Use of Blockchain and Aritificial Intelligence to promote financial inclusion in India

Saon Ray[a], Sandeep Paul[b] and Smita Miglani[c]
[a]Senior Fellow, E-mail: sray@icrier.res.in
[b]Research Associate, E-mail: spaul@icrier.res.in
[c]Research Associate, E-mail: smiglani@icrier.res.in
Indian Council for Research on International Economic Relations, Core 6A, 4th Floor, India Habitat Center, Lodhi Road, New Delhi 110003, India

Abstract

The financial sector covers five broad functions. These are to (i) make and receive payments, including across borders; (ii) save to be able to consume or invest later; (iii) borrow to be able to consume or invest now; (iv) manage risks to income, savings, and transactions; and (v) receive advice on all above. Fintech may spur efficiency gains in the financial sector, offer better and more targeted products and services, and deepen financial inclusion in the developing world. However, it may also pose risks if its application undermines competition, trust, monetary policy transmission, and financial stability. This article examines the potential of Distributed Ledger Technologies (DLTs) and Artificial Intelligence (AI) in financial inclusion. DLT coupled with AI can be beneficial in the domains of control, security and privacy in financial transactions and financial inclusion.

Fintech

The term financial technologies or 'Fintech' is used to describe a variety of innovative business models and emerging technologies that have the potential to transform the financial services industry (OICO-IOSCO, 2017). Innovative Fintech business models offer one or more specific financial products or services in an automated fashion through the use of the internet. Emerging technologies such as cognitive computing, machine learning, artificial intelligence, and distributed ledger technologies can be used to supplement both Fintech new entrants and traditional incumbents.

Alternative finance grew rapidly in the Asia Pacific region in 2016-17 with China an undisputed leader, followed by Australia, Japan, Republic of Korea, Singapore and India in the region. The Asian region is expected to fuel the growth in this sector as financial inclusion and quality access is an unfinished agenda, and mobile and internet penetration is increasing rapidly. In 2016-17, of the USD4.3 billion investment in the region, 45 percent of that amount is attributed to developments in China and 38 percent to India, with the rest for other countries.[1] Globally, two sectors that received most cumulative funding are payments (US$24.3 billion) and lending (US$ 13 billion). The Chinese fintech sector has shown phenomenal growth with relatively short maturity curve. A ranking of the world's most innovative fintech firms gave Chinese companies four of the top five slots in 2017. The most notable growth in mobile payments, online lending and investment. Extraordinary growth in Chinese fintech sector was due to a tech-savvy population, and an underdeveloped banking industry.

Singapore is fast turning into a major destination for investors and foreign industry players owing to extensive government support and expertise of corporate mentors. Indonesia is another country with fast growing fintech industry. It is the fourth largest mobile market in the world with 339.9 million connections and about 43% owns a smart phone and mobile is the preferred medium for internet access but very low levels of financial inclusion so far. The Republic of Korea boasts of a very vibrant fintech business and most notable growth is happening in payment related services and new banking platforms. In July 2017, the Republic of Korea created a separate ministry, Ministry of start-up to strengthen competitiveness and support innovation within the SMEs and start-up space in the Republic of Korea. Digital financial services is yet to make inroads in Thailand. Digital banking penetration in Thailand is close to 19 per cent — far from Taiwan's province of China 92 per cent and Singapore's 94 per cent. Credit card usage in Thailand stands at 3.7 per cent, compared with 51 per cent for Taiwan province of China and 31 per cent for Singapore.

The Indian Fintech industry, and especially payments vertical greatly benefited from digitization policy of government. AADHAR, envisaged to provide residents of India with a unique identity and a digital platform to authenticate anytime, anywhere has been the biggest enabler. It was widely adopted by all the players for customer on boarding and digital Know Your Customer (KYC) verification.[2] Unified Payments Interface (UPI), promoted by the National Payments Corporation of India (NPCI), is fully interoperable across all payments system players. It powers multiple bank accounts

1 2nd Asia Pacific Region Alternative Finance Industry Report (2017)

2 Due to the Supreme Court ruling, Aadhar can be used for E-KYC verification only by banks. See also: https://economictimes.indiatimes.com/wealth/p2p/how-will-the-sc-verdict-on-aadhaar-impact-online-lending-companies/articleshow/66144423.cms

into a single mobile application (of any participating bank), merging several banking features, seamless fund routing and merchant payments into one hood. The Digital India campaign and demonetization also substantially contributed to the growth of digital transactions. Sustained growth in smartphone penetration and internet connectivity also helped.

In recent times, payments, transfers and lending are receiving maximum attention in this space. Innovations in this category are targeted at improving the speed and efficiency of payments, clearing, and settlement, reducing cost and changing the ways people access financial services and conduct financial transactions. Technology can (i) reduce the need for financial intermediaries (specialized financial firms, banks and non-banks alike, that facilitate transactions between two or more parties); (ii) push intermediaries to change their internal structures (possibly leading to partnerships and acquisitions); (iii) induce the entry of new intermediaries while displacing older one. Technology can alter the market imperfections across the financial system, which underpin the need for trusted intermediaries. It can reduce asymmetric information (limited knowledge of one's counterparties to a transaction), facilitate the matching of parties to a transaction, and reduce transaction costs. Technology can also affect the incentives for intermediaries to be horizontally or vertically integrated (offer multiple services to end-users, as does a universal bank, or acquire upstream suppliers). Finally, technology can alter barriers to entry for new intermediaries to compete against incumbents.

In this context we look at two technologies: artificial intelligence and blockchain or distributed ledger technology and their impact on financial inclusion in India.

Artificial Intelligence

Artificial intelligence (AI) has been defined as the theory and development of computer systems able to perform tasks requiring human intelligence. The origin of AI goes back to the 1950s when Alan Turing published a paper on possibility of machines with true intelligence. AI has been defined as, "the scientific understanding of the mechanisms underlying thought and intelligent behaviour and their embodiment in machines" (Association for the Advancement of Artificial Intelligence, (AAAI).[3]

The array of technologies in AI includes audio processing, knowledge representation, speech-to-text, deep learning, expert systems, natural language processing, machine-learning (ML), robotics, and symbolic logic. It is a general purpose technology. Many of these have the potential to be applied in the fintech sector and promotion of financial inclusion. Their popularity picked up after 2011 when IBM, Microsoft, Google and Facebook started investing in AI and machine learning for commercial applications. The commonest use is via machine learning which is essentially understood as computers learn from data and can predict patterns in the data. It enables human-like intelligence and learning capacities to overcome the current limitations of capital and labour (Accenture, 2017).

Use of artificial intelligence in finance

Fintech companies are using AI applications to advance consumer protection and user experience, manage risk, detect fraud, etc. in the country. Other prominent areas of use include credit scoring, chat bots, capital optimization, market impact analysis, trade signaling, and 'reg tech' applications.

Customer support and helpdesk: Chat bots are increasingly being adopted by Indian financial organizations to increase efficiency and reduce cost of customer support – e.g. HDFC Bank's EVA (Electronic Virtual Assistant), City Union Bank's Lakshmi chatbot etc.

Fraud detection: Anomaly detection to prevent frauds and improve monitoring - e.g. National Stock Exchange intends to use machine learning to identify market patterns to improving monitoring and prevent manipulation of its high-frequency trading (HFT) markets.

Risk Management: More personalized products to clients based on historical data, risk analysis, minimizing human errors.

Security: AI-enabled cyber security systems to guard against and prevent possible security breaches.

Wealth management: Robo advisors that provide automated financial planning services like tax planning advice, insurance advice, health, investment advice etc.

HDFC uses AI for its Mobile Banking App, and OnChat, which uses Natural Language Processing where users can interact, confirm and pay for services within chat. It is also planning to develop AI solutions for Customer Support, Process Automation, HR, Security and Fraud Detection.

With respect to AI, the biggest hurdle to innovation and large-scale application is financial investment. Access to funding is a concern for many developers and those seeking to use applications. As pointed out by Accenture (2017), combinations of technologies, multi-variant data and interdisciplinary skills are quite often not in the possession of any single player. This could limit the market to few large players who could successfully navigate the landscape and could cause an oligopolistic market (Accenture, 2017). Hence there is a need to strengthen research and development in AI to ensure ease of entry and sharing of technological breakthroughs.

The Financial Stability Board (FSB, 2017) points out that the black box aspect of AI might also be problematic. There is lack of clarity with respect to ethical considerations, responsibility, governance and regulation in such applications. The rapid pace of adoption of AI in the industry calls for regulatory oversight and policy intervention. The possibility of an open source platform that shares AI frameworks and tools needs to be explored (Accenture, 2017). Integration of AI may also render

[3] https://aitopics.org/tag/artificial%20intelligence

many jobs obsolete but open up new ones. This warrants skilling of a future workforce and retraining of existing workforce. Most importantly, regulatory practices have to be stepped up to ensure that developments and innovations follow fair market practices. A range of legal issues related to privacy and data protection, consumer protection, anti-discrimination and liability issues, and cross-border issues may arise with further development in the industry.

Fintech companies are increasingly relying on Artificial Intelligence-based technologies to expand the unsecured loan business and tap clients who were previously unserviceable; however, it is too early in the day to assess how this is working.

Blockchain

Blockchain, "is a particular type of data structure used in some distributed ledgers which stores and transmits data in packages called 'blocks' that are connected to each other in a digital 'chain'. Blockchains employ cryptographic and algorithmic methods to record and synchronize data across a network in an immutable manner" (World Bank, 2017). Distributed Ledger Technology (DLT) also known as blockchain technology refers to a protocol that allows peer-to-peer transfer of assets over the internet. DLT is a novel way of sharing data across multiple data stores (or ledgers) (World Bank, 2017). The shared database allows peer-to-peer transaction without requiring a central authority.

This technology creates an immutable ledger of all activity across peer-to-peer transactions.[4] Transactions through the DLT are cryptographically logged in 'blocks' of data, which when verified by members of the distributed network, creates a permanent record of the transactions. The network is both a medium of transactions and a means of recording it, since the blockchain file belongs to all members of it (Botton, 2018). The peer-to-peer system means that information can only be modified by a majority of members, thus making it secure.

The technology is characterized by decentralized networks, absolute digitization, and real-time transfer. There are no intermediaries, and trustless exchange, maintenance of high quality data with reliability, longevity and immutability; process integrity and transparency; fast transactions enabling reduced costs required for settlement. The promise of tamperproof record-keeping and data security makes it possible for banks to transition from an independent ledger to a universal and encrypted distributed ledger system and also improve upon their product offerings. Distributed ledger technology can be used to execute transactions in real time by making irreversible/undeletable transaction entries into DLT copy which would be available to all participating entities.

There are five key components of a Blockchain: Cryptography,[5] Peer-to-peer network[6], Consensus Mechanism,[7] Distributed Ledger[8] and Validity rules.[9] Network participants can independently verify the state and integrity of a blockchain.

There are permissioned blockchain and permissionless blockchain: in the former, only authorized members are part of the network; here, it is possible to customize access control structures and consensus algorithms, that is, who can view what and who verifies what can be controlled. Permissioned blockchain has greater potential for adoption in the near future than permissionless chains.

Specific areas with the potential for application include: maintenance of KYC records, application of the DLT, Blockchain Cryptography and Smart Contracts.[10] The technology can successfully be applied in payment processes.[11]

Smart contracts: Smart contracts (computer programs) would be one of the most immediate applications in financial services. They would emulate regular contractual constructs and could be made partially or fully self-executing, self-enforcing, or both. Such smart contracts could replace standing instructions, electronic clearing service (ECS), etc.

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4 https://digitalchamber.org/assets/blockchain-and-financial-inclusion.pdfhttps://digitalchamber.org/assets/blockchain-and-financial-inclusion.pdf

5 A variety of cryptographic techniques including one-way hash functions ensures near full proof security. This is achieved by using public-private key combinations to generate the hash value so that information is visible to and can be processed only by the person for whom it is intended.

6 Equally privileged and capable participants in the blockchain.

7 An algorithm that determines the ordering of transactions in an environment that ensures the parties follow the protocol and prevent unethical practices. This helps maintain the single state of the transactions.

8 A list of transactions of assets grouped together in cryptographically linked "blocks"

9 A smart contract can be conceptualized as, "a computerized transaction protocol that executes the terms of a contract. The general objectives are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimize exceptions both malicious and accidental, and minimize the need for trusted intermediaries" (Cong and He, 2018). Smart contracts are one of the most anticipated applications of blockchain technology. Smart contracts often emulate the logic of regular contractual constructs, and therefore, many kinds of contractual clauses can be made partially or fully self-executing, self-enforcing, or both. Payments Smart contracts can replace standing instructions, electronic clearing services and bill payments.

10 A common set of rules of the network (for example, what transactions are considered valid, how the ledger gets updated).

11 Ripple and Tangle are two other important DLTs. Ripple uses a consensus ledger to confirm transactions and is being used among banks as a worldwide payment system. Tangle was created for B2B models while Ripple simplifies settlement. Tangle's verification method removes transacting costs. Both are non-mineable. See https://stockhax.com/blog/distributed-ledger/

Authentication: Blockchain could also be used to authenticate identities and documents through a digital blockchain recorded version. This would have applications in KYC authentication, due diligence, etc. A central KYC is a related use case in which Blockchain can have a potential use.

Blockchain cannot be implemented in all use cases for digitization or to all transaction related problems. It is most useful when multiple parties share data and need a view of common information. Blockchain can be employed as an effective solution if at least three out of following prerequisites are met (PwC, 2018):

Multiple parties share data – Multiple parties need a common view of the information at hand.

Multiple parties update data - When actions undertaken by multiple parties need to be recorded and the data coming from multiple parties needs to be updated.

Requirement for verification - When it is necessary to build trust amongst parties and make them understand that their actions that are being recorded are valid.

Intermediaries add complexity - When a transaction is dependent on multiple intermediaries and their presence increases the cost and complexity of the transaction.

Interactions are time sensitive - When it is beneficial for the business to reduce delay and expedite a transaction.

Transactions interact - When transactions created by multiple participants interact and depend on each other.

The most important features of Blockchain with respect to payment processes would be reduced turnaround time (no more intermediary/ faster authentication), increased transparency, reduced costs and faster reconciliation. It also leads to reduced risks, data auditability and resilience. Transfer of value via blockchain takes approximately 10 minutes which might not work for retail payment in developed economies, but in developing countries, might increase the speed of transactions significantly. Reduction or elimination of operational and financial inefficiencies and other frictions including improved end-to-end settlement speed.

Use of blockchain/ DLT in finance

DLT and blockchain technologies are of immense importance to the financial services industry, because of which there is much interest in its use among stakeholders in the Indian Banking, Financial Service and Insurance (BFSI) industry. Currently, it is tested largely in applications to do with information sharing. Popular use cases which have gained traction with the Indian industry are intra-bank applications, authentication and document management, trade finance and invoice discounting, applications without a native currency.[12] Some of the use cases of blockchain in India include (Iyer and Kumar, 2018):

- MonetaGo (in trade)
- ICICI, Yes and Axis Bank (in Proofs of Concept)
- NSE collaboration with banks such as ICICI, IDFC, on KYC POC
- Unocoin and Coinsecure (Bitcoin exchanges and wallet)
- EzyRemit (remittance solutions)
- SignZy (document storage, signing, and validation)

The **IndiaChain** initiative of the NITI Aayog is a much anticipated development. The NITI (2017) has reported that, "NITI is parallely working on a platform called 'IndiaChain which will be a shared, India-specific blockchain infrastructure, utilising the power of the Jan-Dhan Yojana, Aadhaar, and Mobile trinity and enable blockchain developers to build social applications." This platform, which is expected to be linked with India Stack, could provide the much-needed boost to adoption of blockchain technology in India.

Having realized the potential of these innovative technologies, banks, finance companies and microfinance institutions are scaling up their expertise and integrating them into operational models. The sector's evolution and growth is very rapid and is expected to bring in new business models, products and services, change consumer preferences and market structure. The regulators' attention has been drawn towards reviewing and reorienting the relevant regulatory framework. Establishment of the inter-regulatory Working Group on Fin Tech and Digital Banking and publishing of white papers and initiatives by the Institute for Development and Research in Banking Technology (IDRBT) are steps in this direction.

Many companies already use many of these technologies to better access and serve previously excluded or underserved customers in the financial sector. It is also argued that an optimal mix of the human touch element along with the adoption of digital solutions promotes access to and usage of financial services. For instance, banking agents and employees can facilitate in bridging the gap between awareness and usage of digital financial services. Agents can help their customers understand different financial processes and products, and ensure that no one is left out in the digital financial revolution.[13] It can be used to provide specific solutions to problems faced by the unbanked to help them through tailored solutions.[14] These products are useful to current consumers and can also bring in the unbanked and under-banked to financial area.

Financial inclusion

Financial inclusion refers to the number of adults having access to banking or financial services. The Global Findex Survey

[12] Digital currencies, and crypto assets such as Bitcoin, Etherium, central bank-issued digital currencies, etc., are applications with native currency.

[13] For details, see Accenture (2015), 'Branching out: The case for the human touch in banking', by Frederic Brunier and Stefano Trombetta' https://www.accenture.com/t00010101T000000__w__/gb-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Dualpub_12/Accenture-Human-Touch-Banking.pdf

[14] *ibid*

(Demirgüç-Kunt, et al., 2018) reported that in the 15+ age group, 79.9% of the population had accounts with financial institutions in year 2017. This meant a strong growth compared to 53.1% reported in the previous edition of the survey in 2014, and 35.2% in 2011. Nearly half of the world's adult population (or 3.5 billion people) are unbanked and under banked (with limited or non-transactional access to finance). Of these 1.7 billion adults in the world without an account, China, India, Pakistan and Indonesia account for the largest unbanked persons.

The first step towards financial inclusion is having an account. Increasingly, digital payments are being used for financial transactions. Ethiopia and India stand out for low use of digital payments: only about a third of account owners in these two countries reported making or receiving at least one digital payment in the past 12 months. In other developing economies, 19 percent of adults (30 percent of account owners) reported making at least one financial transaction in the past year using a mobile money account, a mobile phone, or the internet. However, this figure masks large differences between countries. In economies where a large share of adults have a mobile money account, such as Kenya and Tanzania, the use of a mobile phone to make transactions through an account is close to universal among account owners: in Kenya 88 percent of account owners (72 percent of adults) reported using a mobile phone or the internet to make a transaction through their account in the past year. By contrast, in India less than 10 percent of account owners reported doing so. In China, 49 percent of account owners (40 percent of adults) reported using a mobile phone to make a financial transaction.

Debit card ownership and use vary considerably across developing economies. 100 million adults with an inactive account have a debit card, while nearly 2.5 times as many, while 240 million have an inactive account plus a mobile phone. Brazil, China, Malaysia, Russia, and Turkey follow the general pattern among developing economies of relatively high debit card ownership and use, with about half of those with a debit card using it to make a direct purchase in the past year. In India and Kenya, by contrast, less than half of account owners have a debit card, and among those who do, only about a third used it to make a direct purchase.

Making or receiving digital payments is one important use of an account. Saving is another. Few people, however, reported using their account for saving but not also for making or receiving digital payments in the past year. In India the share was 7 percent. Most relied on money from working or family and friends as the main source of emergency funds in many developing economies. Money from working was most commonly cited as the main source of funds in China, Indonesia, and Tanzania while family or friends were given as the main source in Brazil, Egypt, and India (Demirgüç-Kunt, et al., 2018).

About 56% of all unbanked persons in the world were women in 2017. In India three years ago, men were 20 percentage points more likely than women to have an account. Today, India's gender gap has shrunk to 6 percentage points. This has been due to a strong government push to increase account ownership through biometric identification cards (Demirgüç-Kunt et al., 2018). Technology has been helpful in achieving gender parity and reduced the gap between richer and poorer adults. The Jan Dhan Yojana (JDY) scheme, developed by the government to increase account ownership. Launched in August 2014, the program had brought an additional 310 million Indians into the formal banking system by March 2018, many of whom might not yet have had an opportunity to use their new account. The financial inclusion programmes in India include policies undertaken by the government (like PMJDY, launch of Bharat Interface for Money (BHIM) and UPI), measures taken by the Reserve Bank of India (like the banking correspondent model and launch of financial literacy programme).

How can AI help in financial inclusion?[15]

AI to build credit history: Artificial intelligence can be used to collect information on various indicators which can then be used to create credit history of customers. The information collected could be on crop turnover, Aadhar linked data, GPS data, handset details, insurance etc. to build credit scores for customers. The system can recommend a smaller value loan and then to top up further based on the renewed credit worthiness re-estimated by the AI machine.

AI as a relationship manager: Artificial intelligence can be used as a relationship manager. HDFC has already introduced a chatbot for this purpose. Most of the bank staff have urban orientation and do not have inclination and patience to talk to the rural customer. Natural Regional Language processing based AI trained robot- to train and talk to the rural customers in regional language: explain them about banking products, can also discuss about the amount of the debt that they have and suggest how much do they need to save. AI trained Robots can become their financial advisors.

AI assisted lifestyle based banking: Another way in which AI can be used is to assist in the financial literacy endeavours. There are a number of government schemes like Gram Sadak Yojna, Swachh Bharat Abhiyan, Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) etc. where the incentives go through the Pradhan Mantri Jan Dhan accounts. Banks can use feeds of all such incentive payments data from the Unique Identification Authority of India (UIDAI) database into the AI engine and come up with the best possible products the customer can be offered.

How can blockchain help in financial inclusion?

Opening an account – Individuals can open an account or deposit cash through their phones.

Usability of an account – Transfer of funds using blockchain takes 10 minutes which is faster compared to such transfers through conventional means in developing countries

Costs to the financial institutions – Payments via blockchain do not need to

[15] https://www.edgeverve.com/blog/artificial-intelligence-financial-inclusion/

go through the national payments system and hence there is no need of physical branches. The cost of transfer of funds is a percentage of the value of the transferred and makes payments more feasible.

Currency risk - Individuals and SMEs have the option of adding funds in the fiat currency. This shift the volatility risk to the financial intermediary (FI). FIs are using bitcoin as vehicle currency – the dollar is the dominant vehicle currency and used in 88% of trades. Using boitcoin as vehicle currency and blockchain's platforms means that the recipient and the sender are not exposed to the volatility of the virtual currency.

Conclusion

In this article, we examine how AI and blockchain technologies can contribute to financial inclusion. While the potential of blockchain technology, in general and smart contracts, in particular, to make financial services more efficient, cost effective and inclusive is not disputed, there is concern with respect to scalability, interoperability, cost impact and regulation. Lack of understanding and expertise also create cultural barriers making movement away from legacy system more difficult. Blockchain technology can be a game changer if it is widely adopted and there is agreement on the technology architecture that needs to be put in place for its adoption. As far as AI is concerned, it is a nascent technology and there are challenges such as transaction speed, verification process, and data limits. Its regulatory status is uncertain and there are integration concerns (within an organization, on account of the existing ecosystem), scarcity of talent, and costs involved. The potential of both these technologies in achieving greater financial inclusion is undoubtedly clear. Whether that will happen will depend on many factors including those highlighted above as well as how quickly these technologies are adopted by most fintech players.

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