PERSPECTIVE

BLOCKCHAIN ADOPTION IN FINANCIAL SERVICES

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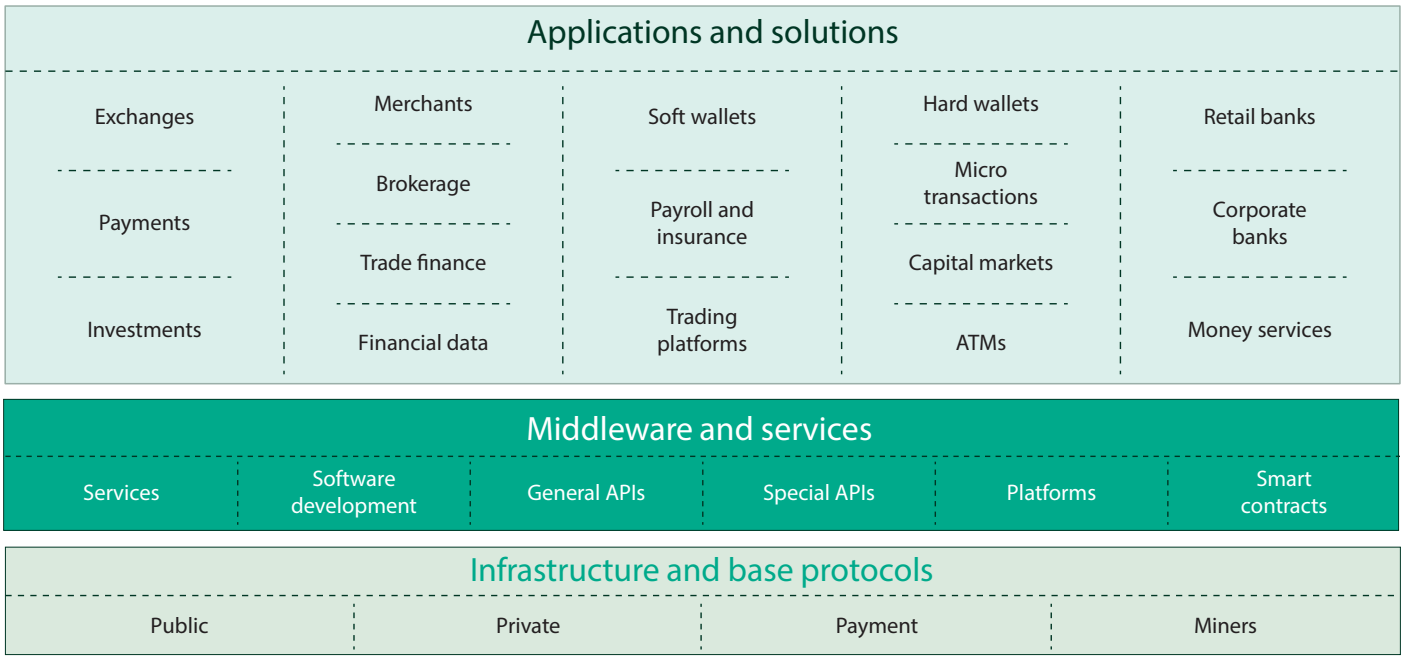
The financial services (FS) industry is witnessing an increase in the number of advocates for the distributed ledger technology (DLT) adoption every day. And why not? After all, DLT – aka blockchain – has shown immense potential. For financial institutions (FIs), it promises huge savings in infrastructure, transaction, and administrative costs. It can disintermediate the transfer of financial assets digitally, reducing the role of central counterparties. It can also help improve the level of trust, accuracy, and resilience in the financial ecosystem. According to a report by Santander in 2015, upon its industry-wide implementation, by 2022, blockchain can reduce banks' infrastructure costs that are attributable to securities trading, cross-border payments, and regulatory compliance by approximately US$20 billion per annum.

Refer the following key attributes of blockchain and an illustrative blockchain ecosystem of FS:

Key attributes of blockchain	
Contains a secure, electronic, time-stamped transaction ledger database that is shared by all parties in a distributed network	Comprises accurate and verifiable record of every transaction ever made; provides auditable and irrevocable transaction history
Has a massive ledger of transactions shared and verified by a global network of computers. Identical copies of the ledger maintained on multiple systems controlled by different entities	Allows participants to review the blockchain entries. Users can, however, update the blockchain only by consensus of a majority of participants
Is based on a cryptographic peer-to-peer (P2P) network that provides a single source of truth and irrefutable proof of existence, process, and provenance	Uses triple-entry accounting and consensus to establish ownership of assets such as virtual currency, securities, etc.
Assures immutability and irreversibility through cryptography; information cannot be erased once entered	Records transaction details without exposing confidential details of parties / subject involved. Enables near real-time settlement
Can be public or private, and ledger can be permissioned or unpermissioned	Can set business rules about a transaction that are tied to the transaction itself. Enables smart contracts whose terms are recorded in computer language and that can be automatically executed



Illustrative blockchain ecosystem of financial services

Blockchain application: Potential FS business domains

Since the arrival of blockchain in 2009, its potential usage across FS business domains have been increasing and they have today exceeded far beyond its initial cryptocurrency applications. Refer the following potential FS business domains usage of blockchain and an illustrative trade finance process flow under the blockchain arrangement.

Examples of blockchain potential usage in FS business domains

Commercial banking

- New and competitive products and services introduction
- Cryptocurrency denominated products (e.g., from Tinker, SolidX)
- Asset and real estate tracking; physical asset registration (house, land, automobile)
- Marketplace, P2P, and syndicated lending
- Real-time loan funding and automated servicing via smart contracts
- Personal financial management (PFM)
- Liquidity management, cash reserve management, and intra-bank settlements
- Customer acquisition and loyalty management

Trade and supply chain finance

- Real-time multiparty tracking and management of letters of credit, bank payment obligations, open account instruments
- Debt servicing, insurance, and factoring
- Receivables financing
- Commodities trade finance
- Decentralized contracts execution
- Document preparation services (trusted private e-doc exchange, real-time review, and approval of documents)
- Interaction between import and export banks (eliminating the role of correspondent banks)

Payments

- Micropayments / retail payments
- Wholesale payments (correspondent banking network, cross-border FX)
- P2P payments (BTC Jam, Coduis, BitBond)
- Payments processing (e.g., Coinbase, BitPay)
- Exchange offerings and virtual wallet (e.g., BitPesa, Bitreserve)
- Currency exchange and cross-border remittances (Ripple, Kraken, MeXBT, Coinbase (Wallet))

Capital markets

- Clearing and settlement (Hyperledger, Serica)
- Trade execution (real-time transaction matching, automated DVP on cash ledger)
- Post-trade (trade reconciliation, trade reporting, monitoring and surveillance)
- Custody and security servicing (escrow and custodian services, asset documentation; record keeping)
- Derivatives transaction
- Asset documentation / registries / servicing / exchange

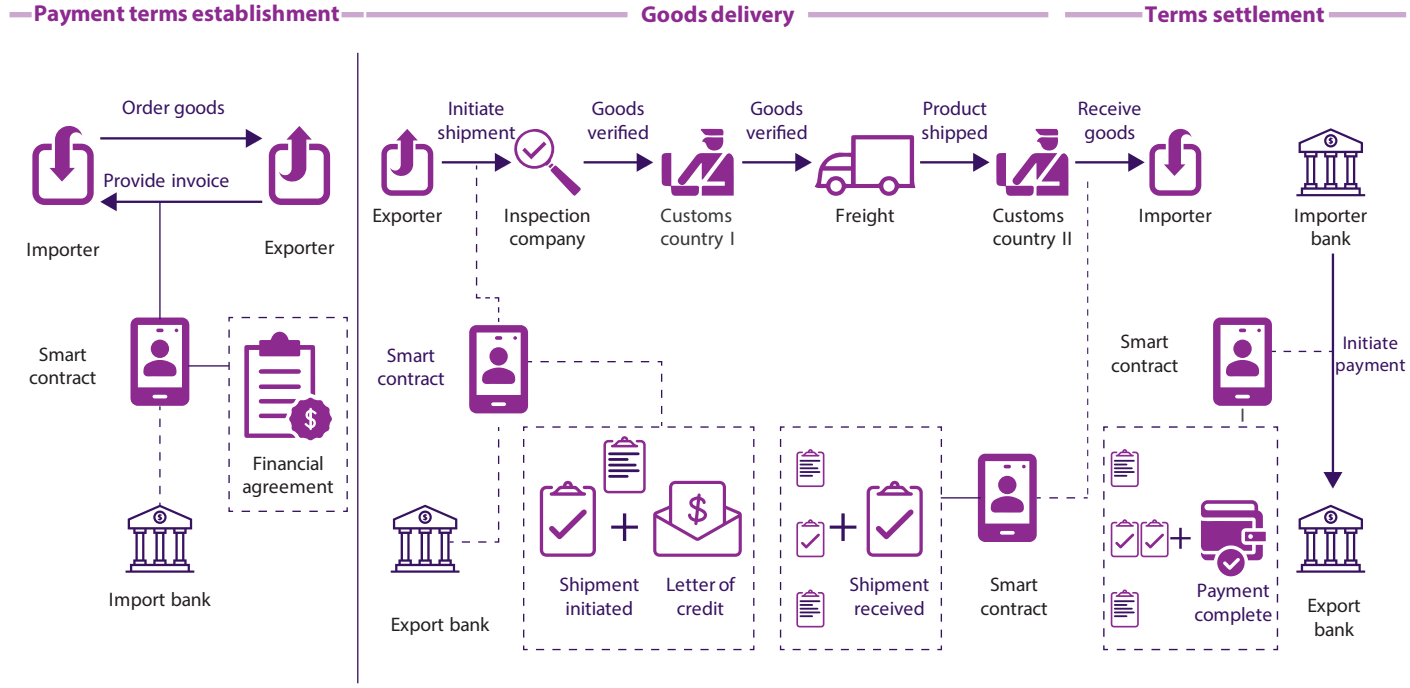
Risk management

- Risk audit, risk underwriting
- Counterparty risk management
- Fraud risk management, identity theft prevention
- Liquidity risk management; capital risk management
- Systemic risk management (real-time global view)
- Operational risk improvements

Regulatory compliance

- Automate compliance activities execution (e.g., CCAR-related, real-time regulatory control limits enforcement (e.g., for asset rehypothecation))
- Regulatory process optimization (e.g., in AML, KYC, CDD); KYC, AML registries
- Sanctions enforcement; tools for regulators (e.g., for parsing real-time feed from FIs, audit trail for compliance verification)
- Regulator reporting automation (through smart contracts, DL as golden source, and unified regulatory reporting protocols)

Examples of blockchain potential usage in FS business domains



Illustrative trade finance process flow under blockchain setup

Benefits of blockchain setup in the trade finance process flow	
• **Real-time review and approval of financial documents:** Linked and accessible through DLT thereby reducing shipment initiation time	• **Reduced counterparty risk:** Bills of lading tracked through DLT. This eliminates the chances of double spending
• **Transparent factoring:** Invoices accessed on DLT enable transparent and real-time view into subsequent short-term financing	• **Disintermediation:** By facilitating trade finance via DLT, banks do not need a trusted intermediary. This eliminates the need for correspondent banks
• **Ownership proof:** Title available inside DLT offers transparency into ownership and location of goods	• **Decentralized contract execution:** As soon as the contract terms are met, status gets updated on DL in real time. This reduces the effort and time needed for monitoring the goods delivery
• **Regulatory transparency:** Regulators are enabled real-time view of the essential documents to assist in AML and enforcement activities	• **Reduced transaction fees and automated settlement:** Contract terms that are executed through smart contract eliminate the need for additional transaction fees and correspondent banks

Blockchain: Capturing the imagination of the financial services ecosystem

Today, central banks, commercial banks, stock exchanges, and many other FS players are keenly exploring blockchain's potential. According to the World Economic Forum report published in August 2016, over 24 countries are currently investing in blockchain. Over 90 corporations are part of .blockchain consortia and more than 2,500 blockchain patents have been filed over the past three years. Additionally, over 90 central banks across the world are engaged in blockchain discussions. Adding to it, over US$1.4 billion has been invested over the past three years through venture capital to explore blockchain usage in the FS industry.

In recent times, various blockchain technology platforms have been and are being developed. Over 300 technology startups, mostly in the UK and the US, have been working on enabling blockchain for the FS space – Kraken, BTCJam, HelloBlock, BlockCypher, Bifubao, Digital Tangible Trust, Ripple Labs, Coinbase, BitPay, and BitPagos to name a few. Even established technology vendors have been playing a key role in the blockchain ecosystem. R3, IBM, ConsenSys and Chain are amongst the key players in the global blockchain technology market. Regulators and policy makers of FS too have begun focusing on blockchain's adoption. FinCEN, Commodity Futures Trading Commission (CFTC), and Securities and Exchange Commission (SEC) are just a few examples.

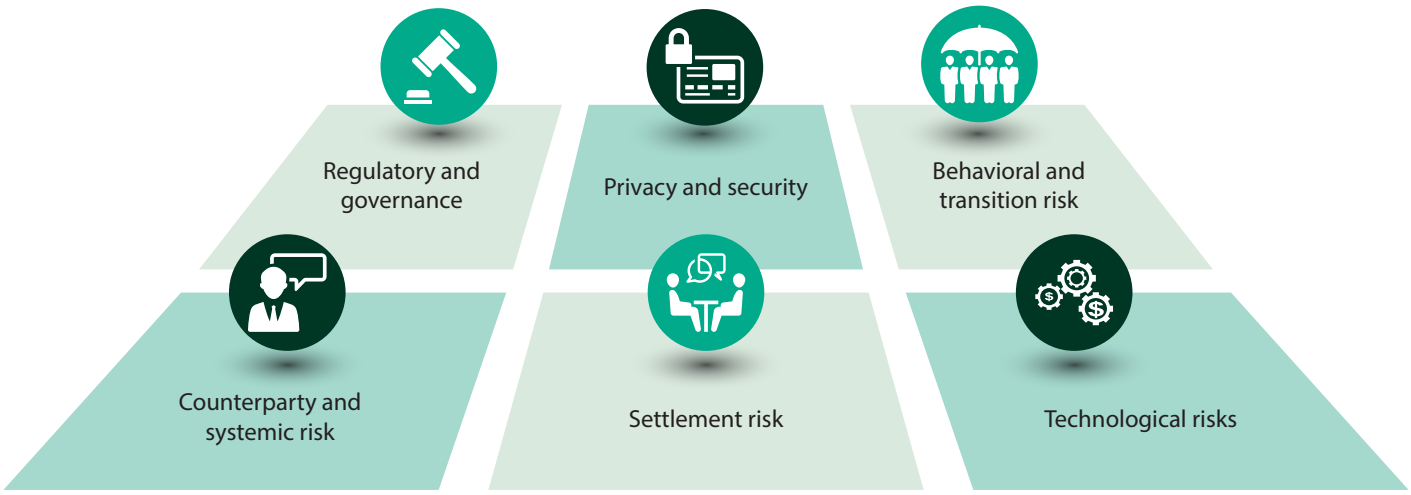
Examples of FIs' interest in blockchain

#	Entity	Elaboration
1	R3 CEV	• The startup is helping set up a private blockchain. Over 40 banks globally, including UBS, Barclays, JPMorgan, Credit Suisse, Royal Bank of Scotland, and Bank of America have supported R3 CEV
2	Depository Trust & Clearing Corporation (DTCC)	• The major New York clearing house and provider of post-trade services selected IBM – in partnership with R3 and Axoni – to rebuild its trade information warehouse using distributed ledger (DL) framework • Solution would automate life cycle events, record keeping, and payment management for over US$11 trillion of bilateral and cleared credit derivatives
3	UBS	• Its UBS Crypto Pathfinder Program, that executes from its London-based Innovation Lab, comprises team members from technology, finance, and business. Through this program, the bank aims to develop and promote open standards for the blockchain technology for financial services industry – including investment banking, corporate banking, retail banking, and wealth management • The program team has been collaborating with UBS employees from business divisions across the world and also with numerous tech startups and external stakeholders such as banks, government, businesses, and universities • In partnership with Clearmatics, UBS has built Utility Settlement Coin (USC). USC is an asset-backed digital cash instrument that is implemented on DLT and is meant for usage within the global institutional financial markets • UBS, Deutsche Bank, BNY Mellon, Santander, and inter-dealer broker ICAP pioneered a blockchain-based digital token that could form the industry standard for trades clearing and settlement
4	Barclays	• Barclays and Wave (an Israel-based innovative startup firm) became the first firms to execute a global trade transaction leveraging the blockchain technology. Using this solution, the bank was able to reduce the time taken from 7–10 days to below four hours • Barclays, along with four other major banks, has worked with Thomson Reuters, Axoni, and IHS Markit to carry out successful testing of blockchain technology and smart contracts for managing affirmations and post-trade life cycle processing for over-the-counter (OTC) equity swaps
5	Nasdaq	• Has leveraged Open Assets Protocol - a colored coin innovation that is built leveraging the blockchain • Launched blockchain-enabled solution for enhancing and expanding the equity management capabilities of its Nasdaq Private Market platform

Examples of regulators' and policymakers' focus on blockchain		
#	Regulator / Policymaker	Elaboration
1	European Commission	• New task force, to be overseen by the European Commission, has been created and entrusted with building expertise in blockchain technologies • In 2016, proposed to bring the virtual currency custodian wallet providers and exchange platforms within Fourth Anti-Money Laundering Directive (4AMLD) scope
2	International Monetary Fund (IMF)	• In 2016, issued report that considers the risks and benefits of DLT • Recognizes the challenges in achieving balanced regulatory framework for blockchain applications, which would require extensive international cooperation
3	Financial Conduct Authority (FCA)	• Has begun monitoring blockchain developments. Is examining ways in which DLT can assist in regulatory compliance • Through its Project Innovate, plans to work with firms that are developing DLT solutions. In the UK, inside its Project Innovate, has considered approving a limited number of firms using blockchain technology. In November 2016, it approved nine blockchain-based firms to enter its Regulatory Sandbox Initiative
4	BaFiN	• The German federal financial supervisory authority warned that the lack of a central regulatory authority for DLT can lead to potential Anti-Money Laundering (AML), compliance, and governance issues
5	Sweden's central bank	• In November 2016, initiated an analysis of the possibility of introducing digital currency to supplement the country's cash
6	New York Department of Financial Services (NYDFS)	• Published 'BitLicense' regulations for virtual currency businesses • The regulations are designed to prevent money laundering and to improve cyber security for virtual currency users
7	Swedish authority	• An approach is being tested by Sweden's national land survey for ownership record of physical property • In this, a blockchain-based system for registering and recording the land titles is to be leveraged for digitizing the real estate processes
8	US Federal Reserve	• Working with IBM to develop a new digital payment system that is tied to blockchain

Blockchain: Risk and compliance concerns

While blockchain's transformational potential is immense, its adoption in FS is fraught with myriad risks and compliance concerns.



Blockchain adoption: Risk and compliance concerns

- **Regulatory and governance:**
  There is a lack of regulatory clarity on blockchain. For example, dispute resolution mechanism, responsible regulatory agencies and their coordination mechanism, legal standing of documents / instruments stored on blockchain, liability ownership (of smart contract failures, etc.), definition (whether virtual currency is commodity or money or property), territorial requirements (e.g., on data), and regulatory reporting (e.g., European Market Infrastructure Regulation (EMIR)-related) are the key regulatory aspects upon which FIs need clarity. Even where limited blockchain rules exist such as New York's mandate for cryptocurrency license for firms, these are fragmented or prohibitively expensive.

  Further, there are concerns that existing regulatory frameworks such as privacy laws, EMIR's mandate of use of central counterparty clearing house (CCP), and product intervention powers for regulators (e.g., Markets in Financial Instruments Directive (MiFID) II) may limit the adoption of blockchain. There are also possibilities that the existing blockchain setup may not be fully compliant with the established regulatory mandates, such as client assets sourcebook (CASS) rules, Dodd-Frank, Finra, SEC mandates, 'Right to be forgotten' under European regulation, and EU General Data Protection Regulation (GDPR). AML, consumer protection, Anti-bribery and Corruption (ABC); Combating the Financing of Terrorism (CFT), and tax compliance are the other key regulatory concerns of blockchain. Money services businesses (MSBs) have come under sharp focus. They are increasingly being expected to have appropriate risk-based AML compliance approaches in place and to file their suspicious activity reports (SARs) promptly. Regulators like the European Central Bank (ECB) also fear that over reliance of economic actors on virtual currency may affect central banks' control over money supply.

  There is a lack of common and transparent governance structure for blockchain. Decision making is primarily left to market dynamics. This creates the risks of network and infrastructure failure, and broader financial system instability. Implementing an effective governance structure is a challenge. There are issues regarding who would control and be accountable for the DL system; its users or other parties involved. For example, smart contracts may have multiple parties (contract creators, contract custodians, contracting parties); and governance and liabilities issues can arise when contracting parties do not comply with the contract, or the smart contract has coding / design defects.

- **Privacy and security:**
  By design, information on DLs are available to all of the network participants. In permissionless ledger, counterparties may be able to explore transaction history including those transactions that they are not part of. The cryptocurrency's pseudonymous relation of the users and wallets is not perfectly anonymous. Chains of transactions are visible to all, and could be traced publicly. There is also the possibility that smart contracts accessing the transaction data may leak information on what is being processed. FIs' commercial terms stored in smart contracts are similarly vulnerable to confidentiality breaches.

  In terms of security, blockchain systems lack robust anti-fraud, Know Your Customer (KYC), and AML tools. There are challenges in linking the cryptographic identities to the real world identities. While it might be possible to identify the owner of an address used for money laundering, it would not be possible to block such transactions in advance. Endpoint security is another concern. There are risks of machines being hacked for fraudulent transactions. Sidechains security, weak key generation by certain blockchain programs, double-spending (conducting two transactions, one of which cancels the other), hacked key, distributed denial of service (DDoS)

attacks (which involve rogue wallets pushing a large number of spam transactions to network), and 'consensus hijack' (malicious third parties managing to control over 50 percent of participants) are other key security concerns.

- **Behavioral and transition risk:**
  Most FIs have diverging and competing interests. Hence, there are risks of lack of cooperation / collaboration between the concerned stakeholders (regulators, exchanges, clearing and settlement services, trading firms, trade bodies, banks, etc.). Additionally, there is a risk of private DLs leading to collusion and cartelization, and algorithms being set up in a manner that produces anti-competitive results. If a private blockchain becomes the default network and gets dominated by major players, competition risks may materialize. Further, if there are high barriers to entry on the private blockchain, smaller providers may be at a disadvantage.

  Moving to a new blockchain-based market infrastructure can be operationally very challenging. Integration with existing non-blockchain systems can be extremely complex. FIs would have to worry about replacing and integrating with the legacy systems, including system of record (SoR), customer relationship management (CRM), business intelligence (BI) / analytics, risk and compliance systems, etc. Replacing / retrofitting these systems with blockchain-based systems would involve a major undertaking and can be cost-prohibitive. Further, in the absence of a solution to record fiat currency on blockchain, managing an interoperable cash ledger would be quite challenging. The prevailing lack of mainstream understanding of blockchain and the paucity of required technical manpower only compounds the transition challenges. Any IT disruption, even for a short duration, may prove catastrophic.

- **Counterparty and systemic risk:**
  Currently, there is significantly less trust in the blockchain ecosystem. This increases the possibility of counterparty and systemic risks. There are also counterparty risks in smart contracts that have external obligations. Any promised right that requires someone to do things outside the Ethereum system creates counterparty risk; and with very limited institutional support to help the party get its right.

  Smart contracts also pose systemic risks. When many obligations and rights get tied into complex proposals for smart contracts, (e.g., one smart contract relying on an external smart contract to work) it creates systemic risks. Further, DLT shared ledgers are immutable – transactions cannot be modified, or canceled. This creates challenges on how mistakes can be reversed quickly.

- **Settlement risk:**
  Settlement finality is a legal requirement in post-trade clearing and settlement. However, by design, public blockchains cannot guarantee settlement finality. As a result, under blockchain setup, legal liability can be ambiguous or difficult to assign. This in turn can adversely impact participants' balance sheets and also their creditors and customers rights. Without guaranteed settlement finality, there are risks of insolvency of one participant undoing the transactions that are otherwise deemed settled, creating myriad liquidity and credit issues for the other participants.

  Alternative solutions such as watermarked token or sidechain do not conform to the commercial and regulatory requirements for definitive settlement finality either. Also, in public blockchain systems, miners can potentially remove a transaction from the blockchain history, thereby unmaking a payment already made. Further, mining pools hold complete discretion on the ordering and reordering of transactions' history. This raises settlement risks. Settlement finality becomes even more complicated if both legs of a financial transaction are considered, for example, in a strict delivery versus payment (DvP) contract.

- **Technological risks:**
  Blockchain adoption by FIs are also beset with myriad technological challenges.

Performance

Interoperability

Standardization

#	Technological risks / challenges	Elaboration
1	Performance	• Even as their adoption requires high initial capital costs, many blockchain applications have demonstrated poor scalability, high transaction processing delays, and latency issues, especially where permissionless ledgers are involved • Owing to their very calculation-intensive cryptographic component, many DLs are significantly slower than the conventional databases • There is a risk that blockchain applications designed for sophisticated multi-jurisdictional use cases may not be scalable, optimally functional, secure, and cost-effective • Smart contracts are not fault-tolerant, and there are chances of coding issues. Reviews have found that large numbers of template contracts for Ethereum scripting system contain significant vulnerabilities. Digital currencies have also shown that they are not always crash prone • In the blockchain setup, when major FIs act as full nodes, there is a risk that the DL size may become unmanageable • As smart contracts are created by humans, these are prone to human error. Correcting errors in smart contracts is relatively difficult as these need to be specifically created for updates
2	Interoperability	• Interoperability is crucial to maximize the power of DLs. However, today, there is a lack of consensus on policy and data interoperability • Using different DLs requires data-sharing capabilities. However, currently, the data exchange protocols and formats are not mature enough. Rival blockchain technologies can undermine system interoperability • Owing to difficulty in transposing different consensus protocols, transaction reconciliation between different DLs may be challenging • There are challenges in using wallet software with separate DLs. Currently, most DLs have their own wallet software. Enabling common wallet for various DLs is difficult
3	Standardization	• There is a lack of industry alignment on certain key design points. For example, access requirements for completely open versus permissioned ledgers, interoperability between networks, improvement approaches, and governance processes • Common DL and network protocols and standards are lacking. Users currently have their own mix of technology and back-office system stacks. There is also a lack of standard DLT tools or interfaces. This creates scalability and integration challenges • There is a lack of consensus on effective international standards and versions of blockchain. There is division between myriad approaches, namely, private blockchains (e.g., R3, DAH) and open-ended blockchains (e.g., Ethereum)

Blockchain adoption – Technological risks and challenges

Conclusion

Breaches in FS space in recent times have shown that blockchain technology is not invincible. FinCEN's US$700,000 penalty on Ripple Labs for AML violation, Internal Revenue Service's request for a huge quantity of transaction and user data from Coinbase for taxpayer investigations, and over US$59 million in Ether stolen from Decentralized Autonomous Organization (DAO) are just a few examples. Indeed, in January 2017, the European Union Agency for Network and Information Security (Enisa) warned that FIs rushing to adopt blockchain must make sure that they work on addressing the associated security challenges.

While the foray of FIs into blockchain adoption is certainly a step in the right direction, we believe that a healthy dose of cautious optimism is required. FIs should note that, while blockchain's transformational potential is immense, its adoption and implementation is fraught with myriad risks and challenges. FIs should, therefore, with technology providers' support, strategically, structurally, and diligently navigate through and address these risks and challenges.

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