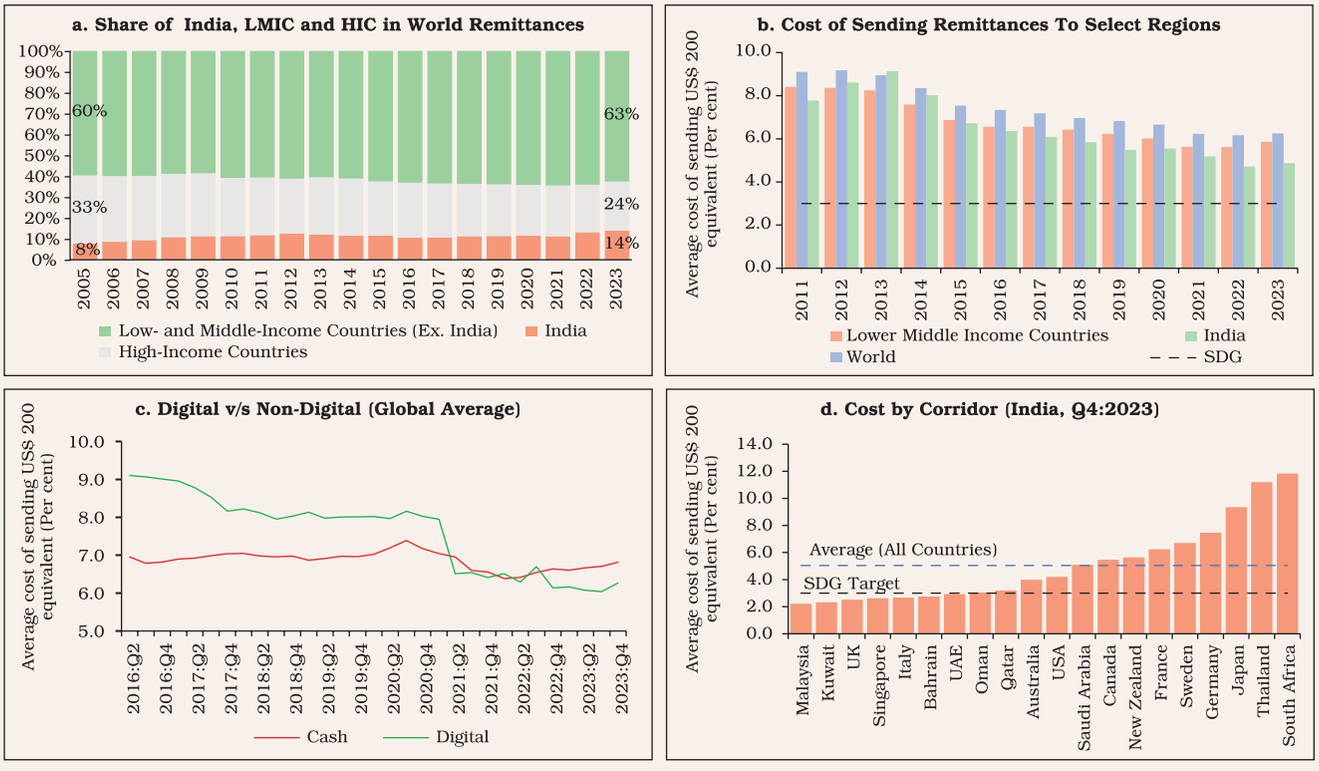
upskilled talent could help India's software export markets leverage AI seamlessly and move them up the value chain. Additionally, India's pool of highly skilled workers is well-primed to take up jobs as AI specialists in non-software domains, such as those requiring the building of domain-specific AI models for tailor-made use by organisations. Hence, there is potential to increase export value addition through AI across all product types. India is in an advantageous position to develop LLMs and their applications suited to the Eastern world, especially for culturally similar regions like South and Southeast Asia.

Digitalisation of Cross-Border Remittance Flows

IV.20 Digitalisation has the potential to improve the landscape of the cross-border remittance flows. Remittances have become the premier source of finance for low- and middle-income countries (LMICs), even exceeding FDI flows by US$ 274 billion in 2023 (World Bank, 2024b). The size of international migrant stock, the driver of remittance flows, has nearly doubled from 153 million in 1990 to 302.1 million in 2023. Globally, inward remittance flows have increased more than seven-fold between 2000 and 2023 to US$ 857 billion, with flows to LMICs amounting to US$ 656 billion.

IV.21 Migrant stock from India comprised 1.3 per cent of its population in 2020. India is the highest remittance recipient country in the world, with its share increasing over time (Chart IV.9a). India's inward remittance receipts stood at US$ 115 billion in 2023, which is 13.5 per cent of the world total.

Chart IV.9: Remittances and Average Sending Cost

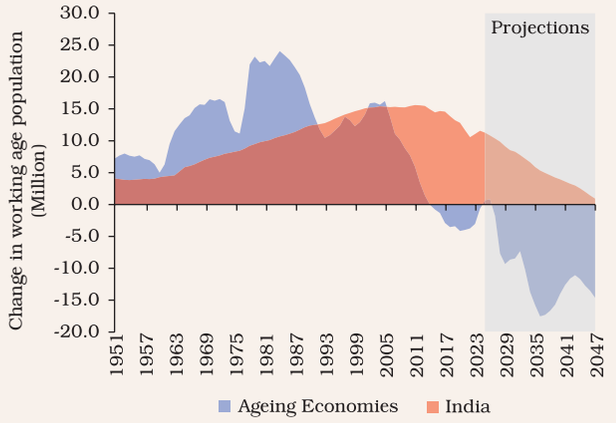


Note: Figure c pertains to the payment instrument used to fund the transaction – either cash or digital payment modes (bank account transfer or credit/debit cards).
Source: Remittance Prices Worldwide, World Bank and RBI staff estimates.

The cost of sending remittances has decreased over time, with digitalisation playing a key role (Charts IV.9b and IV.9c). The average cost of receiving remittances in the case of India stood at 5.01 per cent in Q1:2024 (marginally lower than 5.04 per cent in Q4:2023), but higher than the Sustainable Development Goal (SDG) of 3 per cent per US$ 200 remittance (Chart IV.9d).

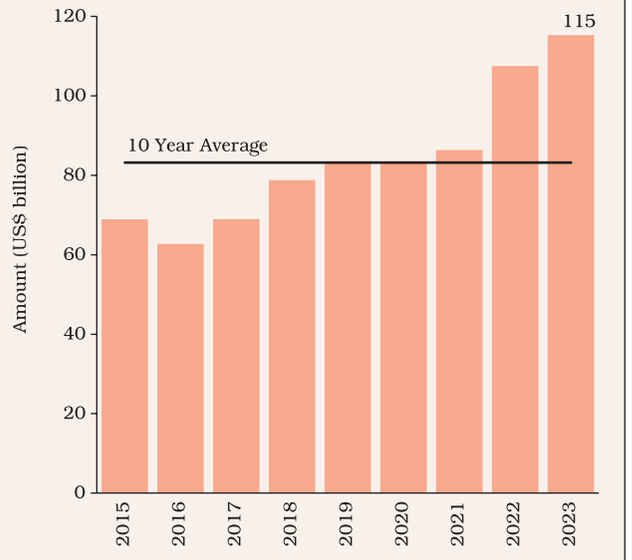
IV.22 In India, the ratio of remittances to GDP has gradually increased from 2.8 per cent in 2000 to 3.2 per cent in 2023 and is now above that of gross FDI inflows to GDP ratio (1.9 per cent in 2023), providing strength to India's external sector. In 2021, more than half of India's inward remittances were from the Gulf countries, while North America accounted for 22 per cent share. Going forward, India is poised to be the world's leading supplier of labour as India's working age population is expected to rise till 2048, while it has started dwindling for major AEs (Chart IV.10). Thus, the global demand for Indian migrant workers will remain high,

Chart IV.10: Population Projections: India *vis-à-vis* Ageing Economies



Note: Working age population includes those aged 15-64 years. Ageing economies include Australia, Austria, Belgium, Bulgaria, Canada, China, Czech Republic, Finland, France, Germany, Greece, Italy, Japan, Portugal, Russia, Singapore, South Korea, Spain, Sweden and the UK. Projections based on the UN medium-fertility scenario.
Source: United Nations World Population Prospects, 2024.

Chart IV.11: Remittances to India



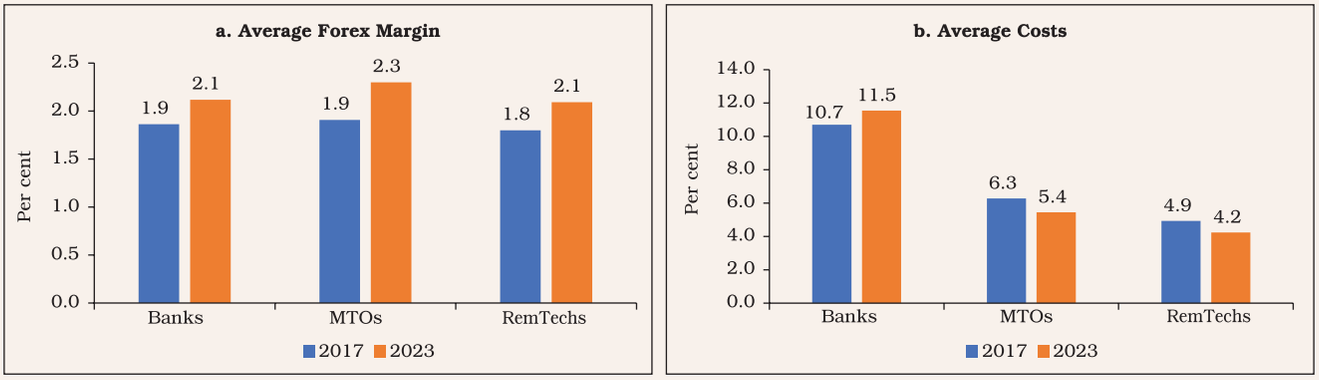
Source: RBI.

which along with continuing skill upgradation of the workforce would provide a sustained boost to inward remittances. Based on the trends observed over the past decade, remittances to India are estimated to increase to around US$ 160 billion in 2029 from US$ 115 billion in 2023 (Chart IV.11).

Cost of Remittances to India: Potential for FinTech Disruption

IV.23 The global average cost of sending US$ 200 as remittance stood at 6.35 per cent in Q1:2024, marginally lower than 6.39 per cent in Q4:2023 (World Bank, 2024c). Nonetheless, it is more than double the SDG target. For India, in Q4:2023, the cost of remittance from Singapore, Malaysia, the UK, Kuwait, Italy and Bahrain was within the SDG target, while the cost from Thailand and South Africa was more than 10 per cent (Chart IV.9d). This may be due to the dominance of banks in the latter set of countries, while the former countries have a competitive remittance industry with banks facing competition from

Chart IV.12: Banks, MTOs and RemTechs: Forex Margins and Costs



Note: 1. Figures pertain to receipt of remittances equivalent to US$ 200.
2. Average forex margin is the average of percentage difference between the foreign currency exchange rate applied to the transaction by the remittance service provider and the interbank exchange rate.
3. The RemTech group is a subset of the MTO group, and includes Azimo, InstaRem, Remitly, TransferGo, Wise, WorldRemit and Xoom (da Silva Filho, 2022).
Source: World Bank and RBI staff estimates.

money transfer operators (MTOs) and FinTechs. Additional factors that influence remittance cost include the speed of money transfer, the payment instrument used for transfer (cash or bank account), and the access point/mode of transfer (bank branch, internet or agent). The digitalisation of cross-border remittance flows would improve the speed and transparency of transactions, while reducing liquidity costs and fees. Since the banking channel requires involvement of several banks communicating through SWIFT messaging, transaction costs are higher in general, while settlements are slower than through FinTechs (Church, 2023). Though banks, MTOs and RemTechs[17] operate on nearly the same foreign exchange margin, the average cost of receiving remittances (US$ 200) through RemTechs is significantly lower than that of the banks (Chart IV.12). Realising the potential of FinTech, the Reserve Bank had selected cross-border payments as the second cohort under its Regulatory Sandbox initiative (RBI, 2022a).

IV.24 As the world progresses towards a more interconnected and digitally driven era, the creation of integrated cross-border payment frameworks and CBDCs would provide new avenues for FinTechs to provide cheaper solutions in cross-border payments (Box IV.2)

Role of Trade Policy in Cross-Border Digital Trade

IV.25 Cross-border digital trade policies play a crucial role in harnessing new opportunities, building trust, and facilitating coordination on regulatory aspects like data security and cybersecurity. Provisions facilitating digital trade can significantly increase trade, especially in services (Herman and Oliver, 2023), and help increase competitiveness. This is especially true for LMICs, where an enabling regulatory environment can help reduce costs of digitally delivered services trade (IMF, OECD, UN, and WTO, 2023; González *et al.*, 2023). Digital trade policy discussions are gaining prominence in multilateral fora, bilateral trade agreements,

[17] FinTechs specialising in transferring remittances.

Box IV.2
Cost of Remittances to India – The Case for Digital Disruption

The cost of sending US$ 200 remittance declined globally from 9.2 per cent in 2012 to 6.3 per cent in 2023, with significant regional variations - the highest in Sub-Saharan Africa (7.9 per cent) and the lowest in South Asia (5.8 per cent) [World Bank, 2023]. Lower transaction costs boost remittances and enhance incomes/savings of the recipients. A one per cent decrease in the cost of remitting US$ 200 leads to about a 1.6 per cent increase in remittances (Ahmad *et al.,* 2021). If the cost of sending remittances could be reduced by 5 percentage points relative to the value sent, remittance recipients in developing countries would receive over US$ 16 billion more each year (World Bank, 2023).

Following Beck *et al.* (2022), the determinants of the cost of remittances to India for a sample of 20 countries for the period Q2:2016 to Q3:2023 are estimated using the World Bank's Remittance Prices Worldwide dataset - a quarterly survey dataset providing the cost of remittances.[18] Interaction terms of access point (type of location where the remittance service is available – bank branch, internet or money transfer agent) and payment instrument (used by the sender to pay for the transaction – cash or bank account) were added to examine the role of digitalisation. Pooled OLS[19] estimates suggest that the cost of sending remittances through bank branches and agents is higher as compared with accessing remittance services directly from

Table 1: Remittance Costs - Marginal Effects from Pooled OLS[20]

Dependent Variable: Cost of Sending US$ 200 (Per cent)	Specification (1)	Specification (2)	Specification (3)
Access Point = Agent	4.822***		4.623***
	(0.379)		(0.454)
Access Point = Bank Branch	6.587***		6.558***
	(0.812)		(0.805)
Access Point = Internet	4.364***		3.404***
	(0.254)		(0.635)
Payment Instrument = Bank Account		5.447***	5.015***
		(0.228)	(0.336)
Payment Instrument = Cash		7.029***	5.095***
		(0.440)	(0.588)
Speed > 1 Hour (Slow)	5.471***	6.404***	5.517***
	(0.090)	(0.091)	(0.0832)
Speed <= 1 Hour (Fast)	5.347***	5.827***	5.312***
	(0.222)	(0.258)	(0.213)
Firm Type = Bank	6.030***	9.232***	6.629***
	(0.318)	(1.046)	(0.685)
Firm Type = MTO	4.680***	4.765***	4.670***
	(0.276)	(0.412)	(0.271)
Interaction Terms			
Access Point x Firm Type	Yes	No	Yes
Access Point x Speed	Yes	No	Yes
Payment Instrument x Firm Type	No	Yes	Yes
Payment Instrument x Speed	No	Yes	Yes

(Contd...)

[18] Data are collected at the customer level for the major service providers in each corridor, including both the primary MTO and banks active in the market. The dataset includes the costs for two amounts – the equivalents of US$ 200 and US$ 500 in local currency. Since data may be collected for different individuals across periods, pooled OLS estimates are used with errors clustered by country.

[19] The underlying estimation also controlled for other variables affecting cost of remittance such as income level of sending country, coverage of the respective MTO's network in sending and receiving countries, and the forex margin charged.

[20] Average adjusted predictions of remittance cost as estimated in the pooled OLS regression models, if all observations in the dataset were to assume the same value for variable of interest X as indicated, with the value for other predictors remaining the same.

Dependent Variable: Cost of Sending US$ 200 (Per cent)	Specification (1)	Specification (2)	Specification (3)
Access Point x Payment Instrument	No	No	Yes
Observations	6,915	6,915	6,915
R-squared	0.590	0.575	0.591
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes
Year*Quarter FE	Yes	Yes	Yes
Standard Errors clustered by	Country	Country	Country

Note: Standard errors (clustered by country) in parentheses; *** p<0.01, ** p<0.05, * p<0.1; MTO – Money Transfer Operator; Pooled OLS was used as different respondents are tracked over time.
Source: RBI staff estimates.

the internet; a bank account as the payment instrument costs less than remitting using cash; fast payments were found to be cheaper, demonstrating the cost effectiveness of digital payments technology; and MTOs provide a cost-effective alternative to banks in the remittance business (Table 1). Deepening digitalisation – for example, through global acceptability of the UPI and the development of CBDCs - can lower the cost of remittances, enhance their volume and improve income/ savings of the recipients.

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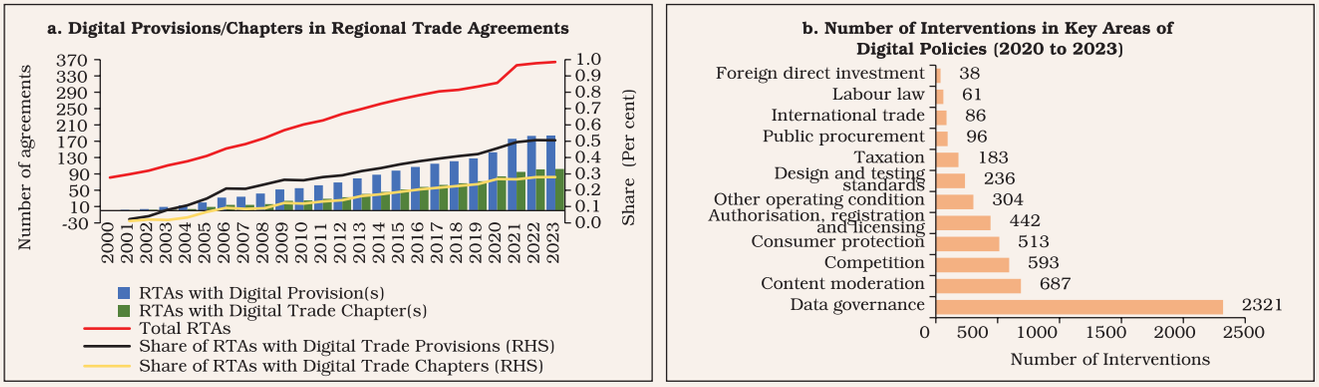
and regional trade agreements (RTAs), digital economy agreements, and domestic regulations (Chart IV.13a). According to the Trade Agreement Provisions on Electronic-commerce and Data (TAPED), among the operational trade agreements since 2000, 184 contained provisions on e-commerce/digital trade, while 102 contained a chapter dedicated to e-commerce/digital trade. Dedicated digital economy agreements (DEAs)[21] have gained prominence in recent times. While incorporating many of the issues discussed in trade agreements, DEAs also extend discussions to emerging areas such as cooperation on AI, digital identity, data innovation, FinTech and digital payments. DEAs are dynamic in nature and designed to deepen mutual understanding of the digital economy, while being responsive to the latest technological developments, business models and regulatory challenges.

IV.26 Many countries, including India, have passed data protection acts[22] to deal with issues of privacy, national security, and intellectual property rights (IPRs). India's data protection regulations aim to align with global standards. Globally, there has been intense intervention in issues pertaining to digitalisation, especially in data governance, content moderation, competition, consumer protection and authorisation, registration, and licensing (Chart IV.13b). Restrictive trade

[21] Examples include Australia-Singapore Digital Economy Agreement (2020), the Digital Economy Partnership Agreement (DEPA) between Singapore, Chile and New Zealand, and the Digital Partnership Agreement between South Korea and Singapore (2023).

[22] India passed Digital Personal Data Protection Act (DPDPA) in August, 2023.

Chart IV.13: Digital Trade Policies – Global Trends



Note: The agreements considered in the chart are currently in force.
Source: Calculations reproduced as in González *et. al.* (2023) using digital provisions and digital trade chapters data from TAPED (November 2023 Update) and WTO RTA Database.

Source: Digital Policy Alert Activity Tracker by St. Gallen Endowment for Prosperity through Trade, 2023.

policies and restrictive domestic regulatory environment may distort global digital trade and risk fragmentation of global value chains (GVCs): 0.1 percentage point rise in the OECD's Digital Services Trade Restrictiveness Index (DSTRI) can lead to a 15.4 per cent increase in international trade costs (González *et al.,* 2023). Conducive trade policies and an enabling domestic regulatory space that balance the benefits of digital trade with the risks to data privacy, consumer protection and cybersecurity are key tasks for policymakers (IMF, OECD, UN, and WTO, 2023; OECD, 2024b).

IV.27 India has seven trade agreements with digital trade provisions and two trade agreements with dedicated chapters for e-commerce/digital trade (Table IV.3). Harnessing technology for customs and trade facilitation and policies encouraging favourable customs

Table IV.3a: India's Trade Agreements with e-Commerce/Digital Trade Provisions

S.No.	Agreement	Country/ Group	Year in Force
1	2	3	4
1	Framework Agreement for Establishing Free Trade Area between Thailand and India	Thailand	2004
2	Comprehensive Economic Cooperation Agreement between India and Singapore	Singapore	2005
3	Framework Agreement on Comprehensive Economic Cooperation between India and the Association of Southeast Asian Nations	ASEAN	2010
4	Comprehensive Economic Cooperation Agreement between India and Malaysia	Malaysia	2011
5	Comprehensive Economic Cooperation and Partnership Agreement (CECPA) between Mauritius and India	Mauritius	2021
6	Australia-India Economic Cooperation and Trade Agreement	Australia	2022
7	Comprehensive Economic Partnership Agreement (CEPA) between India and UAE	UAE	2022

Table IV.3b: India's Trade Agreements with e-Commerce/Digital Trade Chapters

1	Comprehensive Economic Cooperation Agreement between India and Singapore	Singapore	2005
2	Comprehensive Economic Partnership Agreement (CEPA) between India and UAE	UAE	2022

Source: Taped Dataset and Taped Codebook (November 2023).

duties on electronic transmission; contracts using e-signatures, e-invoicing and paperless transactions; consumer protection against data breach and fraudulent transactions; and protection of software source code may be advocated. Building digital readiness for e-commerce is an important issue under the discussions of the UNCTAD's Intergovernmental Group of Experts on e-commerce and the Digital Economy. Key hindrances identified include addressing digital divides to mitigate the risk associated with limited access to financing, particularly for micro, small and medium enterprises (MSMEs).

Digitalisation and Capital Flows

IV.28 In the sphere of capital flows, digital foreign direct investment (FDI) is comparatively a newer area of discussion in the international fora. Although the definition of digital FDI has not yet been formalised globally, it may be defined as a cross-border investment that is often asset-light as the foreign enterprise does not need to invest in building production or delivery assets in the host economy (Chaisse, 2023). The digital FDI framework comprises three key pillars – new digital activities, digital adoption of traditionally non-digital firms and digital infrastructure, and each of these pillars is associated with certain facilitating elements (UNCTAD, 2017). By attracting digital FDI, economies are expected to boost their digital capabilities. However, digital FDI requires certain pre-requisites from both supply and demand perspectives. While the supply-side elements involve policies and structural reforms enabling digital-friendly investment climate and ecosystem, on the demand side, domestic firms need to showcase their need, priorities, and opportunities involving digital investment.

IV.29 Global investors engaging in new digital activities seek data security legislations, copyright laws to protect intellectual property and data privacy regulations (Stephenson, 2020). They also look for availability of e-payment services, policy support for digital businesses and local digital skills along with international, domestic, and urban connectivity. Additionally, global investors seek ease of receiving licenses for digital infrastructure, availability of digitally skilled workforce, use of international standards and regional coordination for infrastructure investment.

Opportunities for Internationalisation of the Rupee

IV.30 The US dollar remains the dominant currency for international payment transactions, notwithstanding a fall in its share in total allocated reserves from around 71 per cent in 2000 to around 58 per cent in 2023 (Table IV.4). The US dollar also remains the dominant invoicing currency, with around 70 per cent share in cross-border trade invoicing in the Asia-Pacific region (Bertaut *et al.,* 2021). A currency may internationalise as a reserve instrument by becoming a global store of value, or as a medium of exchange by being used for international payments (Gopinath and Stein, 2018). Technological innovations in payment systems could promote use of other currencies, leading to more currency competition and the development of digital currency areas or regional reserve currencies (Brunnermeier, James, and Landau, 2019; BIS, IMF, and World Bank 2021).

IV.31 Historically, the two roles - store of value and medium of exchange - have progressively converged. However, this may not hold in a digitalised world. For a national currency to become a reserve asset, full capital account convertibility is a demanding prerequisite. However, to internationalise as a medium of exchange, a currency may leverage cross-border trade using well-developed digital networks to create a digital currency area. Advances in

Table IV.4: Global Finance – Key Indicators

(Shares in Per cent/Index)

Metrics	Period	US Dollar	Euro	Pound Sterling	Japanese Yen	Chinese Yuan	Indian Rupee
1	2	3	4	5	6	7	8
Global Forex Reserves	End-2023	58.4	19.9	4.9	5.7	2.3	_
Export Invoicing	June 2021	54	30	4	4	4	_
Forex Transactions	April 2022	88	31	13	17	7	2
Global GDP	2023	26.1	14.8	3.2	4.0	16.9	3.4
Global Trade	2022	11.2	16.0	3.5	3.2	11.0	2.7
Financial Markets Index	2021	0.900	0.715	0.854	0.856	0.635	0.582
Chinn-Ito Index	2021	2.299	2.275	2.299	2.299	-1.242	-1.242

Source: Currency Composition of Official Foreign Exchange Reserves, IMF, Boz *et al.*, (2022), BIS (2022c), World Economic Outlook Database, April 2024 (based on GDP at current prices US$ billion), World Bank's World Development Indicators, 2022 (based on current US$), European Commission, IMF's Financial Development Index Database, Chinn and Ito (2006) and Atlantic Council Dollar Dominance Monitor.

payment technologies could reduce currency switching costs[23], thus weakening existing network effects and inertia (Kim *et al.,* 2024). With the rise in global geopolitical tensions and geoeconomic fragmentation, bilateral and regional economic cooperation agreements are gaining ground. Nearly a decade ago, the IMF had noted that the INR alongside the Brazilian real, the Chinese renminbi, the Russian ruble and the South African rand have gained significant regional importance and have also shown a marked increase in their usage in international transactions, thus, exhibiting their potential to internationalise, while highlighting that full capital account convertibility may not be a necessary prerequisite for the same (IMF, 2011; RBI, 2022b).

IV.32 Given the potential benefits of internationalisation of INR in terms of lower transaction costs for cross-border trade and investment operations and lower exchange rate risk, various measures have been taken towards this end over the years. Anecdotal evidence suggests that the INR is accepted in Bhutan, Nepal, Singapore, Malaysia, Indonesia, Hong Kong, Sri Lanka, the UAE, Kuwait, Oman, Qatar, and the UK, among others. The Nepal Rastra Bank, Royal Monetary Authority of Bhutan and Bank Negara Malaysia hold Government of India (GoI) securities and Treasury Bills. Some sovereigns, like Singapore, hold Indian equity and bond assets (including G-secs) through their sovereign wealth funds. The Reserve Bank's efforts in recent years to develop India's financial markets have fostered trust, stability, and innovation by making capital raising more efficient, removing segmentation between onshore and offshore markets, and expanding the participation and product base (Das, 2024). Banks are now allowed to access offshore INR markets for FX and interest rate derivatives with a view to improve the efficiency of price discovery and provide greater opportunities to domestic participants. Market-makers have been permitted to deal in such products beyond domestic market hours. Rupee derivatives settled

[23] In Hayek's view (Hayek, 1976), currencies would compete primarily as stores of value. Historically, however, this type of competition has been limited due to switching costs and network externalities. Currencies that act as a store of value may compete with one another, while others that act as a medium of exchange compete separately. When switching costs are low, there is no longer a strong incentive to use one currency for store of value, medium of exchange and unit of account simultaneously. Instead, users of the network can seamlessly switch among currencies and convert units when needed.

in foreign currency have also been permitted in GIFT City. Further, Indian government bonds have begun to be included, in a phased manner, in the JPMorgan Global Bond Index for Emerging Markets (GBIEM) starting June 28, 2024, and will be included in the Bloomberg Emerging Market (EM) Local Currency Government Index, starting January 31, 2025. With this facilitative environment in place, there are multiple ways for internationalisation of the INR as a currency for cross-border payments (Table IV.5).

IV.33 India's merchandise and services trade, investment and remittance flows taken together generated demand for cross-border payments worth US$ 1.9 trillion in 2023-24[24]. Based on the latest available bilateral data for 2021[25], the top ten partner countries account for more than 50 per cent of this demand and could be a starting point in exploring interoperability and expansion of digital public infrastructure towards bilateral/multilateral solutions for cross-border payments. Recently, the Reserve Bank has joined Project Nexus, a multilateral international initiative to connect the FPSs[26] of four ASEAN countries (Malaysia, Philippines, Singapore, and Thailand) and India. These four countries account for more than two-thirds (US$ 110 billion) of India's total flows with ASEAN countries. Its extension to the complete ASEAN bloc could add cross-border flows to the tune of around US$ 45 billion annually. While India has a merchandise trade deficit with these nations, it is set off to a large extent by its services exports, remittances from Indian migrant workers, and FDI inflows.

Table IV.5: Ways to Internationalise the INR

S. No.	Method	Objective/Examples
1	2	3
1.	Bilateral/Multilateral Trade/ Payments Arrangements	To support liquidity arrangements in times of a financial crunch. Examples include the Asian Clearing Union (ACU)[27], the SAARC Currency Swap Framework[28], the UPI-PayNow linkage between India and Singapore and bilateral MoUs such as with the Central Bank of UAE.
2.	Special Rupee Vostro Accounts (SRVAs)	Authorised Dealer (AD) banks are permitted to open SRVA to settle trade transactions in INR with any country. Rupee payments for imports can be credited to these accounts. Balance in the SRVA can be used for any permissible current and capital account transactions.
3.	Local Currency Settlement (LCS) / Bilateral Swap Arrangement (BSA)	To facilitate wider use of local currencies in current and capital account transactions to improve ease of doing business and reduce dependency on hard currencies. Examples include MoUs on LCS with the UAE and Indonesia and the India-Japan BSA.

Source: RBI (2022b).

[24] While investment flows include both FDI and FPI, we consider only FDI in our analysis.

[25] RBI staff estimates using data for calendar year 2021 (the latest available bilateral data) for merchandise trade (Ministry of Commerce and Industry, GoI), services trade (WTO-OECD Balanced Trade in Services Dataset), FDI flows (Department for Promotion of Industry and Internal Trade, GoI), and remittances (World Bank).

[26] A special type of retail payment system in which the transmission of the payment message and the availability of the final funds to the payee occur in real time or near real time and on as near to a 24/7 basis as possible.

[27] The ACU, started in 1974, is presently operating as a clearing and payment system among its members (Bangladesh, Bhutan, Iran, India, Maldives, Myanmar, Nepal, Pakistan and Sri Lanka) for the promotion of trade among the participating countries.

[28] The SAARC Currency Swap Framework came into operation on November 15, 2012, to provide a backstop line of funding for short-term foreign exchange liquidity requirements or short-term balance of payments stress till longer-term arrangements are put in place. Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka are part of the SAARC grouping. Under the Framework for 2024-27, a separate INR Swap Window has been introduced with various concessions for swap support in INR. The total corpus of the INR support is ₹250 billion. The RBI will continue to offer swap arrangement in US$ and Euro under a separate US Dollar/ Euro Swap Window with an overall corpus of US$ 2 billion. The Currency Swap Facility will be available to all SAARC member countries, subject to their signing the bilateral swap agreements.

IV.34 The Report of the RBI's Inter-Departmental Group on Internationalisation of INR (October, 2022) recommended facilitating Local Currency Settlement (LCS) framework for bilateral transactions in local currencies and operationalising bilateral swap arrangements (BSAs) with the counterpart countries in local currencies. A LCS framework could be the most readily acceptable arrangement with economies with which payment flows (to and from) are nearly balanced. Taking an illustrative threshold flow gap of US$ ±2 billion, seven large[29] economies fulfil this criterion. For these seven countries, the annual merchandise and services trade, remittances and investment flows were US$ 163.6 billion in 2021 (around 11.5 per cent of India's total such flows). In this regard, any deficit in trade account can be offset by a surplus in capital account, remittances or services. Such patterns of bilateral cross-border flows can incentivise nations to look towards mutual acceptance of each other's currencies for settlement of cross-border transactions. Additionally, there are various large trading partners with whom trade is invoiced in USD and other foreign currencies. The acceptance of INR could be increased in such cases by leveraging the onward trade relationship of these partners with other countries, where the INR enjoys acceptability.

IV.35 Recent initiatives to promote the use of the INR and the UAE dirham for cross-border transactions and cooperation for interlinking payment and messaging systems between India and the UAE will help reduce settlement risk, foreign exchange risk, and dollar dependence in their bilateral trade (RBI, 2023b). Similarly, the use of local currencies for cross-border transactions between India and Indonesia would optimise costs and settlement time for bilateral trade transactions (RBI, 2024a). This model can be extended to other similar countries. The LCS and the BSA frameworks can act as a catalyst for the financial market deepening and stability in the region. Besides a reduction in transaction costs, the internationalisation of the INR may also reduce India's dependence on hard currencies for cross-border payments.

IV.36 As envisaged in the Reserve Bank's Payments Vision 2025, a mechanism for international INR settlement through Continuous Linked Settlement (CLS) would help increase global acceptance of the INR. The CLS is an initiative by a consortium of the world's largest foreign exchange clearing banks to enable FX settlement in Payment *versus* Payment (PvP) mode to address Herstatt risk[30]. Currently, it supports 18 of the most actively traded currencies globally. The CLS mechanism settles transactions worth more than US$ 6.5 trillion daily (CLS, 2024), which is nearly 87 per cent of the global daily FX turnover (BIS, 2022c).

3. Internationalisation of Digital Public Infrastructure

IV.37 The integration of DPI into economic activities has profound implications for India's open economy digitalisation. India's G-20 presidency in 2023 placed DPI on the global map. The key pillars of India's DPI, such as digital identity, digital payments financial infrastructure, digital governance, and digital industries/ education, offer tremendous opportunities due to their flexible and modular approach, for which various cross-border use cases have been identified (Table IV.6). Furthermore, India's G-20 task force on DPI suggested the creation of Digital

[29] Size of total annual flows greater than US$ 10 billion.

[30] The settlement risk that one party will deliver foreign exchange but the counterparty financial institution will fail to complete its end of the contract.

Table IV.6: Major Leading Digital Public Infrastructure and Digital Public Goods in India

S. No.	Name	Description/useful for	Launch	Usage*	Cross-Border Business Potential	Potential use cases for cross-border trade
1	2	3	4	5	6	7
Digital Identity						
1.	*Aadhaar*	A 12-digit unique identification number	2009	1.4 billion Aadhar numbers issued	G2C, B2C	Distribution of Government scheme through DBT
2.	eKYC	Electronic authentication using *Aadhaar*	2013	14.7 billion eKYC completed as on March 31, 2023	G2C, B2C	Digital onboarding
3.	eSign	Legally valid electronic signature	2016	18 empanelled eSign service providers	B2B, B2C, G2C	Legal enforcement of digital contract
Digital Health						
4.	Ayushman Bharat Digital Mission	Enhancing health services -teleconsultation and e-pharmacy	2020	0.36 billion health records linked	B2C, G2C	Digital health records
5.	CoWIN	Web portal for COVID-19 vaccination registration	2020	2.2 billion Covid-19 vaccinations facilitated	G2C, B2C	Verifiable health certifications, telemedicine
Digital Payments/Financial Infrastructure						
6.	AePS	*Aadhaar* Enabled Payment System	2010	5.5 billion transactions in 2023-24	B2C, B2B, G2C	Facilitating online access to banks through digital identification
7.	APB	*Aadhaar* Enabled Bank Accounts	2011	1.4 billion transactions in 2023-24	G2C, B2C	Help reduce leakages from welfare schemes using direct bank transfers
8.	FASTag	Using RFID technology for toll payments	2014	88.2 million tags issued	B2C, G2C	Easily deployable across countries
9.	UPI	Instant real-time payment system	2016	131.2 billion UPI transactions in 2023-24	B2C, G2C, B2B, C2C	Financial / banking penetration
10.	BBPS	Integrated bill payment system	2016	1.4 billion transactions in 2023-24	B2C, G2C	Recurring payment ecosystem
11.	GSTN	Track and manage the tax liabilities under the GST system.	2017	14 million active taxpayers	G2B, G2C	Offers leakage proof tax compliance system
12.	Account Aggregator	Consent-based flow of digital financial information across FIs	2021	64 million cumulative successful consents	B2B, B2C	Digital financial data aggregation
Digital Governance						
13.	DigiLocker	Allows storage and access to verified digital documents	2015	0.29 billion users as on July 10, 2024	G2C, B2C	Facilitate paperless governance
14.	DIGIT Core	Digital Infrastructure for Governance, Impact and Transformation	2017	2.0 billion citizens across 10 countries benefitted as on July 10, 2024	G2C	Good governance technology platform
Digital Industries/Education						
15.	Udyam	Allowing MSMEs to access government schemes and benefits.	2020	27.3 million MSME (Udyam) Registrations as on July 10, 2024	G2C	Enhance ease of doing business and facilitate cross-border trade
16.	Digital Infrastructure for Knowledge Sharing (Diksha)	Enables collaborative learning and teaching and generates customisable content	2017	1.71 crore registered users on DIKSHA as on July 15, 2024	G2C	Resource and expertise sharing

Note: eKYC: Electronic Know Your Customer, eSign: Electronic Signature, CoWIN: COVID-19 Vaccine Intelligence Network, AePS: *Aadhaar* enabled Payment System, APB: *Aadhaar* Payments Bridge, BBPS: Bharat Bill Payment System, GSTN: Good and Services Tax Network, DIGIT Core: Digital Infrastructure for Governance, Impact and Transformation Core. *: Data as on March 31, 2024, unless otherwise indicated.
Source: National Payments Corporation of India (NPCI), *Sahamati*, eGov and Government of India.

Public Goods (DPG) packages that will ensure availability of the assets such as software codes and documentation among others required for the successful deployment of the DPI solution (GoI, 2024).

Learnings from DPIs Worldwide

IV.38 DPI provides tremendous opportunities to countries in fostering financial inclusion, empowering women, enhancing transparency, and increasing efficiency (Table IV.7). Digitalising government transfers contributed to 865 million people worldwide opening their first financial account to receive money from the government (Demirgüç-Kunt *et al.,* 2022). Countries that already had elements of DPI in place (such as digital databases or ID records and data-sharing platforms) could reach more than three times the beneficiaries during the pandemic than those that had to collect latest information (World Bank, 2022).

Table IV.7: Key Learnings from Cross-Country DPIs

Sr. No.	Country	Benefit	Key Learnings
1	2	3	4
1.	Brazil	Pix plus digital wallets with remote onboarding and pro-digital policies contributed to 75 per cent of Auxilio Emergencial[31] cash transfer beneficiaries using the funds digitally (Lara de Arruda *et al.,* 2022)	▪ Fostering financial inclusion
2.	Mozambique	Beneficiaries spend less than 30 minutes waiting for mobile money payments *versus* more than one hour waiting for cash payments.	▪ Reducing time lag ▪ Enabling faster settlement
3.	India	(i) The use of digital payments has reduced delays in the payment of maternal health conditional cash transfers by 43 per cent. (ii) The onboarding cost of a typical firm is estimated to significantly reduce from around INR 1,500 to INR 10 (World Bank, 2018). (iii) The introduction of biometric-based digital payments in employment and pension schemes reduced leakages by 41 per cent (Muralidharan, *et al.,* 2016). (iv) NITI for States DPI platform is a live repository of 7,500 best practices, 5,000 policy documents, 900+ datasets, 1,400 data profiles, and 350 NITI publications. The knowledge products on the platform span 10 sectors (PIB, 2024).	▪ Cost Saving ▪ Time Saving ▪ Reduces leakages ▪ Increases transparency
4.	Niger	Households where women received digital social assistance payments have shown 16 per cent higher diet diversity than those who received benefits in cash (Aker *et al.,* 2016).	▪ Women empowerment
5.	Singapore	eKYC, facilitated by the Singpass consented data-sharing service, has reduced the time to complete digital transactions by 80 per cent (OECD, 2022).	▪ Reducing time lag ▪ Enabling faster settlement
6.	Estonia	The government, citizens, and residents save a significant amount of working time every year due to the X-Tee data-sharing platform (Vainsalu, 2017).	▪ Time saving
7.	Zambia	Choice-based payments in the educational sector allowed for greater competition among payment service providers and improved customer service.	▪ Foster competition
8.	Türkiye	The Integrated Social Assistance Service Information System, which is linked to 28 public databases, reduced the number of documents needed for applicants of social assistance programmes from 17 to just 1 (World Bank, 2023).	▪ Increasing efficiency

Source: World Bank, OECD and various countries' government websites.

[31] As per the World Bank, the Auxílio Emergencial, a social protection programme, reached up to 55.6 per cent of the population, considering both direct and indirect beneficiaries. The programme helped to improve the average income and reduce the prevalence of poverty and inequality as compared with the immediate pre-pandemic level.

Leveraging India's DPI – New Areas for Cross-Border Trade

IV.39 By integrating emerging technologies like AI capabilities, India's DPI can cater to significant global demand and propel a transformative leap forward towards 'Digital Public Intelligence' (INDIAai, 2023; WEF, 2023; GoI, 2024). First, India's digital public health infrastructure and user base can be leveraged for cross-border telemedicine, remote patient monitoring, and medical diagnostic research. India's CoWIN platform, which managed COVID-19 vaccination programme, shows its capability in building scalable digital public goods and can help other countries develop similar platforms for access to healthcare services and data exchange. Furthermore, the evolution of the National Health Portal into a consolidated repository of health information signifies a significant leap towards a unified and interconnected healthcare model. The infusion of modern technologies, including Natural Language Processing (NLP), sensors, genetic analysis, and AI, promises a patient-centric healthcare system. The convergence of IoT devices and robotics is set to revolutionise healthcare delivery, moving beyond traditional hospital settings to embrace home-based care. India can also carve a niche in specialised digital solutions for the increasing population of senior citizens worldwide. These include robots, customised hardware such as mobiles, tablets, wearables, and security devices, as well as digitally delivered services such as telemedicine, counselling, and financial advice.

IV.40 Second, in the education sector, India's DPI experience has the potential to accelerate the pace of equitable learning experiences across the globe. This can be facilitated *via* digitally empowered classrooms, incorporating augmented reality (AR)/virtual reality (VR) and AI-ML technologies, which aim to make learning collaborative, engaging, and accessible to learners across the globe. Third, the recently launched open-source e-commerce platform, "Open Network Digital Commerce (ONDC)," is poised to be a catalyst for local commerce in India. The open source ONDC encourages start-ups to innovate and build specialised applications, enhancing accessibility to reliable services (Deloitte, 2023). It can also facilitate seamless exports for Indian businesses by connecting SMEs, logistics providers, and financial institutions across cross-border payment providers. The ONDC's interoperable framework reduces complexities and costs associated with international trade, encouraging more MSMEs to engage in global commerce. Finally, the ONDC's transparent platform helps businesses adhere to international trade regulations to access global markets.

IV.41 DPI can also be deployed for the infrastructure sector under the National Infrastructure Pipeline, which has a total investment of more than ₹108 lakh crore. DPI can leverage computerised land records and digitised maps created under the Digital India Land Records Modernization Programme, electronic government clearances, developments in Geographic Information System (GIS), drones and IoT to enable real time, detailed and accurate monitoring of infrastructure and industrial projects. This can be a specialised DPI available to prospective investors, governments and contractors to enable project selection, planning and implementation in a plug-and-play manner. Not only can this help attract foreign investment, but it can also be exported to other countries that face pressing infrastructure needs.

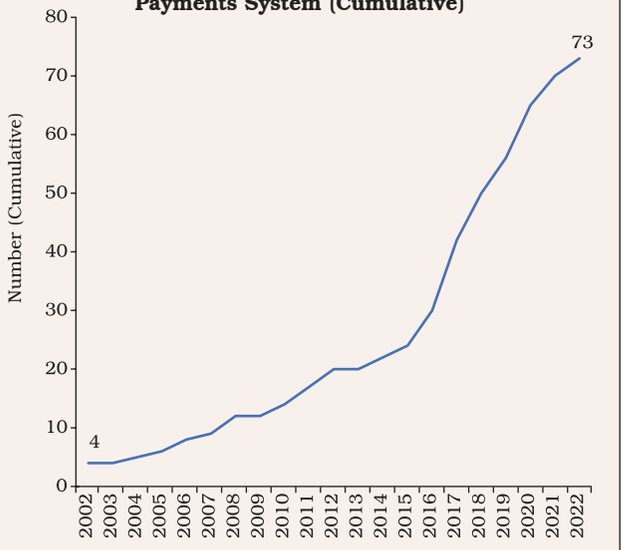
Strengthening India's DPI: Cross-Border Fast Payments

IV.42 By leveraging new digital technology, reducing the number of intermediaries, enhancing openness and competition, FPSs have the potential to make cross-border payments cheaper and faster, while increasing transparency. Cross-border payments include commercial payments executed by financial institutions on behalf of their clients (B2B, B2C, C2B, and C2C flows) and treasury payments related to the settlement of inter-bank trades, securities, foreign exchange, money markets, among others. While banks dominate the B2B and B2C cross-border payment segments, FinTechs have occupied the C2B and C2C segments. The market for cross-border payments has expanded in the recent years driven by a rise in cross-border labour and capital flows owing to the spread of global manufacturing supply chains and e-commerce, foreign investment flows and cross-border asset management. The value of cross-border payments is estimated to surpass US$ 250 trillion in 2027 (Bank of England, 2024). The USD and the EUR are the two most widely used currencies for cross-border payments, with each having an approximate share of 40 per cent (Perez-Saiz *et al.,* 2023).

IV.43 At present, correspondent banking based on SWIFT messaging is the dominant mechanism for cross-border payments. SWIFT also facilitates securities and FX settlement, KYC/AML compliance, trade finance, corporate treasury operations and business intelligence (SWIFT, 2024). It processes approximately 45 million transactions per day (SWIFT, 2022). Median transaction processing time for SWIFT can vary from less than five minutes to more than two days depending on the corridor, while cross-border payments *via* the UPI-Pay Now interlinkage can be completed within a minute (Nilsson *et al.*, 2022; RBI, 2023c). Additionally, charges are not uniform across SWIFT participant banks, which leads to uncertainty for the customer. Hence, there is a case for interlinking of FPSs for cross-border payments to make them faster, cheaper, more transparent and inclusive, as envisaged under the G20 roadmap to enhance cross-border payments.

IV.44 Payment system interoperability and extension is one of the priority themes to help achieve the G20 targets for cross-border payments (FSB, 2022). With more than 70 FPSs operating globally (Chart IV.14), interlinking arrangements[32]

Chart IV.14: Number of Countries with Real Time Payments System (Cumulative)



Source: ACI Worldwide (2024).

[32] Interlinking arrangements for cross-border payments can be defined as a set of contractual agreements, technical links and standards, and operational components between payment systems of different jurisdictions, allowing their respective participating payment service providers (PSPs) to transact with one another as if they were in the same system (BIS, 2022b).

would constitute the first step towards faster and cheaper cross-border payments. Growing use of APIs[33] and the adoption of the ISO 20022 financial messaging standard[34] have opened avenues for payment system interlinking, which would involve benefits such as shortening of transaction chains, reduction of transaction and funding costs, increased payment speed, transparency in fees, and improved competition in the provision of foreign exchange and cross-border payment services.

IV.45 The interlinking of payment arrangements can be differentiated by the type of link (direct or intermediated) between participants and the currency arrangement (single/multi-currency and with/without currency conversion). There could be four key types of links: (i) single access point model, (ii) bilateral link, (iii) hub and spoke model, and (iv) common platform model. The UPI-PayNow linkage is a pertinent example of the bilateral model, which leverages open banking APIs to allow account holders of participating financial institutions in India and Singapore to conduct cross-border remittance transactions with the same ease as domestic transactions through the individual FPSs (RBI, 2023c). In a bilateral link, two FPSs are connected directly through nostro/ vostro accounts of linked systems. The Reserve Bank has also signed an MoU with the Central Bank of UAE to link the UPI with the UAE's FPS – the Instant Payment Platform (IPP), the respective Card Switches (*RuPay* switch and UAESWITCH) and to explore the linking of payments messaging systems – the Structured Financial Messaging System (SFMS) of India with the messaging system in the UAE (RBI, 2023b). There are limits to the scalability of the bilateral model since every FPS may have different technical standards, business processes, governance framework and regulatory requirements, thus, requiring complex technical integration and multi-party legal negotiation (BIS, 2023).

IV.46 At present, India is one of the major countries with a 24x7 RTGS system. According to Central Banking's Payments Benchmarking 2022, only 12 per cent of the respondent central banks operated their RTGS 16–24 hours a day, with a majority operating it for only 7-12 hours per day. India's RTGS runs on ISO 20022 standard and is ready to be streamlined with the internationally accepted standard for cross-border fund transfers. Additionally, the natural working hours of India's financial sector lie comfortably within the global settlement window. Several global outreach initiatives to expand the footprint of the UPI are already underway through bilateral and multilateral linkages and collaborations with relevant stakeholders. As per the Reserve Bank's Payments Vision 2025, steps can be taken to migrate all the Reserve Bank-operated payment messaging systems to ISO 20022 standard. The feasibility of expanding RTGS to settle transactions in major trade currencies such as USD, EUR and GBP can be explored through bilateral or multilateral arrangements. These arrangements could provide real time proceeds in foreign currencies to traders and help develop the country as a major centre for international financial trades.

[33] APIs enable a software application to request a specific piece of data from one or more other software applications, and for data transfer from the data providing application back to the requester, provided the original request was valid.

[34] The ISO 20022 standard enables the consistency of data in payment messages, the ability to reuse components across messages and is more data-rich than its predecessors. It can facilitate automated payment processing with faster messaging and lower payment failure rates.

IV.47 The system of liquidity bridges for seamless transfer of funds can also be explored. In a bilateral liquidity bridge, collateral – usually in the form of cash – is held by payment system participants at a specific central bank (the facilitating bank), denominated in the currency issued by it. The facilitating bank notifies the receipt of the collateral which enables the provision of intraday liquidity by another central bank (the lending bank) in its native currency to the participants or their affiliated entities (*e.g.,* branches or subsidiaries) within the jurisdiction of the lending bank (BIS, 2022a). The benefits of maintaining liquidity bridges include efficient management of global liquidity requirements, lower foreign exchange risk and credit risks for payment system providers (PSPs), and a credit line in times of financial stress.

IV.48 For the extension of its payments technology associated DPI into the global arena, India can provide technical assistance to standardise processes and protocols across countries to make them compatible with the UPI. Given that the UPI offers features like plug-and-play innovation through APIs, CBDC interoperability (with the e-₹), offline capability, ability to link credit cards and collect requests, it is also a highly attractive candidate for countries exploring the market for a readymade FPS to adopt in their jurisdictions (Watson, 2024).

Improving India's DPIs: Challenges and Building Resilience

IV.49 Despite being one of the leading producers of optical fibre cable (OFC) in the world, the fiberisation in India's broadband lines remains low. There is a significant share of digital subscriber line (DSL) and other non-fibre lines in India's broadband lines, which may hinder internet speed and 5G adoption (TechHerald, 2021). Only around 38 per cent of India's mobile towers are fiberised, while 6G technology will require 100 per cent fiberisation (KPMG, 2023).

Strengthening Sea Cable Network

IV.50 For a sustainable growth of India's DPI, reliable high-speed connectivity between strategic locations would be paramount. Globally, US$ 418 billion needs to be mobilised to connect unconnected households (Amaglobeli *et al.,* 2023). The expected rise in internet penetration (46 per cent in 2021), adoption of AI, 5G, IoT and an ever-increasing reliance of the Indian economy on DPIs require expansion in the number and quality of internet connections. Around 99 per cent of all international data is transferred through a labyrinth of OFC stretching across ocean floors. As of June 2024, there were approximately 600 such active and planned cables, spanning nearly 1.4 million kilometres. Traditionally, undersea cables were owned by telecom carriers who would form a consortium of all parties interested in using the cable. Lately, content providers such as Google, Meta, Microsoft, and Amazon have been major investors, accounting for almost a fifth of the US$ 12 billion in planned investments in new systems over the next four years (The Economist, 2023). Centrally located countries in the global OFC network enjoy faster and cheaper connections to the internet. In view of the economic importance of internet services, and to counter the dominance of BigTech and a handful of countries over the global data pipeline, India could benefit by expanding its OFC connections to the world with targeted policies to crowd in such expenditure by telecommunications firms at a large scale.

Strengthening Satellite Network

IV.51 An alternative satellite internet backbone for the nation can diversify risk as well as connect remote geographies. In recent years,

especially during times of geopolitical tensions and fragmentation, satellite internet has emerged as a critical supplement to OFC. Moreover, satellite internet is crucial for disaster recovery and development of next-generation services like telemedicine, remote education, and for the IoT. Utilising constellations of small, mass-produced satellites, some companies have promised cheap, high-speed internet access throughout the world (Graydon and Parks, 2020). Indian telecom giants have also started exploring satellite internet solutions, and these efforts would get a boost from the recent policy framework to attract FDI in the space sector.

Cybersecurity

IV.52 Although digital trade increases cybersecurity risks, trade policy can also strengthen cybersecurity (Meltzer and Kerry, 2019). Trade agreements can include commitments to building public and private sector real-time information sharing mechanisms to promote awareness, plan responses, and help targets adapt and respond. They can also help popularise the use of international cybersecurity standards where they exist as a basis for domestic regulation, and help achieve greater uniformity and coordination. Cybersecurity compliance certification schemes may also be used to establish export conformity across jurisdictions in international trade. Under the G20 New Delhi Leaders' Declaration, India has welcomed the Financial Stability Board's (FSB's) recommendations to achieve greater convergence in cyber incident reporting and the updates to the Cyber Lexicon. It has also expressed interest in the initiative to develop a common format for incident reporting exchange (FIRE). Additionally, on the lines of the Financial Action Task Force (FATF), a Financial Cybersecurity Action Task Force with involvement of both the public and private sectors may be needed to create and promote cyber norms to balance innovation and systematic cyber risk within cross-border financial systems (Huang and Madnick, 2020).

Role of CBDCs in Cross-Border Payments

IV.53 Policy discussions on CBDC have graduated from the preliminary concerns around technology and its impact on cash, bank deposits and monetary policy to more granular, practical, and operational areas such as legal implications, operability across jurisdictions, cross-border payments, and privacy concerns. Pilot projects have been introduced to explore cross-border use cases. Multiple benefits such as financial inclusion, reduction in the cost of printing currency notes, environmental benefits, and creating a more secured and cost-effective settlement mechanism are some of the driving factors prompting central banks to consider the launch of CBDCs and explore its functionality for cross-border transactions. Currently, in more than 90 countries, CBDCs are in various stages of exploration/implementation.

IV.54 In October 2020, the G20 endorsed a roadmap to enhance international cross-border payments and the targets stipulated therein are to be achieved by 2027 (Table IV.8). The identified frictions such as fragmented and truncated data formats, intricate compliance checks, restricted operating hours, outdated technology platforms, lengthy transaction chains, funding costs, and limited competition were associated with higher cost, lesser speed, and lower accessibility in cross-border payment infrastructure. The roadmap aims to enhance the existing payment infrastructure, while outlining an international dimension into the design of CBDCs as part of the forward-looking initiatives (FSB, 2023).

Table IV.8: Roadmap to Enhance Cross-Border Payments: Global Targets to be Achieved by end-2027

1	2	3	4
Challenges	**Retail Payments (<US$ 1,00,000)**	**Wholesale Payments (>US$ 1,00,000)**	**Remittances**
Cost	Global average cost not more than 1 per cent with no corridor costing more than 3 per cent.	–	Global average cost of remitting US$ 200 not more than 3 per cent (by 2030) with no corridor costing more than 5 per cent.
Speed	75 per cent of payments to be credited within an hour from payment initiation, the remainder within one business day.	75 per cent of payments to be credited within an hour from payment initiation or pre-agreed settlement date and time (forward-dated transactions), the remainder within one business day.	75 per cent of payments to be credited within an hour from payment initiation, the remainder within one business day.
Access	All end-users to have access to at least one infrastructure or provider.	All FIs to have access to at least one infrastructure or provider (multiple infrastructures/ providers wherever appropriate).	More than 90 per cent of individuals who wish to send/receive a remittance should be covered.
Transparency Disclosures	Transaction cost (including fees, charges by intermediaries, foreign exchange rate and currency conversion charges), expected fund delivery timings, payment status tracking and terms/conditions of service.		

Source: FSB (2021).

IV.55 Central banks consider CBDCs as an opportunity to streamline and improve cross-border transactions, providing 24/7 settlement even outside closed-loop solutions or those controlled end-to-end by money transfer operators. CBDCs could offer inherent advantages in cross-border transactions by streamlining the cost of international remittances, minimising risks associated with multiple intermediaries, enhancing efficiency through faster settlement times, and providing greater transparency in payment status (Auer *et al*., 2021). However, the cross-border use of CBDCs may expose EMDEs to various macroeconomic and financial sector risks, including currency substitution, heightened volatility in capital flows and exchange rates, and exacerbation of issues like tax avoidance and illicit activities (BIS, 2021; Chen *et al.,* 2022, and Prasad, 2023).

IV.56 Wholesale CBDC developments have doubled in the last two years due to geopolitical environment (Atlantic Council, 2024). There are presently around 13 cross-border CBDC projects, including mBridge, which connects China, Thailand, the UAE, Hong Kong and Saudi Arabia and has more than 26 observing members (BIS, 2024). Central banks are exploring both retail and wholesale cross-border CBDC arrangements (with focus towards the latter), and the ongoing projects endorse both bilateral transactions and multilateral arrangements. One approach to developing cross-border CBDCs involves interlinking individual domestic CBDC systems, making them compatible through adherence to common international and technical standards as well as aligning them to legal, regulatory and supervisory frameworks. Additional interlinkages of CBDC systems can be achieved either through a shared technical interface or a common clearing mechanism (for example, Project Jasper-Ubin and Project Jura), taking into account the member central banks during the development stage itself to reduce reliance on coordinated policy moves in later stages (BIS, 2021). A more nuanced approach involves establishing a single multiple-CBDC (mCBDC) system across jurisdictions, exemplified by projects like Inthanon-LionRock, Aber, mCBDC

Bridge, and Dunbar. This concept revolves around having a unified set of rules, a single technical system and a singular set of participants. While this deeper integration and wider access offers potential operational functionality and settlement efficiency, it poses policy challenges and raises governance and control concerns (BIS, 2021).

IV.57 In India, apart from enhancing international transactions, cross-border CBDC has the potential to overcome challenges relating to turnaround times, high costs, transparency as well as legal and regulatory requirements across jurisdictions, while reinforcing the role of central bank money as an anchor for cross-border payments. Accordingly, the Reserve Bank is examining bilateral and multilateral collaborations. In this direction, the Reserve Bank has also signed an agreement with Central Bank of United Arab Emirates (CBUAE) in the area of FinTech initiatives including cross-border CBDC payments. To learn about global initiatives and progress, the Reserve Bank has joined the BIS Innovation Hub led multilateral projects 'Mandala' and "mBridge" as an "Observer".

Factors Influencing Cross-Border CBDCs

IV.58 Several factors such as digitalisation of commerce, the widespread use of private digital currencies, and specific policy concerns related to financial inclusion, informality, and data privacy could influence the adoption of CBDCs (Auer *et al*., 2023). However, the reasons behind the issuance of CBDCs vary among countries. Duffie (2020) delves deeper into the importance of interoperability in the context of CBDCs, emphasising its role in enhancing efficiency. He (2021) underscores the significant impact of high cross-border remittance costs on both the financial system and the prevalence of unbanked populations, particularly in less-developed regions. Countries also consider external sector implications while adopting cross-border CBDCs (Box IV.3).

4. Data Embassies and India's Potential

IV.59 Data is the pulse of the digital economy. The explosion in the data volume necessitates innovative approaches for data protection and resilience to secure digital information for uninterrupted functioning of the digital economy. Data can be stored within the country in data centres[35] through legal provisions such as data localisation policies or housed outside the country in "data embassies"[36].

IV.60 In recent years, India's focus has been on developing both data centres and data embassies. This move not only enhances cybersecurity but also ensures that a comprehensive range of financial information is safeguarded in a systematic manner. This aligns with global efforts to strengthen data protection and privacy measures. Data embassies have become a viable option for storing and managing duplicate copies of vital state data outside the domestic territory that ensures data sovereignty, while imparting security and resilience in the event of major cyber threats, natural disasters, and terrorist attacks.[37] India is looking to establish data embassies at the GIFT IFSC for countries and businesses looking

[35] A dedicated secure space within a building/centralised location where computing and networking equipment is concentrated for the purpose of collecting, storing, processing, distributing or allowing access to large amounts of data (Data Centre Policy – 2020, MeitY).

[36] A data centre of a country housed within the borders of another country while remaining under the formal jurisdiction of the former country.

[37] The origin of data embassies derives from a bilateral agreement in 2017 when Estonian government's cloud backup was housed in a Luxembourg data facility. Similarly, in 2021, Monaco's e-embassy was set up in Luxembourg, hosting a digital twin of the Monegasque sovereign cloud. Luxembourg appears to be an attractive destination for modern data centres because of its robust business continuity, resilient communication infrastructure, and comprehensive disaster recovery capabilities (Bharat, 2023).

Box IV.3
Factors Influencing the Adoption of CBDCs

Taking cues from Auer *et al*. (2023), which finds high mobile phone usage and innovation capacity important for CBDC adoption, the role of factors such as volatility in exchange rate, economic development and the share of inward remittances in influencing cross-border CBDC adoption is examined. A sample of 97 countries, which have already announced/implemented some version of CBDC has been analysed using a cross-sectional Probit regression model:

$$Prob\ CBDC\_cross\_border = 0,1 / x_i = f(\alpha + \beta x_i + \varepsilon_i) \quad (1)$$

where, the probability of a jurisdiction *i* to announce/ implement a cross-border CBDC project (equals to 1) or not (equals to 0) has been represented as a function of a potential economic/institutional factor x_i. α and β represent coefficients and ε_i denotes error term.

Empirical analysis suggests that the level of economic development (measured by per capita GDP) and share in the global inward remittances encourage CBDC adoption, while volatility of exchange rate discourages its adoption (Table 1). Adverse spillovers from volatility in capital flows and exchange rate could accentuate in the presence of cross-border CBDC (Popescu, 2022). On the other hand, the countries with a higher share in the global inward remittances have an inherent advantage in adopting cross-border CBDC as a faster, more efficient, cost effective and secure option for global payment systems.

Table 1: CBDC Adoption - Results of Cross-sectional Probit Regression

Dependent Binary Variable: Whether the country has announced/implemented Cross-Border CBDC project (1) or not (0)

1	2	3	4
Independent Variables	**Specification 1**	**Specification 2**	**Specification 3**
Constant	0.24 (0.89)	-3.93*** (-3.05)	-4.93*** (-3.60)
Exchange Rate Volatility@	-0.15*** (-2.89)	-0.12** (-2.31)	-0.12** (-2.18)
Log (Per Capita GDP)		0.44*** (3.39)	0.53*** (3.85)
Remittance Share$			0.17** (2.27)
Observations	93	92	92
McFadden R-squared	0.12	0.22	0.26

@: Standard deviation in the monthly real effective exchange rate over a period of 5 years till December 2023.
$: Share in global inward remittances.
Note: 1) *** p<0.01, ** p<0.05, * p<0.1.
2) Robust errors (Huber-White).
3) Figures in parentheses are z-statistics.
Source: RBI staff estimates.

References:

Auer, R., Cornelli, G., and Frost, J. (2023). Rise of the central bank digital currencies. *International Journal of Central Banking, 19(4)*, 185-214.

Popescu, A. (2022). Cross-Border Central Bank Digital Currencies, Bank Runs and Capital Flows Volatility, *IMF Working Paper No 2022/083*.

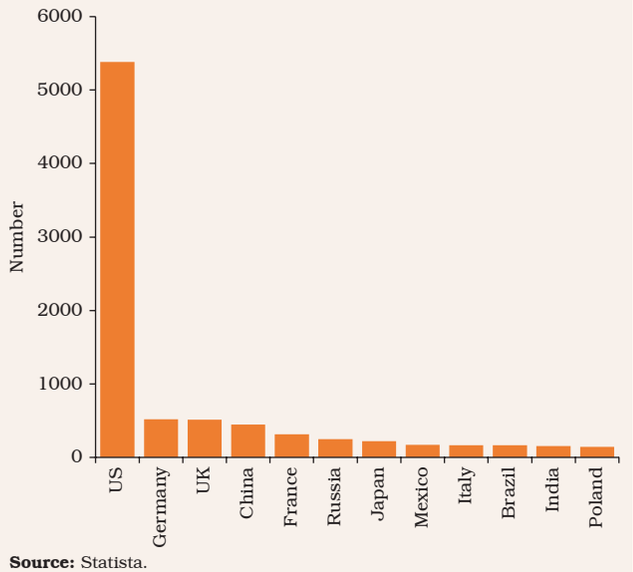
for digital continuity solutions (GoI, 2023). The establishment of data embassies will primarily be facilitated through bilateral agreements with the interested countries. Multinational corporations could use these embassies to store the data of Indian users within the country. This is expected to give a significant spurt to investment in India's data industry, especially from technology infrastructure providers and cloud storage companies. This would help India emerge as a major and trusted player offering a full-fledged data storage ecosystem.

Encouraging Establishment of Data Centres in India

IV.61 The requirement for establishing data centre infrastructure in India is reinforced by the data localisation provision in the Digital Personal Data Protection Act (DPDPA), 2023 for the protection of the digital sovereignty of the citizens in an increasingly connected world. India has enablers in the form of a favourable geographical location, established global connectivity through submarine cables, readily available skilled workforce, a large data consuming market and huge potential for growth in digital infrastructure[38]. These can lay the foundation for a robust and secure digital ecosystem for fuelling economic growth in India and making India a global data centre hub.

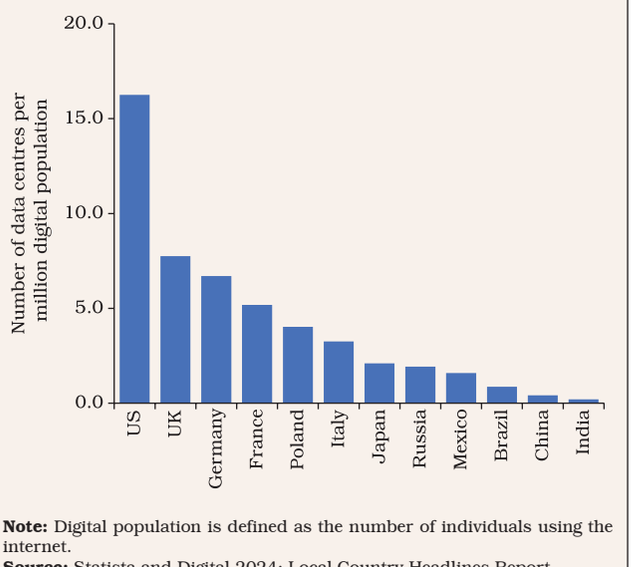
IV.62 India's data centre capacity is estimated to have more than doubled from 521 megawatt (MW) in 2020 to 1048 MW in 2023 in the light of fast-paced rise and spread of digitalisation and growing demand for advanced technologies such as 5G, AI, blockchain and cloud computing (CBRE, 2023). The main drivers creating a conducive environment for development of data centres in India include fiscal incentives, better technology infrastructure and regulatory push. The data centre market in India is, however, still at its nascent stage, relative to both AEs and peer EMEs (Charts IV.15 and IV.16). The Union Budget 2022-23 afforded the status of 'infrastructure' to data centres, thereby placing them at par with sectors such as railways, roadways, and power. This has enabled access to long-term credit on improved terms for the development of the sector. Most states in India have defined data centres as 'essential service' to ensure uninterrupted operations throughout the year. While most state incentives are in the form of stamp duty exemption, power subsidy and ease of approval, some offer tax benefits and a select few offer capital subsidies.

Chart IV.15: Number of Data Centres - 2024



Source: Statista.

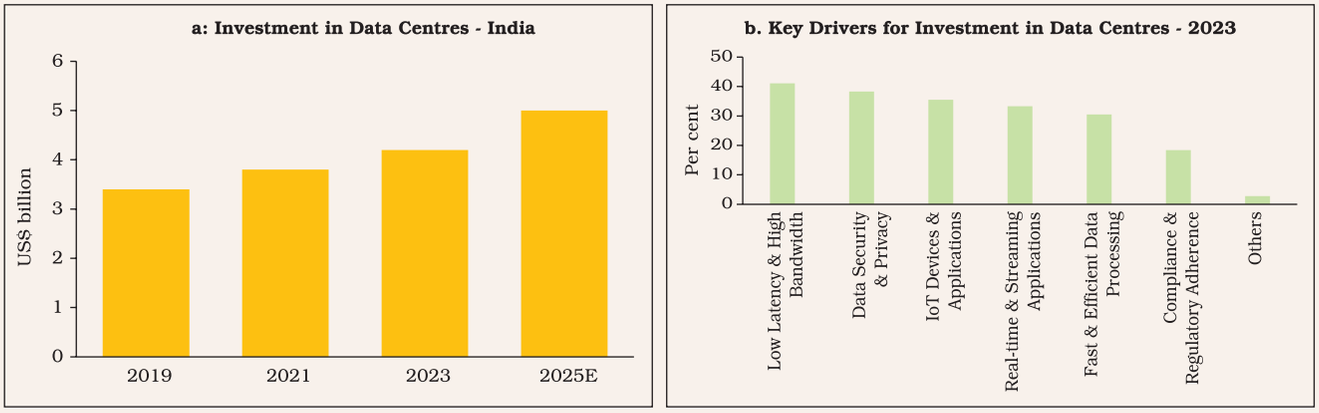
Chart IV.16: Data Centre Density - 2024



Note: Digital population is defined as the number of individuals using the internet.
Source: Statista and Digital 2024: Local Country Headlines Report.

[38] Table A.5 of World Bank (2024a) gives cross-country comparison of select indicators of digital infrastructure.

Chart IV.17: Data Centres - Investment and Key Drivers



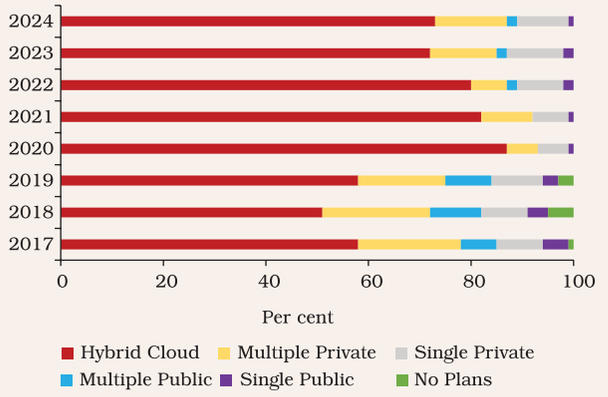
E: Estimate.
Note: Chart (b) presents the results of the Enterprise Edge Adoption Trends Survey, a global survey carried out by Datacentre Dynamics in 2023.
Source: NASSCOM, Amadeus Capital, Arizton and Statista.

IV.63 The annual investment in data centres in India is expected to be US$ 5 billion by 2025, a CAGR of 6.6 per cent since 2019 (Chart IV.17a). This growth is attributed to India's increasing internet usage and cloud computing demands with low latency (best speed and fastest response time) and high bandwidth, Government-led digitalisation initiatives, and the localisation efforts of digital service providers (Chart IV.17b). The growing investment in data centres stokes demand for related infrastructure, encompassing India's IT, electrical, mechanical, and general construction services. As data centres require round-the-clock and large amount of electricity, appropriate policies would be needed to meet the higher energy demand in a sustainable way along with increased role of technology in clean electricity generation. Furthermore, the proper management of e-waste generated by data centres and establishment of green data centres may be encouraged (Raj, 2022). Some voluntary initiatives for greening data centres include switching over to renewable energy and implementing guidance provided by established frameworks such as the Green Data Centre Rating Systems (RBI, 2022c).

IV.64 In the aftermath of the pandemic, the proportion of enterprises with no plan for cloud adoption is close to zero, whereas the proportion of enterprises with hybrid cloud which combines both public and private clouds has increased further (Chart IV.18). Public cloud adoption is also increasing. Cloud adoption is mainly guided by cost and performance.

IV.65 With a view to enhancing the security, integrity and privacy of financial sector data, the

Chart IV.18: Global Enterprise Cloud Strategy



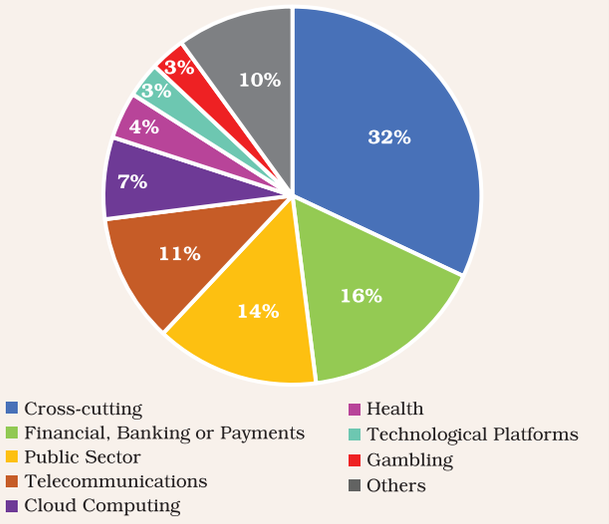
Note: 1. Public cloud is managed by service providers who rent out a part of their distributed data centre infrastructure to customers.
2. Private cloud is dedicated cloud infrastructure of a single company, managed by the company itself or by a third-party service.
3. Multiple cloud means more than a single cloud. The most common type of multiple cloud is hybrid cloud – a combination of public and private clouds.
Source: Flexera Software.

Reserve Bank is in the process of establishing a cloud facility for the financial sector in India. The proposed facility would also facilitate scalability and business continuity (Das, 2023). The cloud facility will be set up and initially operated by the Indian Financial Technology and Allied Services (IFTAS), a wholly-owned subsidiary of the Reserve Bank (RBI, 2024b). Besides, the Reserve Bank is also developing a state-of-the-art greenfield data centre[39] to address capacity expansion constraints in catering to the rapidly growing IT ecosystem's requirements, while also offering a buffer to region-specific risks (Patra, 2024).

Data Localisation and Ring Fencing

IV.66 The multi-fold increase in digital transactions across the financial landscape has necessitated regulatory measures for storage of critical data in the form of data localisation. Data localisation is broadly defined as the requirement of physical storage or processing of data within the territory of the country where it has been generated. Countries view the necessity of localisation measures in the light of growing digital interconnectedness amongst economies, that may have strategic or political implications (Bailey and Parsheera, 2018). As of early 2023, 96 data localisation measures across 40 countries were mandated, prescribing either storage or processing of data within the domestic territory (OECD, 2023b). More than two-third of these measures require domestic storage and prohibit data flow outside the country. Financial, banking and payments sectors have the maximum localisation measures, followed by public sector and telecommunications (Chart IV.19).

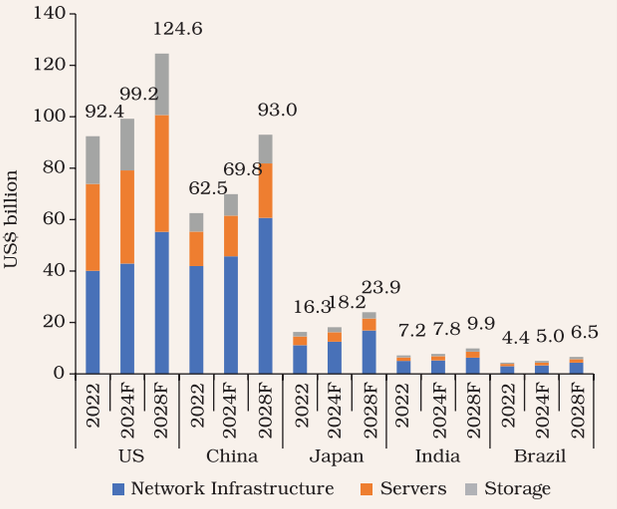
Chart IV.19: Sectoral Mapping of Data Localisation Measures



Source: Reproduced from OECD (2023b).

IV.67 Global revenues from data centres are projected to grow to US$ 575 billion by 2028 from US$ 312 billion in 2022, a CAGR of 10.7 per cent, led by the US (Chart IV.20). The revenue growth presents opportunities for spending on

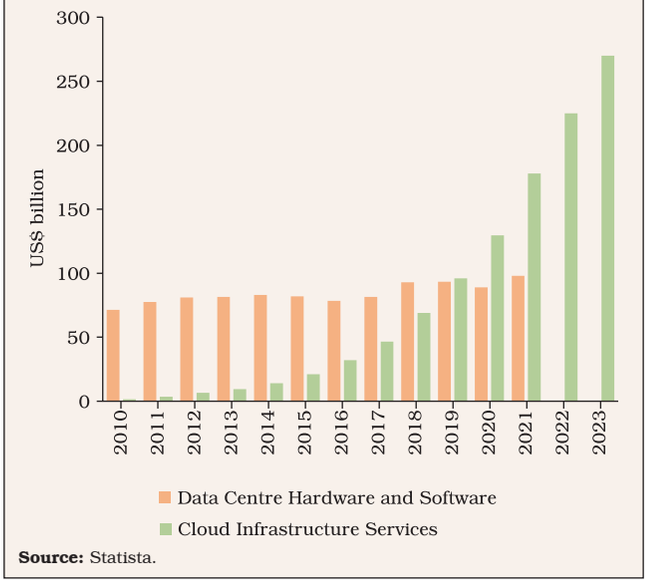
Chart IV.20: Revenue from Data Centres



Note: F: Forecast, the numbers on top of the bars indicate total revenue from all sources.
Source: Statista.

[39] The Reserve Bank currently has three data centres – two brownfield and one greenfield.

Chart IV.21: Global Spending on Cloud and Data Centres



Source: Statista.

cloud infrastructure services (Chart IV.21). The spending on cloud infrastructure, which has overtaken that on data centre hardware and software, helps accelerate internet penetration, digital transformation initiatives and the rise of e-commerce, especially in developing economies.

IV.68 Recognising the primacy of data and its vitality, regulators of various financial domains in India have framed data localisation rules. The Reserve Bank in April 2018 issued the circular on "Storage of Payment System Data" which deals with storage and processing of payments data, constituting end-to-end transaction details and information pertaining to payments. In view of the fast-paced growth in the payment ecosystem, these localisation measures were required to facilitate unrestricted access to all payment data for supervisory purpose. The payment data is to be stored in systems located in India with some exceptions. Even though payments data are allowed to be processed outside India, they have to be brought back to India after processing. The Securities and Exchange Board of India (SEBI) released the circular "Framework for Adoption of Cloud Services by SEBI Regulated Entities" in March 2023, which provides guidelines on data localisation while availing cloud services. It mandates that the storage and processing of data should be done within India's domestic territory. Furthermore, the regulated entity shall keep the original data/transaction/logs for investors incorporated outside India. Similarly, the Insurance Regulatory and Development Authority of India (IRDAI) requires all insurance records to be stored in data centres located in India. Moreover, the DPDPA, 2023 provides overarching powers to agencies or regulators operating in various areas to frame their own rules on data storage and processing.

5. Challenges to Open Economy Digitalisation

IV.69 The challenges to digitalisation in an open economy are multi-faceted, evolving, and far encompassing. These include aspects related to cybersecurity, data privacy, digital rights and access to information, divergent regulatory frameworks, data management and data sovereignty, digital infrastructure gaps and digital divide, skill gaps, job displacements, resource constraints and resistance to adoption of digital technologies, among others. Furthermore, issues related to interoperability and adoption standards, digital governance and accountability, ethical dilemmas and social implications of AI and automation, algorithmic bias and discrimination, digital monopolies and market concentration, digital trust and confidence, and digital disinformation and misinformation also confront policymakers. Intellectual property protection, digital environmental footprint, digital infrastructure resilience, sustainability and preparedness from disruption risks, including possible adverse implications of digitalisation on geopolitical

tensions and trade barriers are amongst the other issues facing policy scrutiny.

IV.70 There is immense scope for India to contribute to an inclusive global economy through its digitalisation and digital trade. According to the World Bank and the World Economic Forum, while online opportunities are accessible to at least 80 per cent of the population in developed countries, only 35 per cent of the population has access to such opportunities in developing countries. Globally, 19 out of every 100 people had fixed broadband subscriptions in 2023, while the figure for high-income countries was 39 per cent. In contrast, Asia-Pacific and Africa had 19 per cent and 1 per cent fixed broadband subscription penetration, respectively (ITU, 2023). Digital divide can exacerbate inequalities limiting opportunities for economic participation, social inclusion and digital empowerment. Further, there are challenges pertaining to labour market disruptions, generation of e-waste and carbon footprint. Digitalisation could also lead to skill mismatches and polarisation of employment opportunities between high-skilled, technology-intensive jobs and low-skilled, routine tasks susceptible to automation.

IV.71 Addressing these challenges require comprehensive strategies and collaborative efforts between governments, businesses, civil society organisations, and other stakeholders to build trust, promote responsible use of technology, and harness the benefits of digitalisation for sustainable development and shared prosperity in an open economy.

6. Concluding Observations

IV.72 The digital age provides immense opportunities for India to accelerate its transition from an emerging market economy to an advanced economy. Digitalisation can provide a strong boost to India's external trade in goods and services, given the country's relative comparative advantage in modern services exports, which are not conditional upon the geographical proximity of the trading partners. Further, digitalisation in international payment systems has the potential to reduce the cost of receiving remittances, thereby leading to higher remittances and income/savings for the recipients. Cross-border digital trade policies would play a crucial role in harnessing new opportunities, building trust, and facilitating coordination on regulatory aspects like data security and cybersecurity. The internationalisation of the INR is progressing backed by a comprehensive and integrated policy approach.

IV.73 Central bank policy initiatives such as interlinkage of FPSs across economies, setting up the system of liquidity bridges and CBDCs are expected to support seamless international transactions, reduce foreign exchange risks and manage global liquidity in an effective manner. India has the potential to revolutionise the global landscape with its DPI. Given solid foundational physical and digital infrastructure, the amount and strength of human capital, and openness to innovation, India can emerge as a major manufacturing hub, leading exporter of services, and provide higher relative returns on global capital. The robustness of India's DPI, recognised by international bodies like the IMF and the G20 (WEF, 2023), provides a scalable model that can address pressing issues in EMDEs, such as financial inclusion, leakages in welfare payments, education, and ease of doing business. With its commitment towards inclusive growth and sustainable development, India is poised to lead

the digital transformation of the Global South, emerging as a pivotal player in setting the agenda for cross-border regulations on DPIs, trade and capital, data, and migration.

IV.74 India's state-of-the-art DPI has enormous potential for enhancing cross-border trade across sectors like finance, health, education, agriculture and MSMEs. These efforts could get a large push from a further deepening of India's DPI resilience by strengthening self-reliance in sea cables, expanding satellite internet connectivity, making UPI global and providing pro-active policy support to data localisation. To fully harness the potential of India's DPI, there is a need to leverage the framework of One Future Alliance, wherein EMEs can share their best practices to fasten the process of digitalisation, and gain from its benefits.

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V DIGITALISATION - TACKLING EMERGING RISKS AND CHALLENGES*

India's financial sector is experiencing a significant transformation driven by digitalisation. Providing enhanced customer experience, ensuring competitiveness, improving operational efficiency and risk management are key factors influencing digital adoption. Banks and NBFCs view FinTechs as both complementary and competitive to their businesses and they favour regulation of FinTechs. Cybersecurity, data privacy, and vendor and third-party risks are key challenges. While digitalisation improves accessibility and convenience of financial services, it can expose consumers to impulsive spending, herd behaviour and data security concerns. Digitalisation can also create a more complex and interconnected financial system with implications for financial stability. The Reserve Bank has been undertaking proactive policy measures to harness the benefits of digitalisation while mitigating emerging risks to enhance customer protection and ensure financial stability. Digitalisation-induced changes in the behaviour of consumers and financial intermediaries can have implications for monetary policy.

1. Introduction

V.1 Digitalisation in the financial sector provides enormous benefits in terms of fostering innovations, expanding access to financial products and services, reducing financial intermediation costs, improving customer experiences and enhancing competition among the service providers, thereby boosting efficiency and inclusivity of the financial sector. These benefits flow from collaborations between traditional players like banks/NBFCs and FinTech firms, enabling both the parties to leverage their strengths and drive innovation in the financial sector. At the same time, digitalisation can bring new risks and challenges through complicated financial products and business models, complex linkages between financial intermediaries and third-party technology/service providers, market concentration, impulsive spending by consumers, cybersecurity risks and financial frauds; all of these could impinge upon macroeconomic and financial stability.

V.2 India's financial sector is undergoing a significant transformation driven by the relentless pace of digitalisation, which is reshaping how financial institutions operate and interact with their customers. New technologies, such as artificial intelligence (AI), big data and blockchain, are fostering innovations that can enhance the efficiency and accessibility of financial services. Yet, the journey towards digitalisation is not without its challenges. As India continues to leverage technology to drive inclusive growth and sustainable development, it becomes imperative to critically examine the opportunities and challenges that accompany this transformative journey.

V.3 Against this backdrop, this chapter explores the multifaceted landscape of digitalisation within the financial sector. Section 2 discusses the

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emerging risks and challenges emanating from digitalisation based on a survey of Indian banks and NBFCs. Section 3 dwells on the effects of digitalisation on customer behaviour. Section 4 discusses the implications of digitalisation for financial stability and monetary policy. Section 5 provides concluding observations.

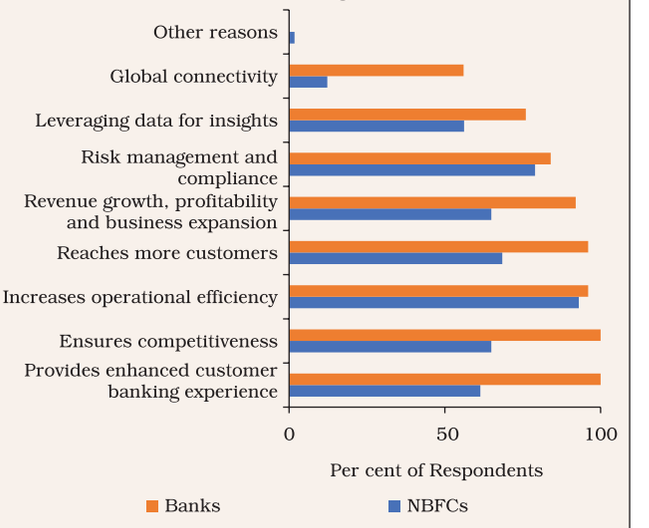
2. Opportunities and Risks of Digitalisation: Insights from a Survey of Banks and NBFCs

V.4 Given the immense benefits and opportunities provided by the digitalisation of finance on the one hand and the evolving risks associated with this process on the other, this section focuses on understanding the perspectives of banks and NBFCs - the key stakeholders – on these critical issues, drawing upon a focused survey conducted in March 2024 covering 25 scheduled commercial banks (SCBs) and 68 NBFCs[1]. The survey aimed at understanding the factors driving the adoption of digitalisation in banks and NBFCs, the extent of digital adoption in their business operations, the impact of digitalisation on customer acquisition and retention, risk perceptions related to data privacy, cybersecurity, third-party and contagion risks, their preparedness to deal with such risks, and their views on the regulatory approach to FinTech.

Factors Driving Digital Adoption by Regulated Entities (REs)

V.5 Digitalisation, according to the surveyed banks, is driven by the need to provide enhanced customer banking experience and remain competitive (Chart V.1). Reaching more

Chart V.1: Reasons behind Adoption of Digital Technologies



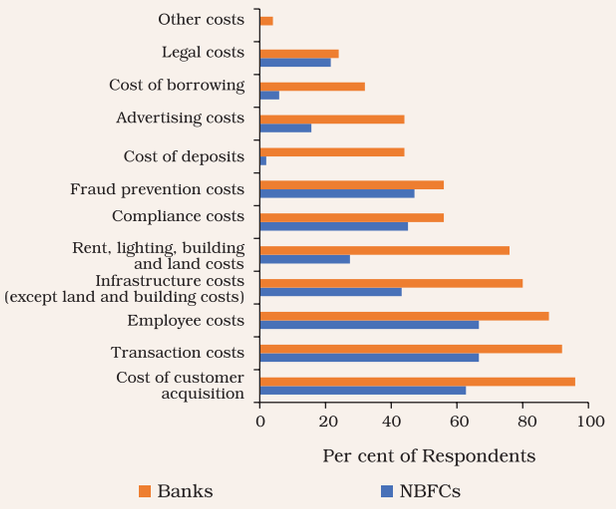
Source: RBI staff estimates based on survey responses from 25 banks and 57 NBFCs.

customers and increasing operational efficiency amidst revenue growth, profitability, and business expansion were seen as other important factors. For NBFCs, increasing operational efficiency, and improving risk management and compliance were the major driving factors behind digitalisation, along with motives like improving customer reach and gaining competitiveness. These motivating factors for the Indian banks and NBFCs align with the findings in the literature (Liu, 2021; PwC, 2023).

V.6 The adoption of digital technologies and automation has helped banks and NBFCs bring down their costs related to customer acquisition, transactions and employees, according to the survey (Chart V.2). A higher proportion of the respondent banks compared to NBFCs noted cost reductions across all the parameters. Large banks may derive greater benefits from

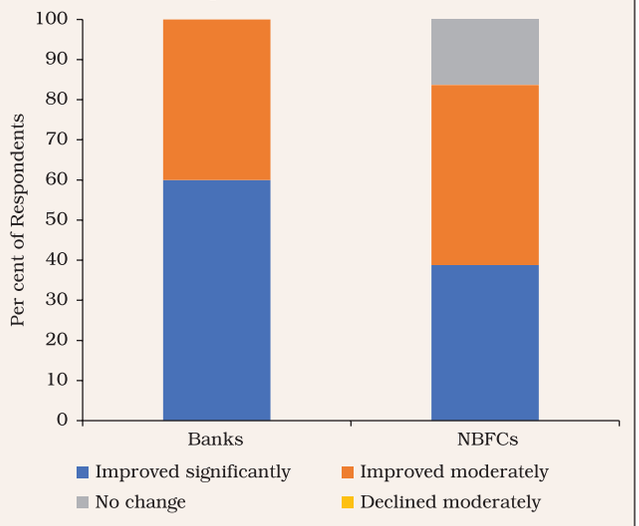
[1] The number of respondent banks and NBFCs differs for different survey questions, and the results presented in this chapter are based on actual responses.

Chart V.2: Types of Costs Reduced Following the Adoption of Digital Technologies and Automation



Source: RBI staff estimates based on survey responses from 25 banks and 51 NBFCs.

Chart V.3: Impact of Digital Technologies on Customer Acquisition and Retention



Source: RBI staff estimates based on survey responses from 25 banks and 49 NBFCs.

digitalisation due to substantial initial investment requirements and increasing returns to scale in the banking industry (Liu, 2021).

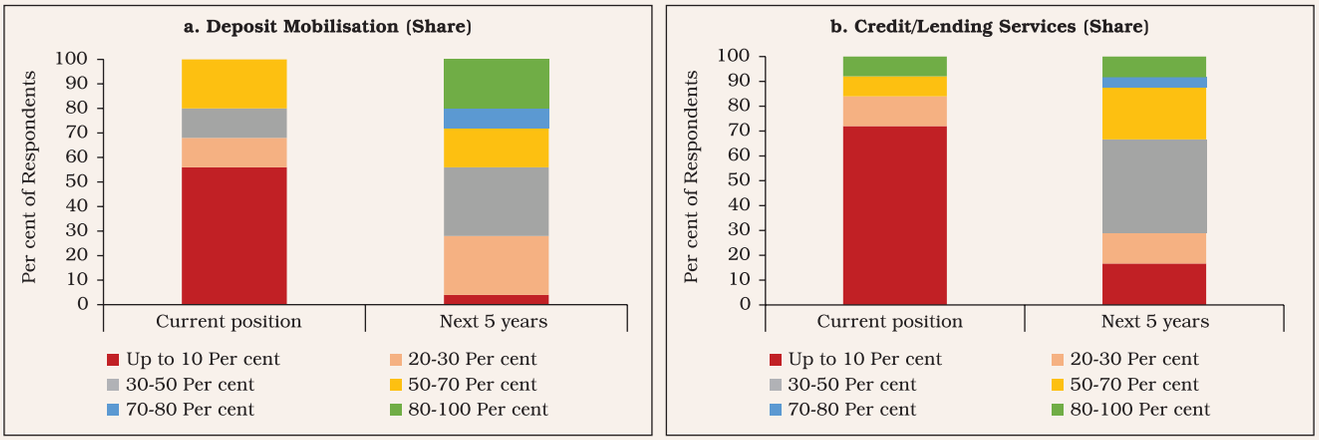
V.7 Technological innovations can improve customer experience, lower costs, increase product diversity, and enhance access to financial services (Elekdag *et al.,* 2024). Most of the surveyed REs indicated improvement in customer acquisition and retention due to the adoption of digital technologies (Chart V.3).

V.8 Banks, NBFCs and FinTechs employ technology to provide new products and business models that expand credit access to sectors like households and micro, small and medium enterprises (MSMEs) [Ernst & Young, 2023]. Many banks have also introduced digital platforms in the primary intermediation services like bank deposit mobilisation and lending activity. While banks are, at present, mobilising only a small portion of their deposits through digital mode, the importance of this channel is perceived to be increasing rapidly. In the coming five years, 44 per cent of surveyed banks expect to collect more than 50 per cent of deposits through online modes (Chart V.4a).

V.9 On the credit side, about three-fourth of the surveyed banks are extending up to 10 per cent of their total lending through digital modes. Over the next 5 years, 33 per cent of the surveyed banks indicated that they would lend more than 50 per cent digitally (Chart V.4b). These trends can be expected to improve credit deepening in the country going forward.

V.10 Digital lending by both banks and NBFCs is primarily in the form of unsecured consumer loans; other major lending categories are secured consumer loans for banks and high value loans for NBFCs (Chart V.5). According to Ernst & Young (2023), the share of NBFCs in total loans disbursed through digital channels by banks and NBFCs has increased from six per cent in 2016-17 to 32 per cent in 2021-22. This is driven by both supply and demand side factors, including efforts to promote financial inclusion, smartphone and internet penetration, improving socio-

Chart V.4: Use of Digital Modes in Banks



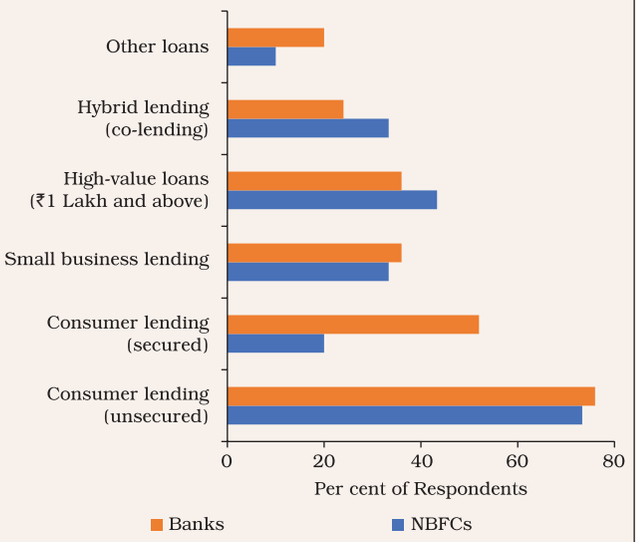
Source: RBI staff estimates based on survey responses from 24 banks.

economic conditions, and supportive regulatory frameworks.

V.11 The evolution of digital banking based on mobile apps and online platforms helps banks to rationalise their branch network to reap efficiency gains (ILO, 2022). India has also witnessed rationalisation in its bank branch network in recent years, reflecting the impact of both digitalisation and mergers in the domestic banking sector (Chart V.6).

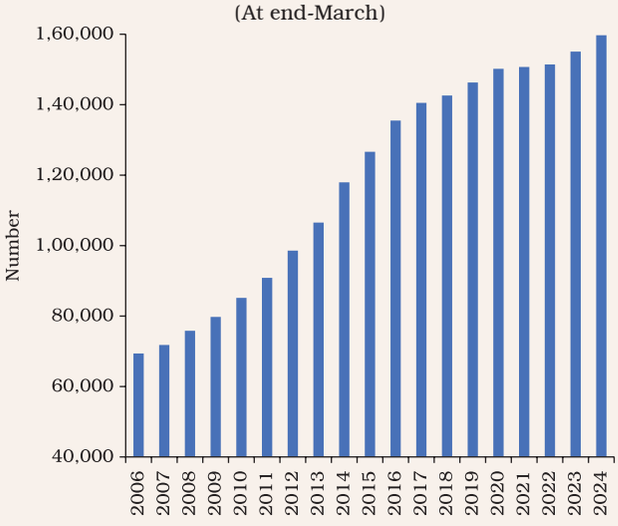
V.12 Around a third of the respondent banks and NBFCs expect a decrease in the role of physical branches in the next 5 years, but most respondents see no change in the current importance of bank branches (Chart V.7). A majority of banks and NBFCs see continued importance of the role of

Chart V.5: Types of Loans Provided Digitally



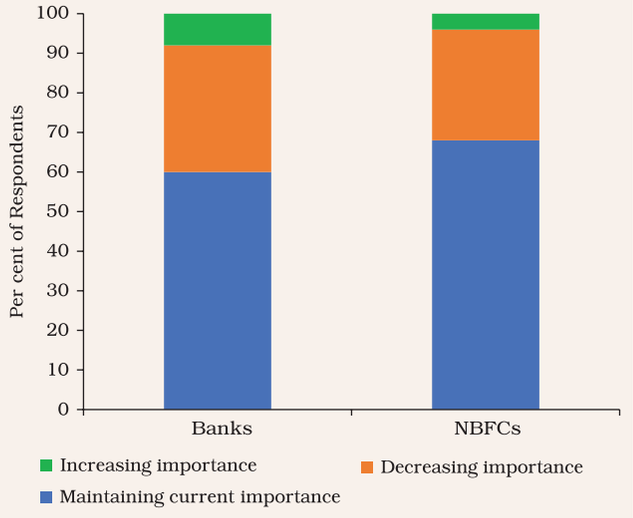
Source: RBI staff estimates based on survey responses from 25 banks and 30 NBFCs.

Chart V.6: Bank Branches in India
(At end-March)



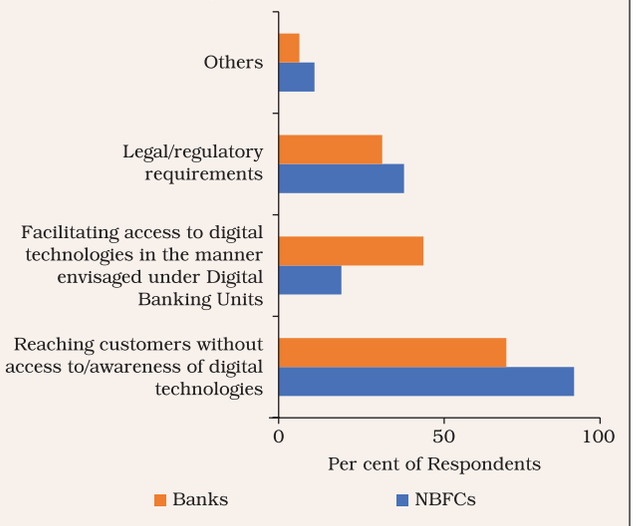
Note: Data pertain to all scheduled commercial banks (SCBs) including regional rural banks (RRBs).
Source: RBI.

Chart V.7: Expectations about the Role of Physical Branches in the Next Five Years



Source: RBI staff estimates based on survey responses from 25 banks and 50 NBFCs.

Chart V.8: Reasons for Continued Importance of Physical Bank Branches



Source: RBI staff estimates based on survey responses from 16 banks and 37 NBFCs.

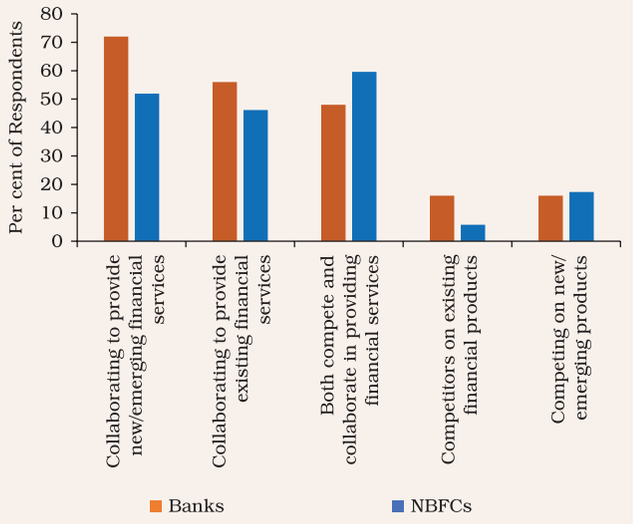
physical branches in reaching customers with no/limited access to digital technology (Chart V.8).

Impact of Digitalisation on Business Models: Complementarity vs. Competition

V.13 FinTech players and the growing popularity of their innovative products have challenged the existing financial sector players in maintaining their market share, margins and customer base (Das, 2022). The incumbent banks and NBFCs are responding to these challenges by adopting various strategies, including making investments in FinTech companies, partnering with them, as well as enhancing their in-house capabilities. A higher proportion of banks (84 per cent of banks compared to 35 per cent of NBFCs) provide a range of digital banking services in collaboration with FinTechs as per the survey (See Chapter 2, Chart II.21). Most of the banks highlighted the importance of collaboration with FinTech companies in providing products and services on banking platforms.

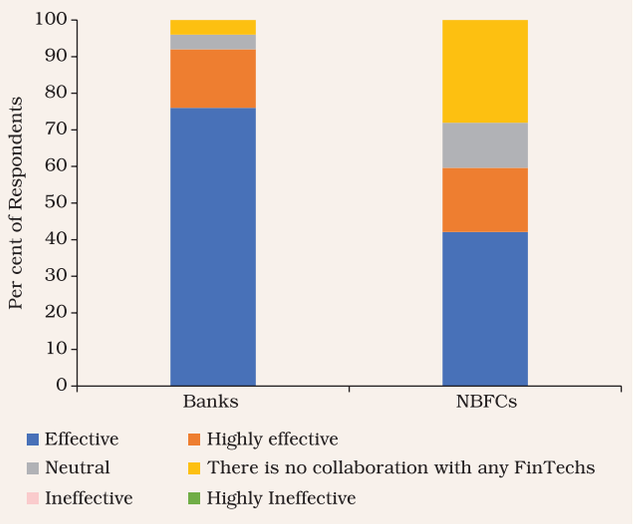
V.14 Greater technological complexity involved with FinTech poses potential systemic risks (Cevik, 2023). With the intermingling of FinTech into the financial system, increased competition among banks can, in principle, lead to heightened financial instability (the 'competition-fragility' view) or more stability (the 'competition-stability' view) [Elekdag *et al.,* 2024]. Therefore, successful collaboration requires careful planning, effective communication, and a shared vision for mutual growth and value creation. In this respect, the survey indicates that majority of respondent banks collaborate with FinTech firms to provide new/emerging services, indicating banks' willingness to harness FinTech's potential in developing new products/services (Chart V.9). FinTechs upend traditional financial services for banks, forcing them to adapt to stay relevant (Pascual and Natalucci, 2022). Nonetheless, most NBFCs compete as well as collaborate with FinTechs in providing financial services.

Chart V.9: Current Association between Banks/NBFCs and FinTechs



Source: RBI staff estimates based on survey responses from 25 banks and 52 NBFCs.

Chart V.10: Effectiveness of Collaboration between Banks/ NBFCs and FinTechs in Driving Digital Innovation



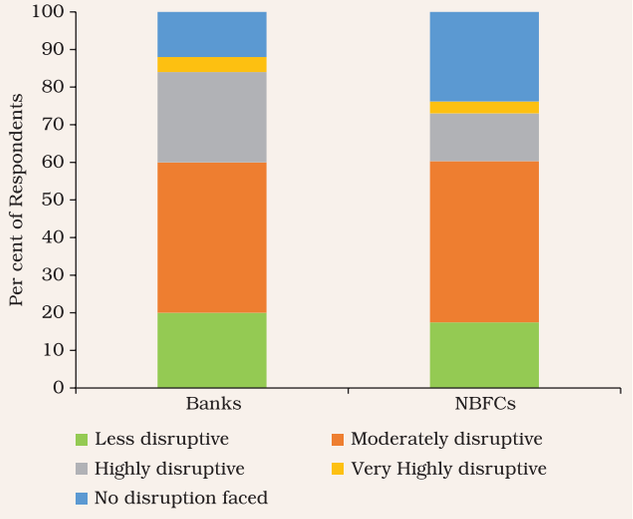
Source: RBI staff estimates based on survey responses from 25 banks and 57 NBFCs.

V.15 Most of the respondent banks and NBFCs viewed their collaboration with FinTech firms as effective or highly effective in driving digital innovation (Chart V.10).

V.16 Majority of respondent banks and NBFCs considered digital technology to be less or moderately disruptive[2] (Chart V.11). Digital disruption by FinTech and platform-based competitors can impact banks' profitability and limit credit growth; it can also help in the reduction of various costs (OECD, 2020).

V.17 On the factors hindering digital adoption, most respondent banks identified cybersecurity threats, the prevalence of legacy core banking applications and customer unwillingness as key challenges. NBFCs reported implementation costs, customer unwillingness and cybersecurity concerns as the primary reasons hindering the successful adoption of digital technologies (Chart V.12).

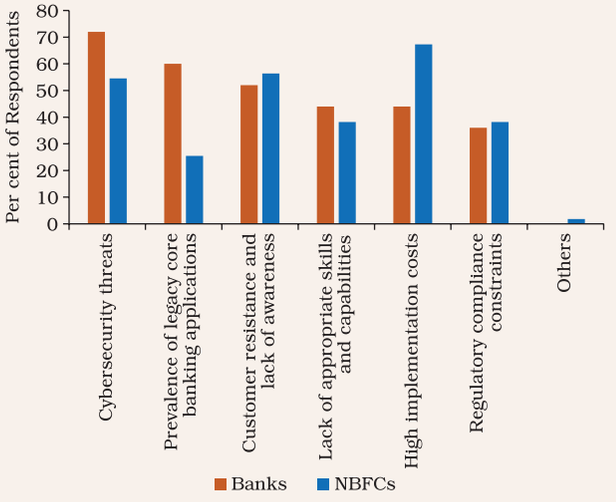
Chart V.11: Implications of New Innovative Digital Technologies on the Existing Business Models



Source: RBI staff estimates based on survey responses from 25 banks and 63 NBFCs.

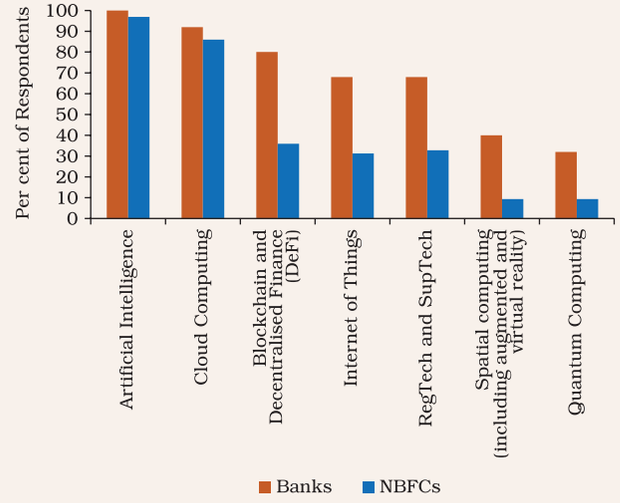
[2] Disruptive FinTech refers to innovative financial technology solutions that challenge traditional banking and finance models through AI, blockchain, and data analytics advancements to offer financial services. One example of disruptive FinTech is peer-to-peer lending platforms, which connect borrowers directly with lenders, bypassing traditional financial institutions.

Chart V.12: Primary Challenges Hindering the Successful Adoption of Digital Technologies



Source: RBI staff estimates based on survey responses from 25 banks and 55 NBFCs.

Chart V.13: Emerging Digital Technologies Impacting Banking in the Next Five Years

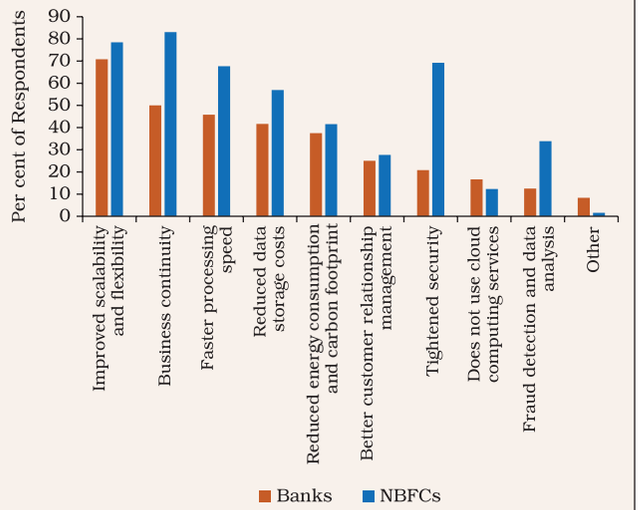


Source: RBI staff estimates based on survey responses from 25 banks and 64 NBFCs.

V.18 Emerging technologies like AI have the potential to impact the banking industry significantly in the next five years (Chart V.13). AI can benefit the banking sector through operational efficiency and better risk management but can also give rise to challenges such as data privacy, reputational risk and model hallucinations[3] (Hernández de Cos, 2024).

V.19 Another emerging digital technology being adopted by the REs is cloud computing. Better infrastructure provision through improved flexibility, scalability, and business continuity are the primary motives behind its adoption (Chart V.14). Cloud computing can help improve efficiency through cost reduction, faster processing, and business scalability and flexibility. However, while using cloud services, banks viewed regulatory compliance and data privacy and security issues as prime hurdles, consistent with the study by Cheng *et al.* (2022). For NBFCs, cost of migrating workload and regulatory compliance were the key concerns (Chart V.15).

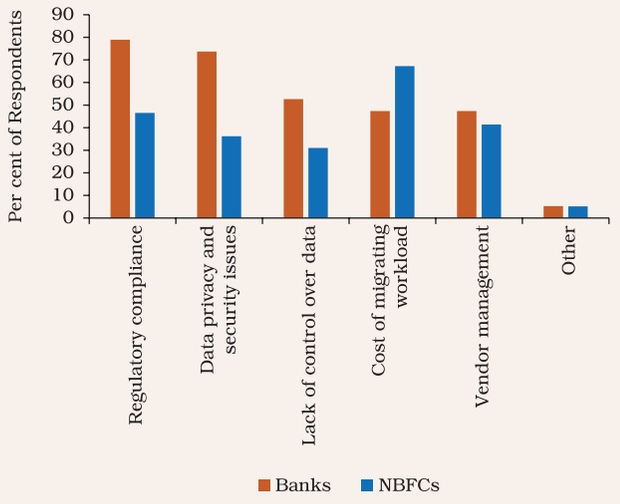
Chart V.14: Motives behind Use of Cloud Computing Services



Source: RBI staff estimates based on survey responses from 24 banks and 65 NBFCs.

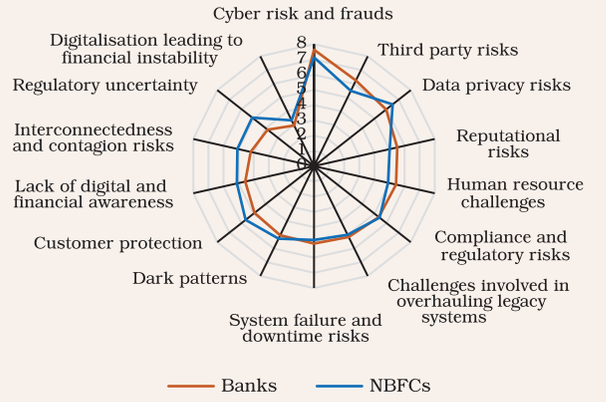
[3] Model hallucinations occur when an AI model generates information that is not based on input data or real-world context.

Chart V.15: Challenges in Using Cloud Computing Services



Source: RBI staff estimates based on survey responses from 22 banks and 58 NBFCs.

Chart V.16: Potential Risks and Challenges of the Ongoing Digitalisation for the Financial Sector



Note: This chart presents frequency-weighted risk scores based on survey responses. Banks and NBFCs were asked to attach risk weights to the listed categories of risks and challenges that may arise as part of the ongoing digitalisation of the financial sector on a scale of 0 (no risk) to 10 (extremely high risk).
Source: RBI staff estimates based on survey responses from 25 banks and 63 NBFCs.

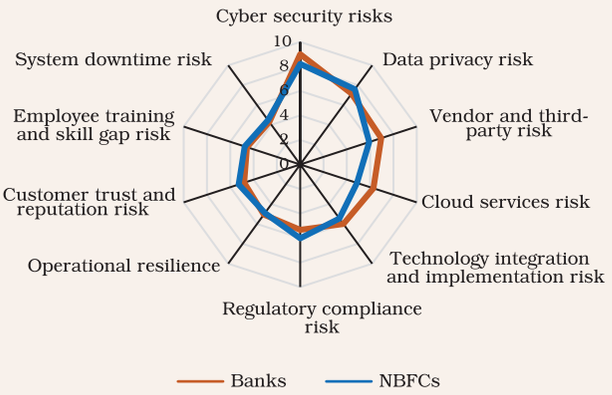
Digitalisation and Financial Stability

V.20 Digitalisation could pose financial stability concerns owing to cybersecurity threats, data breaches and the speed at which information and rumours can flow through the system. Cyber fraudsters are increasingly targeting financial institutions instead of end users globally. Accordingly, cyber risks and frauds, third-party risks, and data privacy issues were indicated as the most significant risk factors by banks and NBFCs at the current juncture as well as going ahead (Charts V.16 and V.17). Risks associated with cloud services and technology integration and implementation were also highlighted as major concerns going forward.

Regulatory and Supervisory Approaches

V.21 Regulation of FinTech involves balancing innovation with customer protection, ensuring fair competition, and maintaining financial stability. Although most FinTech companies are relatively small, they can grow faster than traditional lenders across riskier clientele and industry sectors (Pascual and Natalucci, 2022). Regulators may adopt a passive approach to monitor FinTechs through bespoke regulation or adopt test-and-learn policies through institutional arrangements like innovation hubs and sandboxes (Bains and Wu, 2023). Currently, the changes that seem small can grow rapidly endangering the stability

Chart V.17: Types of Risks that are Expected to Arise in Future



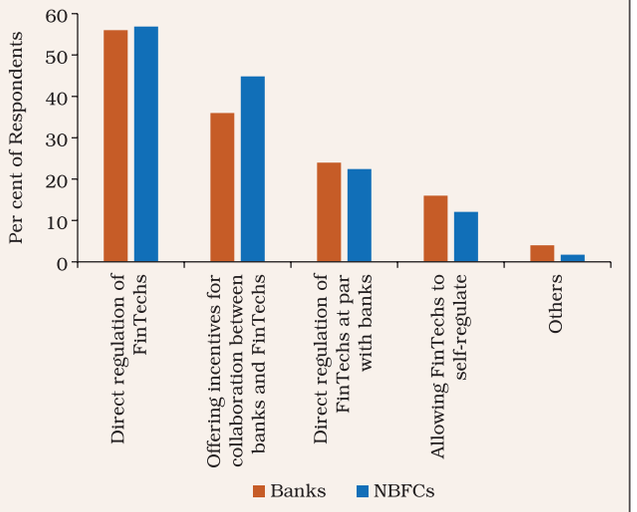
Note: This chart presents frequency-weighted risk scores based on responses. Banks and NBFCs were asked to attach risk weights to the listed categories of risks that are more likely to arise in the future on a scale of 0 (least important) to 10 (most important).
Source: RBI staff estimates based on survey responses from 21 banks and 39 NBFCs.

of the financial system, which requires regulators to be watchful of all the financial developments that are taking place and respond appropriately (Rao, 2022).

V.22 In India, the regulatory approach has been to strike a balance between mitigating the potential risks without impeding financial innovations through several tools that include research on FinTech developments, proactive engagement with existing and new entrant FinTech firms, clear communication with various stakeholders, risk mitigation strategies, modifications to supervisory processes and issuing guidelines or regulations. As the FinTech ecosystem is a force multiplier, the Reserve Bank has taken several steps to create a nurturing environment to foster innovation, including issuance of guidelines for Account Aggregators (AAs) in 2016 and laying out of regulations for P2P lending in 2017, recognising the sector's potential in India (Sankar, 2023). In August 2019, the RBI released a regulatory sandbox framework for live testing of innovative products or services in a controlled environment for their effective implementation.

V.23 Most of the respondent banks and NBFCs preferred regulation of FinTechs and favoured incentives to collaborate with them (Chart V.18). However, as FinTechs bring innovation, they also raise concerns related to customer protection, data privacy, cybersecurity, grievance handling, internal governance, and financial system integrity. The regulation of this dynamic sector needs to be balanced, nuanced, and reasonably anticipatory. The Reserve Bank's approach, therefore, has been to encourage self-regulation in the FinTech sector. In this regard, the Reserve Bank released the 'Framework for Self-Regulatory Organisation(s) for FinTech Sector' (SRO-FT framework) in May 2024, detailing the processes

Chart V.18: Role of Regulations with Respect to FinTechs



Source: RBI staff estimates based on survey responses from 25 banks and 58 NBFCs.

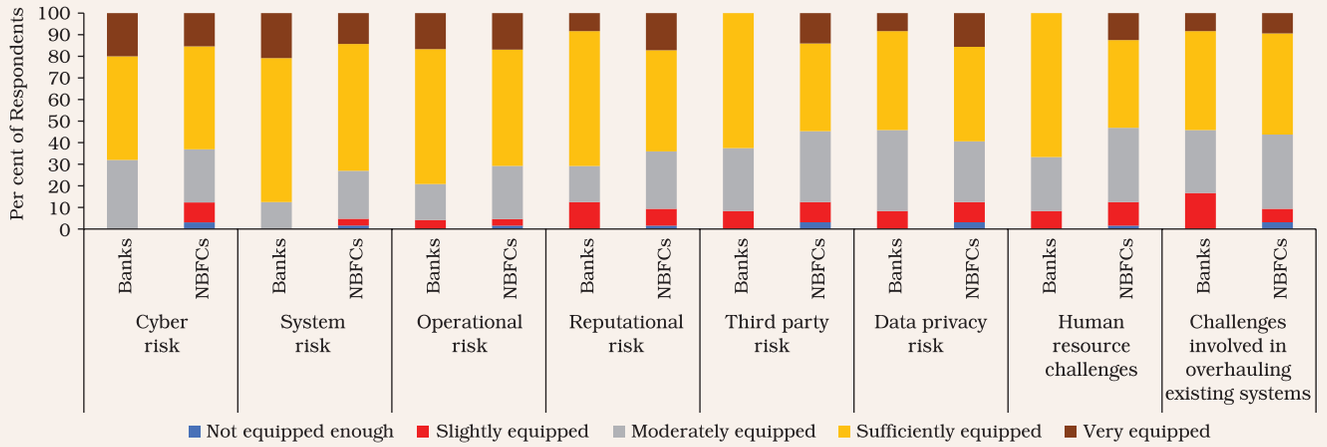
involved, governance standards, eligibility criteria and expectations.

Preparedness in Dealing with the Risks

V.24 The evolving digital landscape requires continuous assessment of preparedness for various risks by the REs as well as the regulators to design suitable policy responses at their end. The qualitative assessment of survey responses indicated that the respondent banks and NBFCs are largely equipped to deal with major risks (Chart V.19). NBFCs also indicated that there is scope for improvement in the case of third-party risk, data privacy risk, cyber risk, and human resource challenges.

V.25 To sum up, the survey suggests that banks and NBFCs in India are increasingly leveraging the digital revolution to reduce costs related to customer acquisition, transactions and employees, while favouring collaboration with FinTechs to maximise gains. Cybersecurity threats, implementation costs, legacy core banking applications and customer unwillingness are seen as the primary challenges hindering the

Chart V.19: Adequacy of Existing Infrastructure to deal with Major Risks



Source: RBI staff estimates based on survey responses from 24 banks and 64 NBFCs.

adoption of digital technologies. The respondent banks and NBFCs identified cybersecurity, data privacy and third-party risks as key challenges and indicated that they are largely equipped to deal with such risks. The surveyed REs favoured regulation of FinTech firms for harnessing the benefits of digitalisation and securing financial stability in India.

3. Digitalisation and Customer Behaviour

V.26 Digitalisation has transformed the way consumers interact with the market while offering convenience, personalised experiences, and unprecedented access to goods and services. Digital financial services through mobile banking apps, online payments, and digital wallets enable consumers to conduct transactions with a few clicks at any time from any location, overcoming the constraints of traditional banking hours or physical branch presence. These advantages, however, come with risks related to impulsive spending, herd behaviour, data security and cyber fraud.

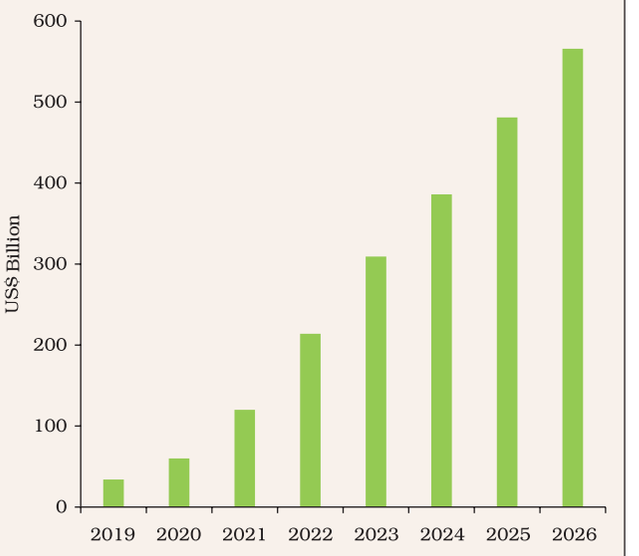
V.27 Digital platforms enable quick dissemination of financial trends and choices, allowing information about investments, spending habits, and financial products to spread rapidly across social networks. This viral spread can result in social contagion, as consumers are influenced by the financial actions and recommendations of their peers, influencers, or trending topics (Shrotryia and Kalra, 2022). When customers observe large groups engaging in certain financial activities, such as mass buying or selling of stocks during a market frenzy, they are more likely to follow the crowd. Similarly, driven by herd behaviour, depositors may withdraw their money from banks, leading to potential bank runs/failures. Sentiments in social media amplify the classic bank run risk factors (Cookson *et al.*, 2023). The combination of social contagion and herd behaviour in financial digitalisation can lead to rapid collective shifts in customer actions, often amplifying market trends and contributing to volatility.

V.28 Globally, digital platforms offer deferred payment options like Buy Now Pay Later (BNPL), where lenders do not undertake a detailed credit check or rigorous assessment of a consumer's ability to repay. This can lead to consumers

overextending themselves financially, particularly if they use multiple BNPL services concurrently. In India, BNPL is treated as a credit product and requires similar due diligence and credit appraisal standards as for other loans. The global annual BNPL transactions are projected to grow from US$ 309 billion in 2023 to US$ 566 billion in 2026 (Chart V.20). India is among the top five countries in terms of BNPL users. BNPL share in e-commerce was about 3 per cent in India in 2023 as compared to 5 per cent globally.

V.29 With the integration of FinTechs and e-commerce platforms, consumers may become more vulnerable to misuse of their personal and confidential information (Box V.1).

Chart V.20: Global BNPL Market Size



Source: Statista.com.

Box V.1
Data Collection Practices of Banking and FinTech Apps: Assessing the Necessity and Scope

In the digital age, mobile applications (apps) have become the face of banks and FinTech firms, mirroring the front desk of traditional financial institutions. These apps, pivotal for customer interaction, handle a spectrum of functions, ranging from onboarding and service delivery to grievance handling and continuous monitoring. In this process, these apps might be collecting more data than declared in their privacy policies (Austin *et al*., 2018). FinTech apps in India often collect more information than necessary, sometimes even critical personal data that could jeopardise users' privacy (Arrka, 2023). Also, mobile wallets access the maximum number of sensitive permissions amongst various apps, while banking apps feature in the list at the fifth position.

Against this backdrop, the permissions sought by apps listed on Google Play Store are assessed by extracting information on data/privacy-related policies of banks and FinTechs using Google Play Scrapper[4]. This analysis of access to users' data by FinTech apps suggests that Indian apps largely seek similar types of permissions as in the case of the US (United States) and the EU (European Union)[5], barring mainly access to SMS data (Table 1).

Further, a detailed analysis of requested permissions by practice area tags for India, encompassing 339 FinTech and banking apps[6], indicates that around 42 per cent of them access contacts, with banking Tech apps leading the pack (Table 2). Nearly three-fourth of the apps track user location and access photos, media, and storage[7].

(Contd...)

4 Mingyu, J. (2019). Google-Play-Scraper. MIT. Available at https://pypi.org/project/google-play-scraper/

5 FinTechs in the US and EU are identified by using database maintained by Cambridge Centre for Alternative Finance, while Tracxn database is used in case of India.

6 Google Play Store publishes permissions requested (that the developer of the app takes from the user in course of installation/usage of the app) by each app on its platform. Accordingly, information was collected from 339 mobile applications (158 banking apps belonging to 48 banks, and 181 FinTech apps belonging to 172 business-to-consumer FinTech firms identified from the Tracxn database with practice area tags, *viz.,* payments, alternative lending, banking tech, forex tech, remittance tech), identified manually on Google Play Store for each bank/FinTech.

7 Since FinTech apps pertaining to digital lending may also be providing payments services, they may be using permissions which otherwise are not encouraged for digital lending apps.

Table 1: FinTech Apps Seeking Permissions to Access Users' Data – A Global Perspective

Share (Per cent)	Identity	Contacts	Phone	Camera	Calendar	Wi-Fi connection information	Microphone	Device ID and call information	Storage	Location	Photos/Media/ Files	Device and app history	SMS
EU	10	30	40	83	3	68	65	35	83	45	83	0	0
US	18	40	40	68	3	80	30	38	80	68	80	0	0
India	14	35	55	86	6	73	44	51	76	72	76	3	34

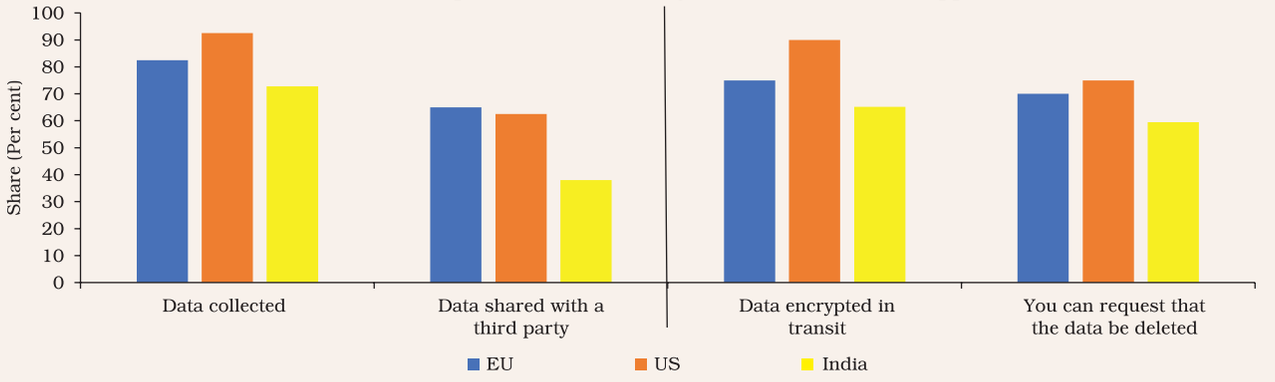
Note: The analysis covers 40 apps each in case of the US and the EU and 181 apps in the case of India.
Source: Google Play Store; RBI staff estimates.

Table 2: Data Permissions Sought by Bank and FinTech Apps in India

	Number of Apps	Device and app history	Location	Photos/Media/ Files	Camera	Storage	Phone	Calendar	Device ID and call information	SMS	Microphone	Contacts	Wi-Fi connection information	Identity
	Counts (Number)													
Alternative Lending	99	2	71	63	89	63	46	7	41	37	44	21	73	13
Bank Apps	158	19	118	116	119	116	116	3	114	79	50	79	116	33
Banking Tech	20	1	16	19	15	19	14	1	12	6	11	15	16	3
Payments	50	2	38	45	44	45	36	2	36	17	23	23	33	9
Others	12	0	6	10	8	10	4	0	4	1	2	4	10	0
Grand Total	**339**	**24**	**249**	**253**	**275**	**253**	**216**	**13**	**207**	**140**	**130**	**142**	**248**	**58**
	Share in Grand Total (Per cent)													
Share of Apps		**7.1**	**73.5**	**74.6**	**81.1**	**74.6**	**63.7**	**3.8**	**61.1**	**41.3**	**38.3**	**41.9**	**73.2**	**17.1**

Note: The categorisation may not be mutually exclusive, and certain permissions may be necessary for app functionality for other functions being provided by the app. The analysis covers 181 FinTech apps and 158 banking apps.
Source: Google Play Store and RBI staff estimates.

Chart 1: Comparison of Data Safety Practices of FinTech Apps



Note: The analysis covers 40 apps each in case of the US and the EU and 158 apps in the case of India.
Source: Google Play Store and RBI staff estimates.

Additionally, a comparison of data safety practices of Indian apps *vis-à-vis* their counterparts in the US and the EU on select parameters indicates that the surveyed Indian apps appear to perform relatively better in terms

(Contd...)

of data sharing with third-parties, while being laggards in data encryption and users' choice to request data deletion (Chart 1). It may be noted that the RBI's digital lending guidelines advocate for minimal and necessary access to customer data (RBI, 2022). These guidelines emphasise the importance of obtaining explicit user consent, suggesting a path towards more responsible data management. Compliance with regulatory guidance on data privacy becomes paramount in letter and spirit. App stores also have a crucial role in upholding privacy standards.

References:

Arrka. (2023). Privacy Research and Insights Study of Mobile Apps and Websites. INDIA. PRISM.IN 2023. Available at https://arrka.com/wp-content/uploads/2024/01/PRISM_IN_2023.pdf

Austin, L., Lie, D., Sun, P. Y., Spillette, R., D'Angelo, M., and Wong, M. (2018). Towards Dynamic Transparency: The AppTrans (Transparency for Android Applications) Project.

Reserve Bank of India (2022). Guidelines on Digital Lending. RBI Notifications, September 2, RBI/2022-23/111/DOR.CRE.REC.66/21.07.001/2022-23.

Ensuring the integrity and privacy of user data is, therefore, pivotal. The journey towards a more secure digital FinTech landscape not only involves regulatory compliance but also includes building trust and ensuring the ethical use of technology.

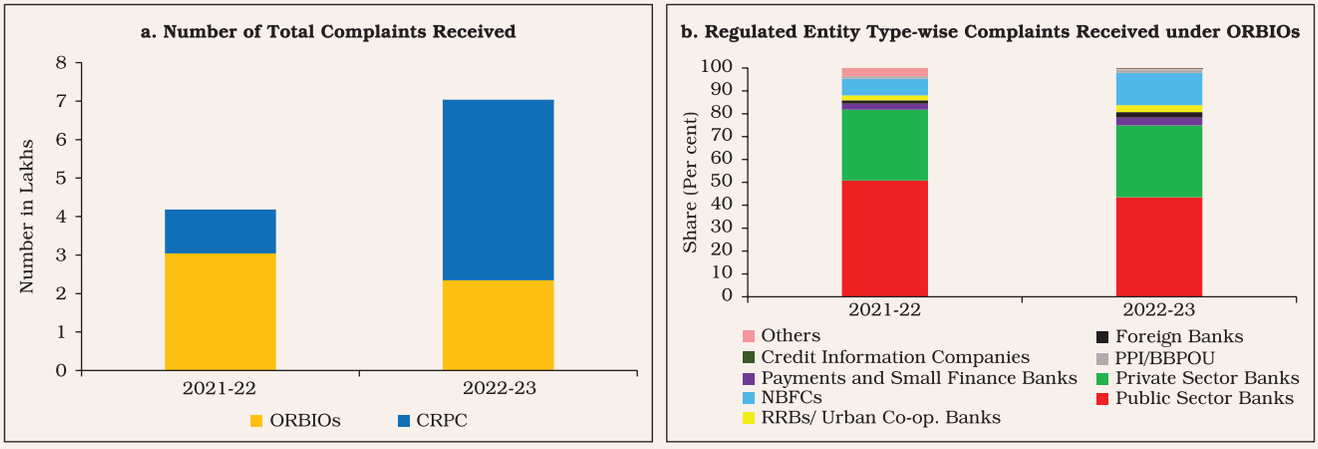
V.30 The total number of complaints received by Offices of RBI Ombudsman (ORBIOs) and the Centralised Receipt and Processing Centre (CRPC) increased in 2022-23 due to intense public awareness initiatives and the simplified process for lodging of complaints under the Reserve Bank - Integrated Ombudsman Scheme (RB-IOS), 2021 (Chart V.21) [RBI, 2024a]. Approximately 20 per cent of the complaints received by the ORBIOs in 2022-23 pertained to mobile or electronic banking.

As more personal and financial transactions shift to online platforms, the digital footprint of individuals and businesses has expanded, creating a target for cybercriminals.

V.31 Population groups with low levels of digital and financial literacy have a higher risk of falling victim to online frauds or scams (OECD, 2021). In a consumer survey conducted by the Committee for Review of Customer Service Standards (Chairman: Shri B. P. Kanungo), 16.3 per cent of respondents considered technology-based services as a major area of concern (RBI, 2023).

V.32 The Reserve Bank has taken several customer-centric measures to improve service quality and consumer protection (RBI, 2024b).

Chart V.21: Complaints Received under RBI Ombudsman Framework



Source: Reserve Bank of India.

It has formulated a Charter of Customer Rights, which outlines five basic rights for bank customers: fair treatment; transparency, fair and honest dealing; suitability; privacy; and grievance redress and compensation. The Reserve Bank - Integrated Ombudsman Scheme (RB-IOS) 2021, by adopting a One Nation-One Ombudsman approach, has integrated the erstwhile three Ombudsman Schemes of RBI and brought the Non-Scheduled Primary (Urban) Cooperative Banks with deposit size of and above ₹50 crore, and the Credit Information Companies under its ambit; and simplified the grievance redress process by adoption of 'deficiency in service' as a single broad-based ground for filing of complaints. Furthermore, Fair Practices Codes have been instituted for lenders, underscoring the importance of ethical treatment and transparency in their interactions with customers. The Reserve Bank conducted various focused customer awareness programmes including Ombudsman Speak, Talkathon and Nationwide Intensive Awareness Programme to educate customers on safe banking practices; RBI's Alternate Grievance Redress (AGR) mechanism, and extant regulations for protection of consumer interests. To disseminate information about safe digital banking, the RBI has also been conducting Electronic Banking Awareness and Training (e-BAAT) programmes, actively undertaking digital awareness campaigns in the print and Audio-Visual media, including the Reserve Bank's flagship programme "*RBI Kehta Hai*".

V.33 Furthermore, the RBI launched three booklets *viz.*, 'Be(A)ware' in March 2022, 'Raju and the Forty Thieves' in April 2022, and 'The Alert Family' in March 2024 to create awareness among public about the *modus operandi* of the frauds, provide guidance on financial frauds and dispel common misconceptions regarding various banking services and facilities, while also providing inputs on precautions to adopt in carrying out financial transactions. In addition, the Reserve Bank has introduced measures to ensure the safety of customer transactions, *viz.* (a) facility to switch on/switch off card transactions, (b) Card-on-File tokenisation, (c) mandating legal entity identifier (LEI) for high-value transactions in centralised payment systems (CPS), (d) positive pay system for high-value cheques, and (e) mandating additional factor of authentication (RBI, 2022). These measures by the RBI are aimed at fostering a transparent, fair and efficient financial system, and instilling a sense of reassurance and confidence in the stakeholders.

4. Digitalisation: Financial Stability and Macroeconomic Implications

4.1 Digitalisation and Financial Stability

V.34 The digitalisation of finance presents significant benefits to the economy and the financial system by promoting efficiency, transparency, accessibility, and convenience of financial services (Table V.1). FinTech lending[8] can reduce transaction costs and information asymmetries and increase financial inclusion by alleviating collateral constraints (Sahay *et al.,* 2020). On the other hand, lending by FinTech platforms may involve greater financial risks due to concentration and over-reliance on data-driven algorithms (Cevik, 2023). The interconnectedness among banks, FinTechs, and technology firms

[8] In India, FinTech entities do not lend on their own balance sheets and merely act as loan sourcing agents (defined as Lending Service Provider in Digital Lending Guidelines). In other jurisdictions, FinTech lending can mean multiple things – including lending by FinTechs on their own balance sheets, P2P lending, or simply loan sourcing.

Table V.1: FinTechs and Financial Stability

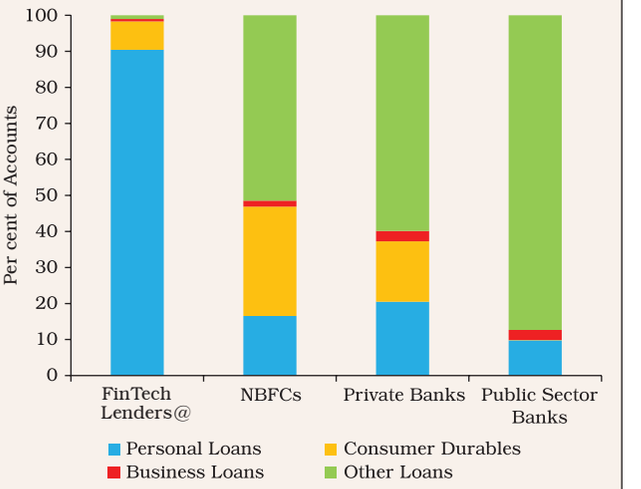
Benefits	Risks
Decentralisation / diversification • FinTech can lead to greater decentralisation and diversification of the financial system, dampening the effects of financial shocks in some cases.	**Cyber risks** • Susceptibility of financial activity to cyber-attacks is higher in the interconnected network of financial institutions, especially in the presence of weaker institutions.
Efficiency • Financial innovations have the potential to enhance efficiency in decision-making processes and improvement in the models used by financial institutions and investors.	**Third-party reliance** • FinTech activities could increase reliance on third-party service providers exposing the system to operational risks.
Transparency • Increased and better use of data can reduce information asymmetries.	**Contagion** • Greater automation with more sophisticated algorithms may lead to new and unpredictable sources of contagion in financial markets.
Access to, and convenience of, financial services • Potential for greater access to a range of financial services across economic functions and regions.	**Procyclicality and excess volatility** • Interaction between investors and borrowers on FinTech lending platforms could exhibit larger swings in sentiment-based borrowing and lending leading to undue volatility.

Source: BCBS (2024) and FSB (2017).

complicates risk assessment and management, potentially accelerating financial contagion. Moreover, digitalisation can amplify traditional financial risks like liquidity, pro-cyclicality, and concentration risks, stemming from reliance on specific market infrastructures or third-party service providers (BCBS, 2024). Globally, the growth of non-bank institutions in the lending business also adds a new dimension that could raise regulatory arbitrage between traditional banks and FinTech firms. FinTech firms have complex and less transparent funding structures, making it harder to assess their risk transmission on overall stability. However, in the case of India, non-bank entities in lending are regulated as NBFCs by the RBI, while FinTechs and banks work in partnership in bank-led model subsiding any issue of regulatory arbitrage. Moreover, FinTech entities cannot lend on their own balance sheet; they only act as a loan sourcing agent.

V.35 In India, FinTechs are quickly integrating themselves into the financial intermediation chain, offering specialised services and unlocking new business opportunities. In collaboration with banks and NBFCs, they have accelerated lending to new borrower accounts, particularly focusing on the personal loan segment (Chart V.22). This emphasis on low-ticket loans enables access to

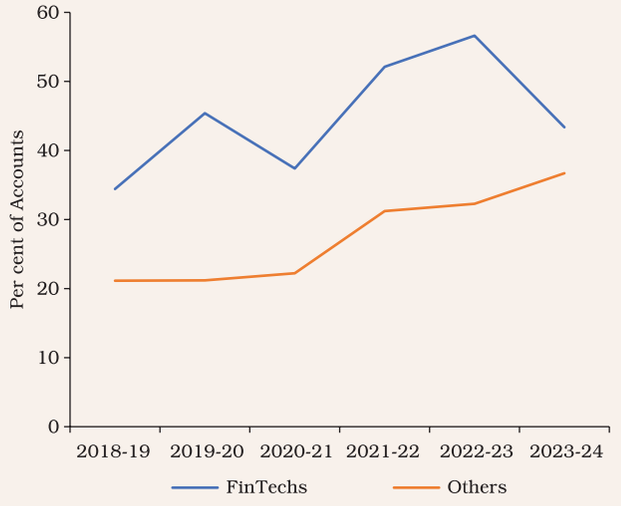
Chart V.22: Distribution of Loan Origination by Lenders in India during 2023-24



Note: Data of FinTech lenders pertain to a cohort of about 130 credit institutions based on the on-book lending.
Source: TransUnion CIBIL.

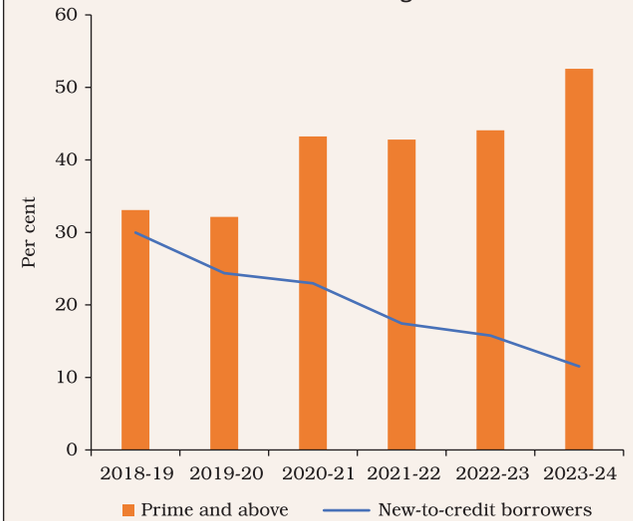
@ The methodology for classifying FinTechs is based on TransUnion CIBIL's market knowledge that they have a digital first approach for their lending business and/or are members of industry bodies like FACE, DLAI and IAMAI.

Chart V.23: Same Day Processing of Personal Loan Applications



Note: Others pertain to banks and NBFCs.
Source: TransUnion CIBIL.

Chart V.24: Share of New and Above-Prime Borrowers in FinTech Lending



Note: Data pertain to lending for consumer durables and personal loans.
Source: TransUnion CIBIL.

credit for individuals previously excluded from traditional banking due to factors like lack of credit history or sub-prime status. This strategy, however, could entail credit risk for the lenders due to surge in unsecured personal loans. As per available information, secured lending through digital lending partners has also started.

V.36 By leveraging on technology in application processing, KYC checks, identity and risk checks with automated scorecards, FinTechs also have a higher proportion of same day loan processing as compared to conventional lenders (Chart V.23). Despite sophisticated lending practices, it is hard to implement true risk-based pricing by using big data and advanced technologies, as compared to the traditional credit rating framework (Johnson *et al.*, 2023). For India, a study on FinTech lending firms suggests that alternate credit scoring using mobile and social footprints can expand credit and reduce the overall default rate (Agarwal *et al.,* 2020).

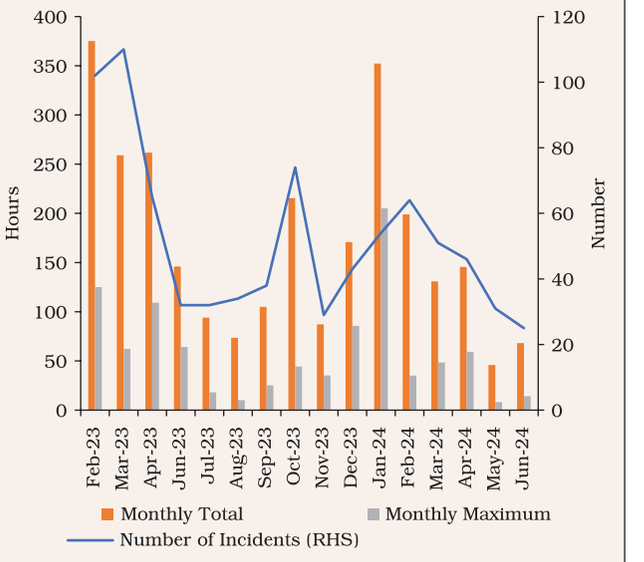
V.37 In India, the share of prime and above-prime borrowers in FinTech lending has been rising since 2018-19, suggesting improvement in their loan portfolio (Chart V.24). The share of new-to-credit borrowers serviced by FinTech lenders has declined, which could be reflective of the caution exercised by lenders due to higher observed delinquencies in small ticket personal loans (RBI, 2024c) as well as proactive measures by the Reserve Bank in terms of issuance of digital lending guidelines in September 2022.

V.38 Notwithstanding the fast penetration of FinTech firms in India, they still face significant challenges in counterparty credit risk assessment. A large portion of the population lacks a formal credit history, making traditional scoring models less reliable. As per the FinTech lending risk barometer study conducted by FACE (2023), issues related to data rank among the top ten risks faced by the Indian FinTech sector. BigTech companies from sectors like e-commerce, social media, and ride-hailing are expanding into finance, leveraging extensive customer data to tailor offerings for those with limited credit history. Even traditional lenders are adopting FinTech platforms for credit assessment. While these developments could have a positive impact

in terms of enhancing inclusion and further penetration of financial services, they also raise concerns about concentration risk and potential spillovers. Therefore, potential risks to public policy objectives of maintaining competition, market and business conduct, operational resilience, data privacy, cybersecurity and financial stability need closer attention (Das, 2022).

V.39 As per the systemic risk survey conducted by the Reserve Bank among financial sector professionals and academicians, cyber risks have been increasing consistently since 2020 (RBI, 2024c). The dominance of a few technology service providers, outages or cyber incidents could give rise to macro-financial stability risks (IMF, 2024). In India, the incidence of outages, as reflected in banks' UPI downtime, has been falling (Chart V.25).

Chart V.25: Banks' UPI Downtime in India



Source: National Payments Corporation of India (NPCI).

Policy Initiatives by the Reserve Bank

V.40 To harness the benefits of digitalisation in the financial sector while mitigating the emerging risks, the Reserve Bank has been undertaking proactive policy measures. These include (i) issuance of digital lending guidelines in 2022, focusing on credit intermediation, customer protection, data privacy and cybersecurity issues; (ii) issuance of guidelines in 2023 for further strengthening banks' IT systems as well as employing robust frameworks for fraud prevention and detection measures; (iii) issuance of master directions on outsourcing of IT services in April 2023, which stipulate REs to report cyber incidents within six hours of detection by a third-party service provider; (iv) issuance of Guidance Note in April 2024 for improving and further strengthening banks' Operational Risk Management Framework to identify, mitigate and recover from cyber incidents and technology failures and enhancing their ability to deliver critical operations, thereby ensuring their Operational Resilience; and (v) releasing the SRO-FT framework in May 2024. Furthermore, to accelerate and widen the reach of digital banking services and lessen the hesitation among customers for availing financial services digitally, the concept of "Digital Banking Units" (DBUs) was introduced by the Reserve Bank in April 2022.

V.41 The Reserve Bank also undertook several initiatives for strengthening the cybersecurity preparedness of supervised entities, including initiating the process of setting up of cyber range for conducting cyber drills, examining the feasibility of implementing the Cyber Sectoral Security Operations Centre (S-SOC), and conducting phishing simulation exercises (RBI, 2024b). It also proposed to set up a Digital Payments Intelligence Platform for network-level intelligence and real-time data sharing across the digital payment ecosystem in June 2024. To enhance the safety and security of digital transactions with a focus on detecting, preventing, and combating financial frauds, the Reserve Bank announced its third edition of the global hackathon, "HaRBInger

2024 – Innovation for Transformation" with two overarching themes *viz*., 'Zero Financial Frauds' and 'Being *Divyang* Friendly' (RBI, 2024d). The Reserve Bank launched initiatives in line with the Payments Vision Document 2025 across anchor goalposts of integrity, inclusion, innovation, institutionalisation and internationalisation during 2023-24 for enhancing the payments ecosystem and fostering a regulatory environment conducive to the growth of payment systems. As part of the agenda for the run-up to RBI@100, the Reserve Bank has taken initiatives to establish a cost-effective cloud facility for the financial sector to enhance the security, integrity and privacy of financial sector data while facilitating scalability and business continuity.

4.2 Digital Transactions and Monetary Policy

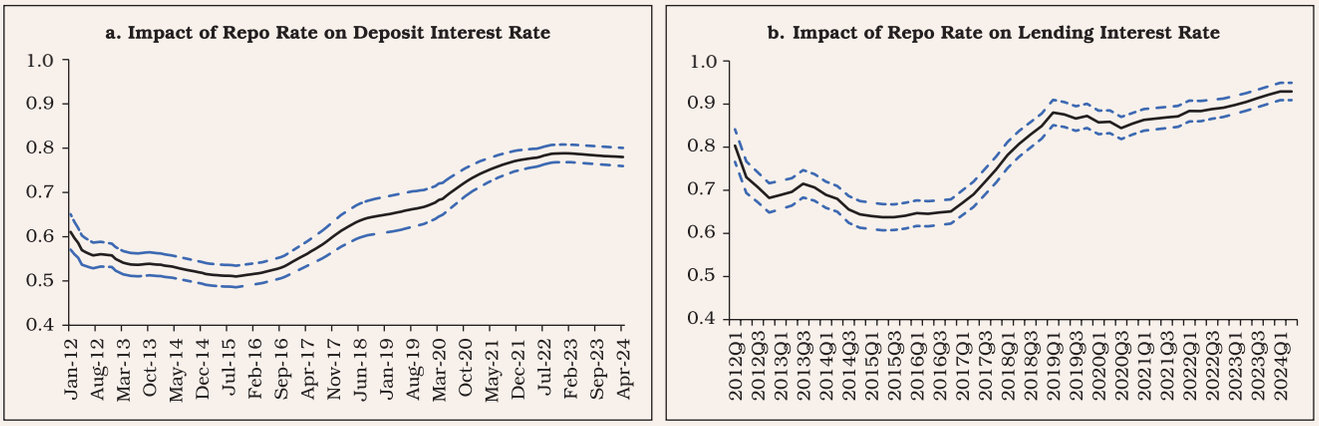
V.42 The digital transformation of the financial sector is reshaping the landscape in which monetary policy operates. Digitalisation influences various aspects of the economy, from financial intermediation and credit conditions to market dynamics and global integration, reshaping the traditional channels through which monetary policy affects economic variables such as growth and inflation. The widespread adoption of digital payment platforms alters how money circulates in the economy, which can enhance or mitigate the liquidity effects of monetary policy. Financial digitalisation could amplify the effects of monetary policy by loosening credit constraints. The monetary policy impact could be dampened if digitalisation leads to shifting of credit supply from banks to less-regulated / unregulated nonbanks (Buchak *et al*., 2018; Elliott *et al*., 2022; Chen *et al*., 2018), or by offsetting reductions in bank deposits (Xiao, 2020). Financial inclusion can enhance the effectiveness of interest rate based monetary policy by increasing the number of people responsive to interest rate cycles (Patra, 2021). Digital financial system can automatically adjust interest rates on deposits and loans in response to policy rate changes, potentially accelerating the transmission of monetary policy. The impact of policy under the risk-taking channel could be stronger due to digital lending if risk appetite of FinTechs is more sensitive to changes in monetary policy (Stein, 2013; IMF, 2016; Ding and He, 2023).

V.43 The overall impact of digitalisation on monetary policy transmission is ambiguous (Hasan *et al.,* 2024). It would depend, *inter alia,* on whether financial services offered by non-banks complement or substitute those offered by banks. While the complementarity could lead to higher financial intermediation and stronger monetary policy transmission, substitution of bank deposits could enhance financial disintermediation and weaken monetary policy transmission. Against this backdrop, the evolution of monetary policy transmission in India is examined by estimating the response of deposit and lending interest rates to the policy repo rate in a recursive regression framework for the period April 2004 to March 2024. The results suggest an improvement in the degree of interest rate pass-through since 2016-17, reflecting, *inter alia,* the combined impact of the adoption of flexible inflation targeting (FIT) framework in 2016 and the introduction of mandated external benchmark system for lending rates for select categories starting 2019, even as there has been rapid pace of digitalisation over the same period (Chart V.26).

Digitalisation and Inflation

V.44 Digitalisation also has implications for the primary monetary policy objective of inflation management. Digitalisation can impact the flexibility of prices, relative prices of online and offline products, market competition, and market concentration, all of which may potentially influence the New Keynesian Phillips Curve (NKPC) – the central element of the workhorse

Chart V.26: Rolling Regression Estimates of Monetary Policy Transmission



Note: The charts show the impact of a one percentage point rise in repo rate. Dashed lines represent one standard deviation error bands.
Source: RBI staff estimates.

model employed by modern central banks for assessing inflation dynamics and policy evaluation. Digitalisation can increase the degree of flexibility in prices (Anderton *et al.*, 2021; Anderton *et al.*, 2020). It can also reduce menu cost as changing the prices of goods is possible at almost zero cost without reprinting price tags or re-establishing pricing strategies. Information costs have also undergone significant changes under the influence of digitalisation. Digital tools, such as search engines, e-commerce platforms, and social media greatly reduce the time and energy costs for consumers to obtain information, compare prices, and make purchasing decisions, thereby changing the process of price formation and adjustment (Cavallo, 2018; Cavallo, 2017; Jiang and Zou, 2020). Digital technology is key in reducing menu and information costs and reducing price stickiness. A decrease in price stickiness may weaken the effectiveness of monetary policy (Alvarez *et al.,* 2016; Glocker and Piribauer, 2021).

V.45 Algorithmic pricing strategies in the digital realm may lead to collusion, resulting in prices above competitive levels. Additionally, the large initial investment in digital technologies, coupled with lower scaling costs, can lead to a higher level of market concentration and the emergence of natural monopolies or "superstar" firms. The rise in online product competition can lower inflation, while the increase in market concentration of firms, and the resulting higher mark-ups and profit margins, could lead to upward inflation pressures. The net effect of digitalisation on the market power can vary across sectors, depending on changes in market competition, inflation responsiveness, and changes in the structure of the NKPC. Digitalisation forces can, thus, impact inflation by impinging upon all the key components of the NKPC, *i.e.,* the slope, mark-up, slack (output gap), and inflation expectations (Chu *et al.*, 2023):

$$\pi_t = \underbrace{\alpha E_t\{\pi_{t+1}\}}_{\text{Expectations Channel}} + \underbrace{\beta}_{\text{Slope Channel}}\underbrace{(y_t - y_t^n)}_{\text{Slack Channel}} + \underbrace{\gamma(d_t)}_{\text{Markup Channel}}$$

Where, α,β and γ are constants, π_t represents current inflation, $E_t\{\pi_{t+1}\}$ represents the current expectation of the one period ahead inflation, $(y_t - y_t^n)$ represents the current slack, *i.e.,* the deviation of current output (y_t) from potential level (y_t^n), and d_t represents time-varying markup emanating from price elasticity of current demand.

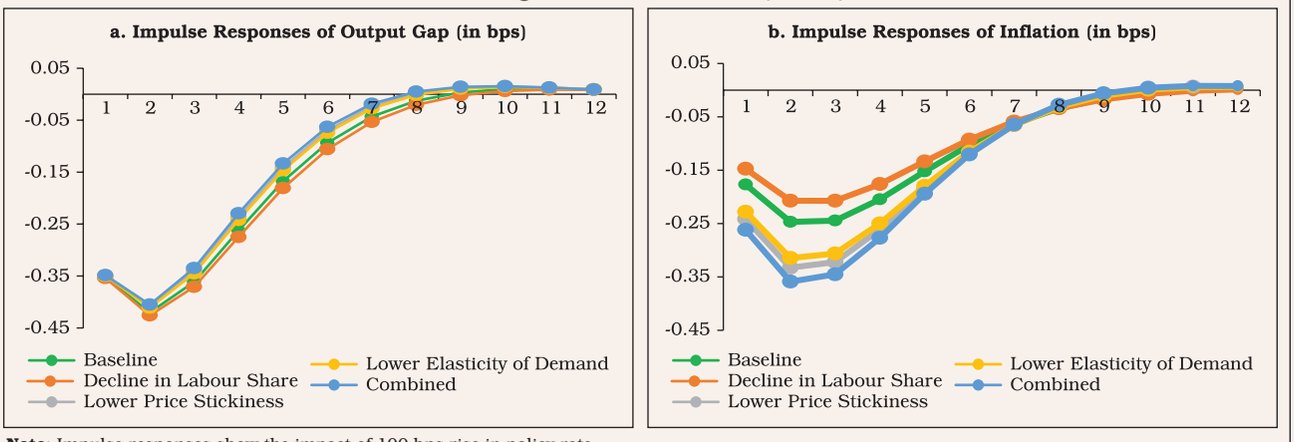
V.46 The slope channel is dependent on the price stickiness (*i.e.,* the fraction of firms not adjusting the prices), the price elasticity of demand, the elasticity of marginal cost to sales and the elasticity of firms' mark-up (Anderton *et al*., 2021). The NKPC could become steeper, making inflation more volatile if the impact of higher price flexibility, induced by digitalisation, outweighs the impact of greater availability of product varieties. By lowering the labour share in aggregate output, the digitalisation-induced higher market concentration may reduce the slope of the NKPC, while the availability of more product varieties can offset the impact of increased market concentration, and lower mark-ups. Technological shocks can impact mark-ups and marginal costs more frequently, which may negatively affect inflation expectations and the stability of the NKPC. Given these diverse channels, a small-scale New Keynesian model, calibrated to Indian macroeconomic conditions, suggests that digitalisation can, on balance, enhance the effectiveness of monetary policy transmission (Box V.2).

Box V.2
Impact of Digitalisation on Monetary Policy Transmission

To study the potential impact of digitalisation on monetary policy transmission, a New Keynesian model with three equations, namely dynamic IS equation, NKPC, and an inflation-targeting interest rate rule, is considered (see Galí, 2015). The IS equation captures, *inter alia*, the responsiveness of aggregate demand to the expected real rate of interest. The NKPC characterises the responsiveness of inflation to the output gap along with backward-looking and forward-looking inflation expectation components. The interest rate rule features inflation gap and output gap, including the interest rate smoothing term. To assess the implication of digitalisation, a baseline model (Banerjee *et al*., 2023; Sharma and Behera, 2022) is compared with counterfactuals performed by changing the structural parameters of (i) labour's share in the production process, (ii) price stickiness, and (iii) elasticity of demand as an indicator of competitiveness in the market. These parameters are changed one at a time and the resulting paths of impulse responses of output gap and inflation are compared.

In the baseline model, a 100 basis points (bps) rise in the policy rate leads to a fall in output and inflation by 40 bps and 25 bps, respectively, at their peak (Chart 1). In the scenario of digitalisation improving factor productivity,

Chart 1: Effects of Digitalisation on Monetary Policy Transmission



Note: Impulse responses show the impact of 100 bps rise in policy rate.
Source: RBI staff estimates.

(Contd...)

the peak effect of monetary tightening on output remains the same while that on inflation is lower at 20 bps. If digitalisation were to lead to a decline in nominal rigidity by 10 per cent, say, due to the rising online presence of retail stores and dynamic pricing algorithm, inflation fall could be higher at 35 bps. If the price elasticity of demand falls, inflation could drop by 30 bps (5 bps more than its baseline level) due to steepening of the slope of the Phillips curve. Considering all three channels together, the peak impact of a 100 bps increase in the repo rate on inflation could be around 35 bps (10 bps more than its baseline level).

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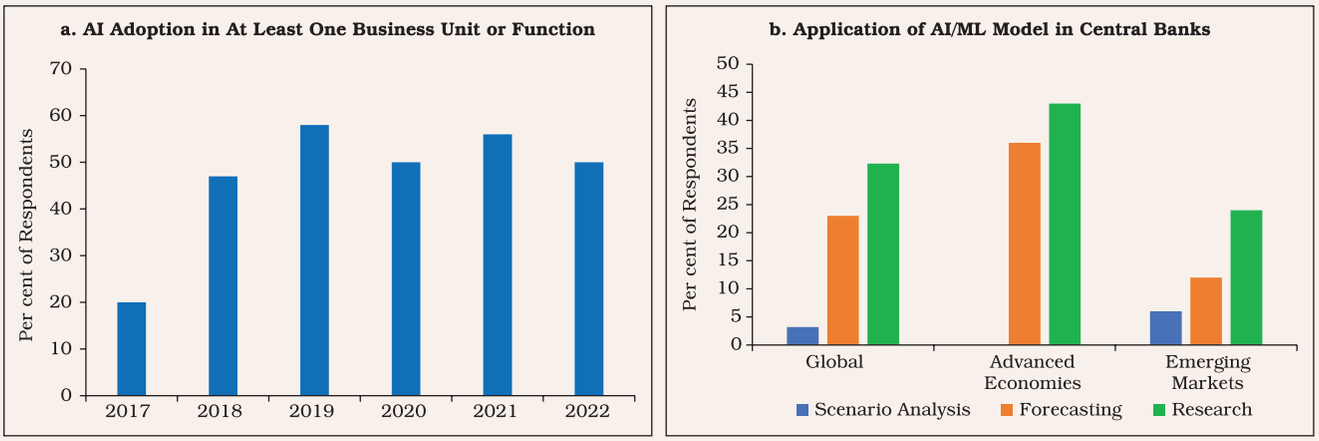
Monitoring and Forecasting in the Age of Big Data

V.47 An improved understanding of digitalisation induced changes in the behaviour of consumers, firms and financial intermediaries would be necessary for enhancing the effectiveness of data-driven policy making. The availability of large volumes of data enabled by digitalisation has opened up scope for the use of AI/ML techniques for faster processing and analysis of data as well as for macroeconomic forecasting (Chart V.27). In central banks, Big Data and Machine Learning are being used in a variety of areas, including research, monetary policy, and financial stability (Doerr *et al.*, 2021 and Serena *et al.*, 2021). Big data and ML can improve inflation forecasting performance (Chakraborty and Joseph, 2017; Singh and Bhoi, 2022); however, elevated geopolitical tensions, more frequent climate shocks and high volatility in global financial markets and commodity prices continue to pose significant challenges for the assessment and forecasts of output and inflation.

Chart V.27: Global AI Adoption



Source: McKinsey (2022); and Central Banking (2022).

5. Concluding Observations

V.48 Digitalisation is transforming India's financial sector by changing the way financial institutions operate and interact with their customers and provide financial products and services. Amidst several benefits, *e.g.,* fostering innovation, expanding access, enhancing competition, reducing intermediation costs, and improving customer experiences, digitalisation also brings new challenges in terms of complex financial products, greater interconnectedness, cybersecurity risks, financial frauds, and customer protection, with implications for macro-financial stability. These issues need to be addressed to realise the full potential of financial digitalisation.

V.49 A survey of select banks and NBFCs in India indicates that providing enhanced customer banking experience, remaining competitive, and improving operational efficiency and risk management are the major drivers of their digitalisation efforts. There is an improvement in customer acquisition and retention due to the adoption of digital technologies. Banks and NBFCs benefit from collaborating with FinTech companies in providing products and services, and they prefer regulation of FinTechs. The respondents view cybersecurity, data privacy, and third-party risks as their prime concerns.

V.50 Digitalisation can impact inflation and output dynamics, and monetary policy transmission in diverse manners and the overall impact could vary over time given the fast pace of developments. In this environment, central banks would need to incorporate digitalisation aspects comprehensively into their models for the continued efficacy of monetary policy and the achievement of their price and financial stability goals. Empirical analysis suggests a strengthening of monetary policy effectiveness amidst reforms in policy framework and operating procedures, along with the ongoing digitalisation in India.

V.51 Digitalisation can also bring new risks and challenges for customer protection and financial stability. While improving accessibility and convenience of financial services for customers, digitalisation raises concerns related to impulsive spending, herd behaviour and data security. The Reserve Bank has been undertaking proactive policy measures to harness the benefits while mitigating the emerging risks of digitalisation in the financial sector. The regulatory sandbox approach has produced practical and innovative solutions in domains such as retail payments, cross-border payments, MSME lending and prevention of financial frauds (Das, 2023). By integrating digital payment systems and FinTech innovations into its regulatory framework, the Reserve Bank has maintained financial stability while fostering economic growth. The RBI has set out guidelines for banks to implement robust cybersecurity measures, ensuring the safe and secure functioning of digital financial transactions. While encouraging innovation, the Reserve Bank is also proactive in safeguarding customer interests (Patra, 2024). These measures include, *inter alia,* formulating a charter of customer rights, integrated ombudsman scheme for grievance redressal, laying down of fair practices codes for lenders, and several consumer awareness and educational programmes to reinforce confidence of stakeholders in the financial system. Through these strategic initiatives, the Reserve Bank has been playing a constructive role in creating an innovation-friendly ecosystem in the financial sector consistent with its macro-financial objectives.

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