



BLOCKCHAIN

Opportunities for Private Enterprises in Emerging Markets

Second and Expanded Edition, January 2019

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Chapter 1, *Blockchain in Development—A New Mechanism of ‘Trust’?* has been published previously as Marina Niforos, *Blockchain in Development—Part I: A New Mechanism of ‘Trust’?* EM Compass Note 40, IFC, July 2017.

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Creating Markets, Creating Opportunities

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INTRODUCTION

The World Bank Group has set a goal of Universal Financial Access by 2020, and IFC has a long-standing commitment to financial sector development. The continued digital transformation of financial services is critical to both objectives. Only the reach and efficiency of digital finance can sustainably bank the next billion people. Both existing and newly emerging technologies will be part of this transformation. Mobile networks, cloud-based services, and big-data analytics are already helping to reach thousands of previously unbanked customers with transaction accounts, savings products, and credit. Many emerging markets lack connectivity infrastructure and trusted institutions and counterparties. Distributed ledgers may provide some of the infrastructure these markets need.

This collection attempts to focus attention on the potential of blockchain, and of distributed ledger technology (DLT) more generally, to address some of the economic and financial challenges that emerging markets face today. These challenges are many, and include Know-Your-Customer gaps, the de-risking by global financial institutions that prevents emerging markets from accessing the global financial system, and the costs and inefficiencies of processing remittances through the interlinked ledger system that is today's correspondent banking network infrastructure. Various approaches using distributed ledger technology could provide solutions, as well as a new infrastructure for financial services in emerging markets.

Of the nine chapters that follow, the first six were written in 2017, while the last three are more recent and bring the perspective of more than a year of development in this nascent technology. They also revisit several issues from different perspectives. Chapter 1 provides an overview of blockchain technology, followed by a look at its unfolding applications in emerging markets in Chapter 2. Chapter 3 examines whether blockchain can be used to mitigate de-risking by financial institutions. Chapters 4 and 5 look more closely at the financial services sector, including an overview of how blockchain fits into the spectrum of financial technology (fintech) innovations and the resulting provision of financial services (Chapter 4), and an analysis of blockchain's contribution to reaching the unbanked and

underbanked in various emerging markets, including in Latin America, Asia, and Sub-Saharan Africa (Chapter 5). Chapter 6 looks “beyond fintech” to explore how developments in applied blockchain technology can impact agribusiness, drug safety, and more generally provide enforcement tools to promote the reach of sustainable and inclusive business. Chapter 7 discusses the proper regulatory environment needed to stimulate competition and investment in blockchain technologies in emerging markets and beyond. Chapter 8 examines the potential of blockchain to accelerate the transition to low-carbon energy solutions in these countries. Chapter 9 offers a review of legal issues associated with the use of blockchain and how these can be addressed.

These chapters are a continuation of the initial exploration of this topic. Sound use cases for blockchain beyond cryptocurrencies are yet to be validated at scale. Many of the proposed implementations remove key attributes of distributed ledgers (for example, distributed write capability or absence of intermediaries) in order to integrate blockchains into existing institutional structures and business interactions. Many proofs of concept to date have focused on the question “Can this be done using a blockchain?” rather than “Is blockchain the most efficient and effective way to do this?” Given the present higher cost and slower operation of DLT systems, the benefit of choosing DLT as an operational database may be limited to specific use cases. Gaining traction in those uses will require the cooperation

of those who currently control data or business processes, as well as getting those who currently rely on trusted counterparts to accept alternative governance mechanisms.

As money pours into any new technology, it is important to distinguish hype from reality, and speculative fervor from strategic early-stage investments. Investments made under the “fear of missing out” do not guarantee the longevity of the business model. The continued volatility and decline in value of prominent cryptocurrencies and the corporate governance deficit plaguing some highly visible Initial Coin Offerings has taken some of the air out of the bubble. With that has come the ironic realization that blockchain-enabled business ventures must abide by codes of governance and regulatory compliance if these supposedly trustless systems are to gain the trust of economic participants.

Blockchain’s accelerated investment cycle has fostered intense experimentation and focused attention not only on the mechanics of digital ledgers, transactions, and counterparty connectivity, but also on the need for sound governance. The ongoing grappling with use cases is illuminating the processes underlying counterparty interactions and challenging practitioners to think in new ways about the building blocks of financial intermediation and value, or need for change, in existing institutional structures. Solutions may emerge that leverage distributed ledgers, or that apply this new understanding to create combinations of, or innovations on top of, more standard databases. IFC will continue to monitor developments, looking for the technology to mature. To demonstrate sufficient value to market participants, applications will need to make progress on both the technical and the organizational levels, such that the ecosystem can both leverage and benefit from distributed ledger technology. ■



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EXECUTIVE SUMMARY

Blockchain is an emerging technology that offers the possibility of re-engineering economic models and enabling the creation of markets and products that were previously unavailable or unprofitable across emerging markets.

This report is intended to introduce readers to current developments in distributed ledger technology, or blockchain, with the vantage point of possible benefits to emerging markets. The first six chapters were written a year ago, while the last three are more recent and bring the perspective of a year of development in the nascent technology.

Blockchain is a database ledger that functions like a distributed network. It is often referred to as a *distributed ledger* that can register blocks of cryptographically-secure, tamper-proof data with members of a network. This unique structure offers near-frictionless cooperation between these entities, allowing them to transfer value or information without need of a central authority or intermediary. It has the potential to deliver productivity gains to multiple industries, from the financial services sector to energy markets, supply chains, intellectual property management, the public sector, and beyond.

And blockchain may prove particularly valuable in emerging markets. Yet the technology is in early stages of development and will need to overcome serious challenges and risks, both technical and regulatory, before it achieves widespread adoption. Questions remain about blockchain's scalability, interoperability, security, transition costs, data privacy, and governance.

In such a context of uncertainty, business leaders and policy makers will need to think long and hard about when and under what conditions a blockchain initiative is warranted. Companies—in emerging markets and elsewhere—can neither afford to wait until the outcome is evident nor expose their existing business models to overly risky wholesale blockchain initiatives. Instead, they will need to adopt an experimental approach that allows them to develop

options and thereby learn in the process, inform their strategies, and improve their value propositions.

Blockchain can be used to mitigate de-risking by financial institutions. Such de-risking is a significant challenge to banking in developing economies, as it affects recipients of remittances, businesses that need correspondent banking relationships, and charities working in conflict countries. Blockchain appears to have potential to lower verification costs when offering remittance services, as well as for the provision of trade finance, among other things.

The financial services industry has been an early experimenter on and adopter of blockchain technology. Financial institutions around the world find their business models continually tested by technological innovation. The emergence of innovative digital financial technologies (fintech), including blockchain, is challenging traditional players in the sector by demonstrating new ways to deliver value across the entire financial value chain. And emerging markets may prove to be ideal for the adoption of blockchain-based financial solutions due to their underserved populations, higher banking risks, lower bank penetration and legacy systems, and greater presence of digital financing. The convergence of these factors may provide the basis for a faster adoption of the technology and could result in a technological leapfrog that boosts financial inclusion and growth.

Blockchain can also be used beyond fintech for a more sustainable and inclusive management of global supply chains. Two critical attributes of the blockchain in particular—the reduction of agency costs and auditable traceability—may help to facilitate trade as well as ensure compliance with specific goals regarding sustainability and inclusion. Two supply chains where specific experimentation with

blockchain is taking place are food and agribusiness, and pharmaceutical safety.

Of course, exploiting the benefits of blockchain for emerging market economies will require a proper regulatory environment to stimulate competition and investment—and to allow innovation to flourish. If blockchain-enabled markets are to come to life, regulators and businesses must collaborate to enable a governance framework where they can both experiment and learn, and so shape the future of the technology in a way that benefits all parties and society as a whole.

Blockchain also has enormous potential to accelerate the adoption of clean, affordable, reliable, and resilient energy sources in emerging markets. Investors, policymakers, and regulators need to work together here, too, to promote the development and implementation of blockchain-based solutions that aid the transition to low-carbon energy and achieve a modern, clean energy future in these countries.

Finally, the usage of blockchain presents its own legal issues though several have been identified and overcome before at similar innovative leaps in the recent past, such as the commercialization of the Internet or cloud computing. It is key that enterprises understand any risks inherent in blockchain systems, including being able to identify clearly who is accountable and legally responsible.

Implications for emerging markets

Many emerging markets experienced a reduction of available financial services in recent years as banks and other institutions sought to curb risks and lower compliance costs in the wake of the financial crisis. The economically vulnerable in these countries, as well as organizations that serve them, have suffered considerably from this type of de-risking. Blockchain, through its ability to reduce regulatory costs and increase transparency, can help reverse this trend and broaden access to financial services. It may also

facilitate and decrease the costs of trade finance and remittances, both of which boost growth and improve living standards in poor countries.

Blockchain technology can help individuals establish a digital identity, inexpensively, which is necessary to gain access to the financial system, and to disclose their personal data securely. And it can complement platforms such as mobile banking, which is rapidly growing in the developing world.

While Europe and the United States continue to lead the world in blockchain adoption and innovation, their dominance is now being challenged by Asia—and China in particular—which is rapidly increasing its share of global blockchain venture capital financing. Blockchain-based applications and services are also springing up across Africa and Latin America.

Cognizant of blockchain's substantial potential benefits for their citizens, but also wary of the risks, emerging market governments are taking this technology seriously. Some are even becoming major financial supporters of the technology with the hope of using it to provide their citizens and economies with a technological advantage and a boost to growth. China, for example, has explicitly made blockchain a pillar of its economic development strategy and is pushing regulators and industry to collaborate on emerging standards.

Blockchain is a technology still at a very early stage of development, and there is no shortage of challenges to its adoption and efficient implementation. We are at the beginning of this experiment and the road to maturity is likely to create both winners and losers before sustainable and profitable business models can emerge and full network effects can be seen. Companies and regulators in emerging markets will need to strike a balance between allowing enough space for the innovation ecosystem to flourish, while also effectively managing the associated risks and costs. ■



CHAPTER 1

Blockchain in Development— A New Mechanism of ‘Trust’?

By Marina Niforos

Blockchain is an exciting new technology that may prove to be a radical innovation—similar to technologies such as the steam engine and the Internet that triggered previous industrial revolutions—with the power to disrupt existing economic and business models. It has the potential to deliver productivity gains to multiple industries, from the financial sector to energy markets, supply chains, intellectual property management, “virtual firms”, the public sector, and beyond. Its ability to provide disintermediation, improve transparency, and increase auditability can significantly reduce transaction costs, introduce efficiency into existing value chains, challenge revenue models, and open new markets. And blockchain may prove particularly valuable in emerging market economies. Yet the technology is in its early stages of development and serious challenges and risks, both technical and regulatory, will need to be addressed before it achieves widespread adoption. Questions remain about blockchain’s scalability, interoperability, security, transition costs, data privacy, and governance. And business leaders and policy makers will need to think long and hard about when and under what conditions a blockchain initiative may be warranted.

Blockchain has generated an enormous amount of interest over the last three years, with evangelists for the technology calling it a pillar of the Fourth Industrial Revolution and sceptics dismissing it as an overhyped combination of existing technologies.²

So, what is blockchain?

Confusion persists among the public, businesses, and policymakers as to blockchain’s structure, utility, and applicability—and even its name. The term blockchain is often used interchangeably with the term distributed ledger technology, and the technology is still associated with its first incarnation, bitcoin.

Though it has existed since 2009, blockchain has attracted a new level of interest over the last two years amid growing awareness that it could be exploited beyond digital currencies and used for other types of inter-organizational cooperation and value transfer.

Thanks to its enabling potential for digital proof of identity and costless verification, blockchain could have

a wide range of applications, in the financial sector and beyond. These include peer-to-peer technology, energy markets, supply chain certification and intellectual property management.

OVERVIEW OF DISTRIBUTED LEDGER TECHNOLOGY

Evolution of ledgers: from centralized to distributed

Blockchain introduces a database that functions like a distributed network, hence the term ‘distributed ledger’—with the promise of near friction-free cooperation between members of complex networks that transfer value to each other without central authorities or middlemen.

Blockchain is often referred to as a ‘radical innovation’³ or general-purpose technology (GPT) not unlike the steam engine or the electric motor.⁴ In other words, a

technology that can create “subsequent innovation and productivity gains across multiple industries,” similar to the Internet before it.⁵

Blockchain’s primary value is its ability to deploy cryptographic mechanisms to reach consensus across parties in the ledger. This eliminates the need for a central authority or intermediary, thereby creating a distributed trust system of value transfer.⁶ No single entity can amend past data entries or approve new additions to the ledger (Figure 1).⁷ Eliminating the need for a central trusted party can increase speed, lower transaction costs, and enhance security in the network.

Blockchain first appeared in the form of bitcoin, a peer-to-peer electronic cash system launched by Satoshi Nakamoto in 2009 “based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without any need for a trusted third party.”⁸ Cryptographic proof refers to the cryptographic process of reaching consensus through proof of work eliminating the need for a trusted intermediary. Bitcoin originally had a strong anti-establishment undercurrent, backed by a community of techno-libertarians or crypto-anarchists seeking to establish a currency outside of government control and censorship.

Bitcoin’s commitment to anonymity in transactions unfortunately also opened the platform to illicit activities such as drug trafficking and tarnished its reputation with governments and the public alike. Despite this, the development of bitcoin continued. Its market capitalization is approximately \$42 billion and it is used by millions of people for payments, including a growing remittances market.⁹

Designed to be much more than a payment system, Ethereum was launched in 2014 as an open-source, public, blockchain-based distributed computing platform that provides a ‘crypto-economically-secured’ platform for the development of any kind of decentralized application.¹⁰ Given the extended capabilities it provides to the original bitcoin-oriented technology, it is often called Blockchain 2.0.

Ethereum uses ‘ether,’ a cryptocurrency token to compensate participant nodes for computations performed. Ethereum introduced the possibility of smart contracts, or “deterministic exchange mechanisms controlled by digital means that can carry out the direct transaction of value between untrusted agents.”¹¹ Ethereum’s market capitalization exceeded \$26 billion in July 2017, which is especially noteworthy since it stood at under \$1 billion just six months earlier.¹²

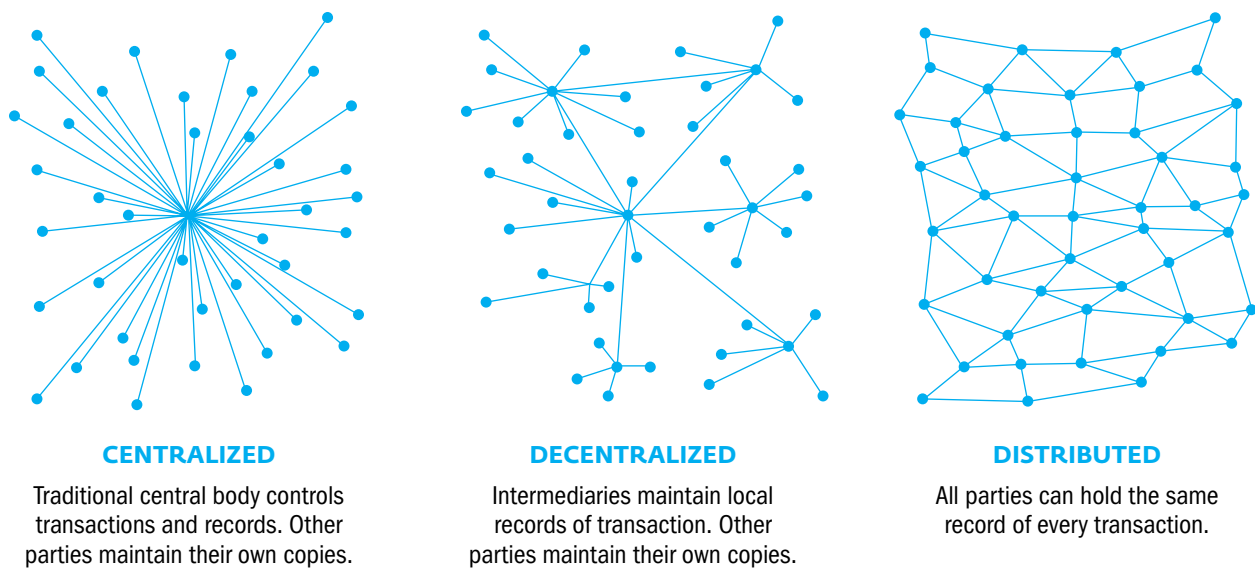


FIGURE 1 Evolution of Ledgers

Source: Paul Baran, *On distributed communications networks*, 1964, and Marina Niforos, 2017.



FINANCIAL	VALUE EXCHANGE	ASSET REGISTRIES	SECURITY
Currency Exchange & Remittances	Network Infrastructure & APIs	Gold & Diamonds	Digital Identity Management
Syndicated Loans	Document Storage & Delivery	Property Titles / Land Records	Authentication & Authorization
Private Shares	Digital Content	Data Storage	Compliance / KYC / AML
Treasury Repos	App Development	Supply Chain Management	Governance & Risk Management
Loyalty Points	Marketplaces	Logistics	Auditing
Interbank Payments	Smart Contracts	IOT	
P2P Transfers			
Insurance			

FIGURE 2 Blockchain Value Chain

Source: *The Blockchain Lab*; theblockchainlab.com

How does blockchain work?

Blockchain is essentially a meta-technology that consists of game theory, cryptography, and mainstream software engineering.¹³ Blockchain protocols verify numbers or programs, time stamp them, and enter them as a block into a continuous chain linked to all previous blocks linked to the original transaction.¹⁴ Assets may be created directly on the network. For example, cryptocurrencies and rights to real world assets can have a digital representation as a token¹⁵ (referred to as “tokenized assets”).¹⁶

A distributed ledger technology, or DLT, network can be either open (permission-less) or private (permissioned). Assets on a DLT network, whether the network is public or private, are cryptographically secured using a public-private key combination. A public key is the “address” where the digital asset is located on the network. A private key is the code that gives the holder access to the asset at the address represented by the corresponding public key. Once a transaction is initiated, it is broadcast on the network to all ‘nodes’, or participating computers,¹⁷ and the nodes acknowledge acceptance of the block by using its hash¹⁸ as an input when working on creating the next block.¹⁹

A cryptographic hash function represents the process by which miners (nodes participating in the computational review process performed on each “block” of data) verify and timestamp transactions. Time stamped records are displayed in a sequential manner (‘blocks in a chain’) to all parties on the network who have the appropriate access levels (Figure 2).²⁰

The time required to verify and record a transaction on the distributed ledger technology network varies depending on the process employed (for example, ‘proof of work’²¹ for bitcoin or ‘proof of stake’²² for Ethereum).

Open versus private distributed ledger technology networks

Open (permission-less) networks are accessible to anyone wishing to join, without restriction on membership. Data stored on these networks is visible to all participants in encrypted format. Digital currency bitcoin is an example. Open distributed ledger technology networks do not have a central authority. Instead, they rely on network participants to verify transactions and record data on the network, based on a certain protocol.

The ‘miners’ participating in the verification process are incentivized to perform computationally complex tasks in exchange for bitcoin rewards (‘tokens’). This consensus-based process (‘proof of work’ in bitcoin) to ensure encryption of the data requires intense computational power, which some qualify as wasteful and restraining to the scalability of the system. However, it is this feature that guarantees the chain’s robust security, making bitcoin more resilient to attacks. On a public blockchain, sensitive data needs to be encrypted to ensure privacy, but encrypted data cannot be used by smart contracts, so there is less flexibility on bitcoin for complex or highly regulated ‘transactions’ (see Challenges below).

By contrast, **private or permissioned networks** cannot access data without prior permission. Permission levels may be tiered, such that different entities and individuals may have varying levels of authority to conduct transactions and view data (as such, they are closer to relational databases currently in use in large corporations). There are ‘trusted’ nodes or system administrators that control access and rights onto the network. They can still have an important effect in reducing transaction costs within the ecosystem of participating entities.

Established companies, particularly those in the financial industry, are gradually adopting private distributed ledgers for internal use, as well as for conducting transactions with trusted partners, attempting to experiment with the new technology while maintaining data confidentiality. This also allows them to comply with regulations, something not possible under the conditions of complete anonymity of open networks.

Noteworthy industry initiatives to pilot private distributed ledger technology in financial services include Digital Asset Holdings, Chain, R3’s Corda (which describes itself as a distributed ledger technology but not a blockchain), and Ripple/ Interledger. Linux Foundation’s HyperLedger Project and Ethereum Enterprise Alliance, while focusing primarily on the financial sector, have a vision to test applications beyond financial services, with HyperLedger already involved in proofs of concept in supply chain provenance initiatives.

BOX 1 Key advantages for Distributed Ledger Technology

Distributed and sustainable. The ledger is shared, updated with every transaction and selectively replicated among participants in near real-time. Privacy is maintained via cryptographic techniques and/or data partitioning techniques to give participants selective visibility into the ledger; both transactions and the identity of transacting parties can be masked. Because it is not owned or controlled by any single organization, the blockchain platform’s continued existence isn’t dependent on any individual entity.

Secure and indelible. Cryptography authenticates and verifies transactions and allows participants to see only the parts of the ledger that are relevant to them. Once conditions are agreed to, participants can’t tamper with a record of the transaction. Errors can only be reversed with new transactions

Transparent and auditable. Participants in a transaction have access to the same records, allowing them to validate transactions and verify identities or ownership without the need for third-party intermediaries. Transactions are time-stamped and can be verified in near real-time.

Orchestrated and flexible. Business rules and smart contracts that execute based on one or more conditions can be built into the platform, helping blockchain business networks to evolve as they mature and support end-to-end business processes and a wide range of activities.

Consensus-based and transactional. All relevant network participants must agree that a transaction is valid. This is achieved by using consensus algorithms. Blockchains establish the conditions under which a transaction or asset exchange can occur.

Source: IBM Institute for Business Value

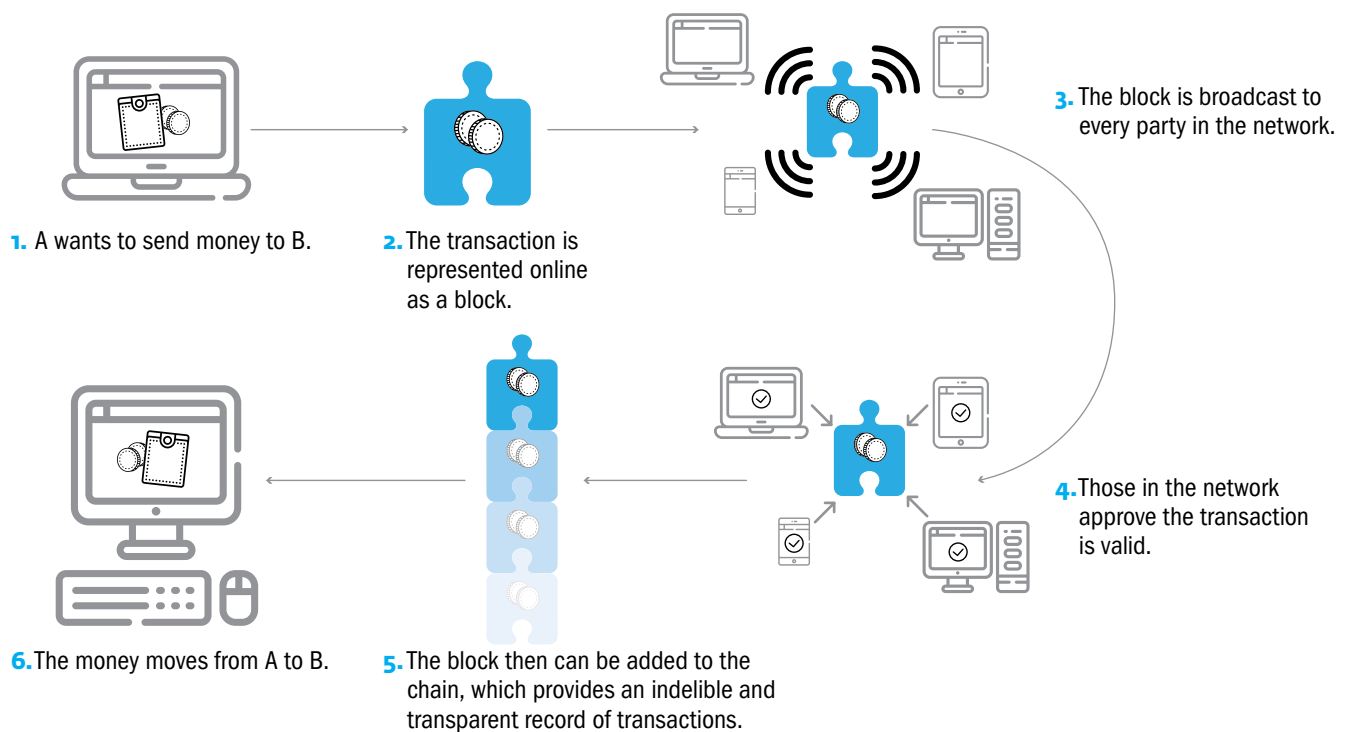


FIGURE 3 How does blockchain work?

Source: *Financial Times*

While private networks are practical and encourage other companies to adopt the technology, they may hinder security, since private blockchains are paradoxically more vulnerable to external attacks. And questions about the interoperability of these coexisting private blockchains may arise in the future.

A heated debate, akin to that of the 1990s Internet versus intranet concepts, surrounds the question of open or private networks relating to improved security, creating new markets, and promoting inclusiveness.²³

However, public or private blockchains are not mutually exclusive. There may also be “partially decentralized” blockchains. In these, the right to read the blockchain may be public, or restricted to the participants, or have hybrid routes that allow members of the public to make a limited number of queries. Additionally, data from a private blockchain can be periodically fingerprinted (hashed) and sent to a public one, which can provide additional auditability.²⁴

The blockchain ecosystem is currently in full experimentation mode, bringing new innovations and hybrid solutions. Consortia are emerging globally to discuss and provide solutions, address governance and industry standard issues, and provide regulatory insights. These include The Ethereum Enterprise Alliance and China Ledger, which are attracting participation from dozens of major industry players, innovators, regulators, and governments.

Enabling a ‘distributed trust’ system through Distributed Ledgers—Economic and business model implications

The innovation of blockchain is capable of transforming the infrastructure of our economic systems, not only financial services, where most of the attention is currently concentrated, but entire global value chains and revenue models. It offers a chance to reimagine industries, rebuild financial processes, and build

markets once considered improbable or unprofitable.

The blockchain provides an infrastructure where trust in transactions is not brokered by intermediaries—as has been the case until now—but is embodied algorithmically in the transaction itself. The algorithmic consensus process is the trust agent. Its effectiveness can be further enhanced if combined with the use of smart contracts and digital compliance (Box 1)

This process of disintermediation and decentralization, coupled with increased transparency and auditability, provides for improved efficiency, speed, and cost reduction (such as in Know-Your-Customer verification). Its immutability provides for a verifiable audit trail of any physical or digital asset.²⁵

Financial Services: Blockchain was first used in the financial services industry, where it has been enabling digital payment systems and remittances as well as testing more complex financial instruments and transactions such as insurance, deposits, lending, capital raising, and investment management.²⁶

Global payments, trade finance, and automated compliance are some of the most active experimentation domains for blockchain today. There have been more than 2,500 blockchain related patent filings and over \$1.4 billion in investments in just three years.²⁷ At least 24 countries are investing in the technology, 50 corporations have joined consortia around it, and 90 banks are in discussions about it worldwide. Deloitte reports that 80 percent of banks will be initiating projects on blockchain by next year.²⁸

Beyond financial services—A potential business and public governance paradigm shift: In principle, any type of asset can be tokenized, tracked, and traded through a blockchain. Blockchain can serve as a registry, inventory system, and transaction platform for recording, tracking, monitoring, and transferring rights to different asset classes, including intellectual property, votes, digital identity, health data, and real estate. Information about the origin of goods, identity credentials, and digital rights can be securely stored and traced with a distributed ledger.

Text Box Although its innovation is in early stages, blockchain use already includes medical record

companies such as MedRec and Pokitdok; digital rights and micropayments innovators such as the Brave browser, Ascribe, and Open Music Initiative; identity companies such as Uport, BitNation, and BanQu; supply chain innovators such as Everledger, Hyperledger, and Provenance; and peer-to-peer renewable energy disruptors such as LO3 Energy and the Sun Exchange.²⁹

Additionally, distributed ledger technology can replace partially or entirely the government’s role as the direct authority in identity authentication, issuing certificates, land titles, storing health records, disseminating social security benefits, and managing votes and civic participation.

“We should think about blockchain as another class of thing like the Internet—a comprehensive information technology with tiered technical levels and multiple classes of applications for any form of asset registry, inventory, and exchange, including every area of finance, economics, and money; hard assets including physical property; and intangible assets such as votes, ideas, reputation, intention, health data, information, etc.”

— MELANIE SWAN, Founder, Institute for Blockchain Studies

“A distributed ledger is essentially an asset database that can be shared across a network of multiple sites, geographies or institutions. All participants within the network can have their own identical copy of the ledger. Any changes to the ledger are reflected in all copies in minutes or seconds.”

— MARK WALPORT, UK Government Chief Science Advisor

“It has math. It has its computer science. It has its cryptography. It has its economics. It has its political and social philosophy.”

— VITALIK BUTERIN, Founder of Ethereum

Estonia is a good example of how blockchain can be used in this way, with the country's blockchain-enabled platform, known as X-Road, used to provide integrated services to citizens across multiple programs. Similarly, the Dubai government recently announced a comprehensive blockchain strategy to help its agencies run more efficiently, with the aim of saving up to 5.5 billion dirhams per year.³⁰

Since it operates without the need for a central authority, distributed ledger technology challenges the assumptions of governance systems that underpin today's business models and economic and political systems, threatening entire professions and even governments. Blockchain has both the economic and organizational potential to reduce costs across global value chains and 'redefine an organization's traditional boundaries,' blurring the lines between private and public, individual and collective.³¹

CONCLUSION

In the real world, the choices for business leaders regarding blockchain will not be clear cut. While the potential of blockchain is immense, so is the uncertainty surrounding it. The technology is not

a complete solution to be applied ubiquitously, but instead is one piece of a well-articulated digital transformation strategy that probably includes artificial intelligence and big data management, among other emerging technologies. Companies need to proceed deliberately but cautiously, in the context of a thorough cost-benefit analysis. There is no magic formula that fits all firms or situations.

Before embarking on a blockchain initiative, organizations need to determine whether blockchain is anchored in their strategy and how it will address existing business problems. They will also need to decide if blockchain can reduce costs and promote market expansion, and determine whether and when to reengineer their business model to stay ahead of the competition.

Decision makers must also measure the potential technical, financial, and reputational risks associated with blockchain implementation, and find ways to hedge against them, for example by limiting the perimeter of the project or starting with middle- or back-office improvements that have no direct customer exposure. Businesses also need to determine the direct and organizational costs of testing and adopting blockchain technology, as it may stress already limited resources. ■

CHAPTER 2

Blockchain in Development—How It Can Impact Emerging Markets

By Marina Niforos

As discussed in Chapter 1 Blockchain is an innovative new technology with the power to disrupt existing economic and business models. Blockchain also has enormous potential for emerging markets. These nations appear poised for a more rapid adoption of blockchain, though a framework is needed to assess how the technology can be deployed and which applications and use cases are likely to be seen in the near future. While the potential of blockchain is great, the technology is still at an early stage of development and will need to overcome potential setbacks—technical, regulatory, and organizational—before it becomes mainstream. In such a context of uncertainty, companies in emerging markets can neither afford to wait until the outcome is evident nor expose their existing business models to overly risky wholesale blockchain initiatives. Instead, they will need to adopt an experimental approach that allows them to develop options and thereby learn in the process, inform their strategies, and improve their value propositions.

Blockchain's full capability is difficult to predict at this early stage in its development. Yet while most of the attention surrounding blockchain has taken place in advanced economies, its greatest potential for decisive impact may lie in emerging market economies.

In 2016 Christian Catalini, Assistant Professor of Technological Innovation, Entrepreneurship, and Strategic Management at MIT's Sloan School of Management, and Joshua Gans, Professor of Strategic Management at the University of Toronto's Rotman School of Management, proposed an economic framework to assess the potential impact of blockchain and its capacity to disrupt the current market by reducing verification and networking costs.³²

Their paper concluded that when blockchain is combined with cryptocurrency, marketplaces can be 'bootstrapped' to function without the use of traditional 'trusted parties' and thereby result in significantly lower networking costs for participants.³³

The paper also finds that open blockchains will likely have the most drastic effect on market structure, challenging the market power of incumbents

and lowering the cost of entry for new entrants.

Nevertheless, given the relatively high costs of the proof of concept, it is likely that most early adoptions of blockchain will take place in the form of (i) value-added applications built on top of existing blockchains such as bitcoin; (ii) private or semi-private blockchains targeting process efficiencies in financial services; or (iii) extensive margin applications enabling new marketplaces.

The coexistence of public and private blockchains is assured, depending on the type of services and the nature of the industry where they are applied. A compelling business case for blockchain can be made in currently neglected or underserved markets, where there is a less competitive market structure and high verification costs.

Use cases that are relatively simple to design and implement, and which are combined with already tested technological solutions such as cryptocurrencies, will likely find early adoption (for example, adding a digital currency payment option for wallets and cross-border payments). Intra-organizational projects intended to reduce organizational complexity and reconcile multiple databases would be another possibility.³⁴

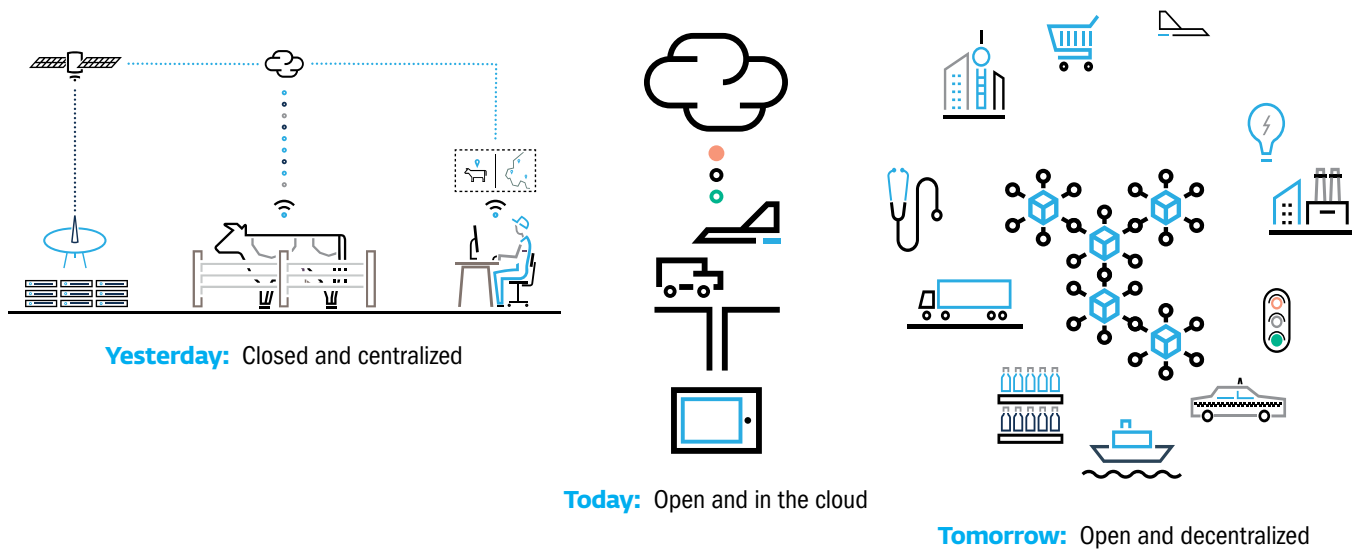


FIGURE 4 Blockchain for Internet of Things

Source: [Hewlett Packard Enterprise](#)

Financial services firms are extending that kind of collaboration to trusted counterparties to reduce costs through private blockchains. Truly disruptive blockchain solutions that depart from existing business practices carry high potential for future growth, but their heightened complexity and need for stakeholder collaboration (such as elaborate financial instruments and smart contracts) will likely delay their adoption.

Building on this hypothesis, emerging markets appear poised for a more rapid adoption of blockchain technology, as they meet many of the conditions listed above, including high verification costs, underserved populations, and in many cases have a relative lack of traditional incumbents with significant market power to impede new entrants.

In financial services, for example, the existing infrastructure is shallow in almost all low-income countries, many of which have also suffered from de-risking in the wake of the financial crisis.

Fortunately, this handicap may accelerate adoption of blockchain, as a lack of financial infrastructure also means less organizational resistance to the new technology and lower transition costs for moving from a legacy to a new system. Consequently, regulators and existing financial institutions in emerging markets have

less incentive to prevent the blockchain revolution, as it does not massively disrupt existing market conditions.

Global payments and trade finance are examples of sectors experiencing a flurry of initiatives from market frontrunners and new entrants alike. Both have high transaction and verification costs that blockchain can reduce by improving the speed, transparency, and process.

Emerging market nations have large population segments that remain underserved in terms of financial and banking services due to the high cost of customer acquisition for traditional financial institutions.

In addition, the extensive use of mobile based services, particularly in Africa and Asia, provides an easy avenue for a blockchain-based system to extend its services. Even in lower income countries, mobile penetration is extremely high, at 83 percent among the 16-to-65 age bracket.³⁵ If blockchain manages to provide proof of concept for a viable business model in payments for mobile banks and other financial players, it would advance the longstanding developmental goal of financial inclusion. Serving previously unprofitable customers and small and medium-sized companies can generate up to \$380 billion in additional revenues.³⁶ So blockchain may provide emerging markets an opportunity to leapfrog traditional technologies, as

happened with mobile technology in many emerging market regions, particularly Sub-Saharan Africa.

Financial services

In the financial services sector blockchain initiatives fall under two main categories.

The first is **process efficiency rationale**, which occurs in countries with established financial market leaders (typical in OECD countries). Blockchain projects in such cases focus on a gradual application of the technology, leveraging process efficiencies in existing business models and utilizing private or semi-private blockchains, either within their organization or through consortia such as R3, Hyperledger, and Digital Asset Holdings.

And the second is **new market creation rationale**, in which new market players target the inefficiencies of existing business models to deliver value in emerging markets. These can be start-up businesses originating from advanced or from emerging market economies, or large non-financial players that see an opportunity in expanding the value chain of a current service. Global payments, or remittances, and digital wallets are examples.

These initiatives tend to flourish in markets with a combination of relative volatility due to political or currency risk, an absence of a strong traditional banking system, large underserved customer segments, a digital or mobile finance culture, and explicit support or tolerance by regulators. In this sector, blockchain initiatives tend to be open networks, backed by a cryptocurrency—usually bitcoin—and tend to be local.

Examples of such start-ups include BitPesa (Kenya), Bitso (Mexico), Remit.ug (Uganda), Satoshi Tango (Argentina), BitSpark (Hong Kong), OkCoin (China), OkLink/Coinsense (India), CoiNnect (Mexico/Argentina), Rebit and Coin.ph (Philippines). There are also large players in this space, including MPesa, a mobile money transfer service launched by telecommunications giant Vodafone in Kenya, and e-commerce companies, including AliPay, a subsidiary of China’s Alibaba.

China is a noteworthy player in this classification, with companies that have a dynamic presence in both segments (start-ups and large established players), with regional coverage across Asia and venture capital investors who have global ambitions beyond emerging markets.

Bridging the institutional gap. The positive effect of blockchain in emerging markets can be not only

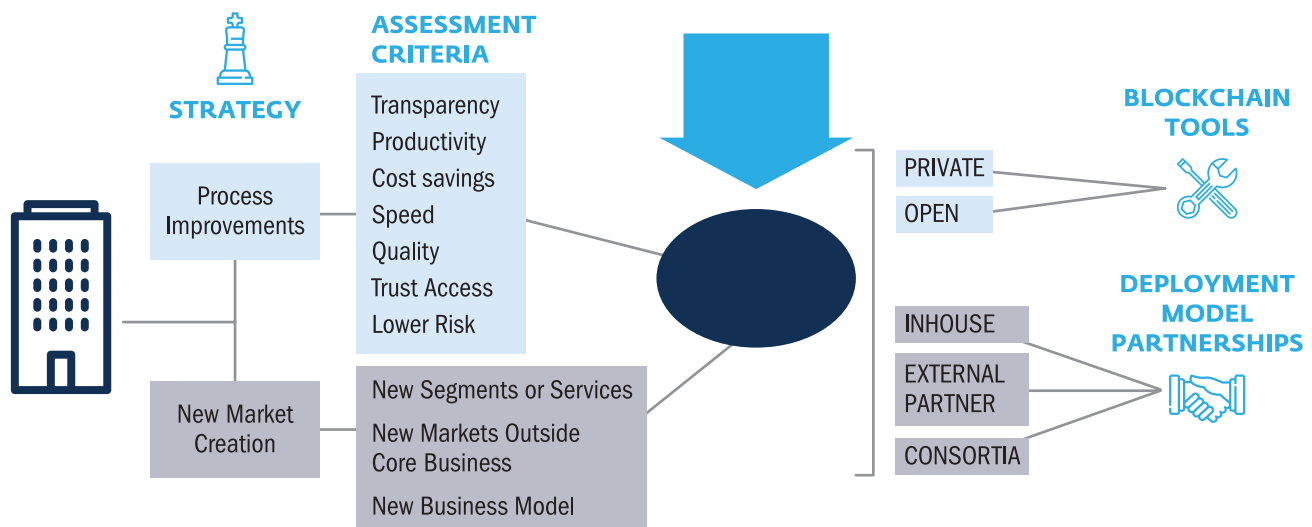


FIGURE 5 Blockchain Strategy Assessment Matrix

Source: Marina Niforos

technological, but also institutional. From a governance and societal perspective, blockchain's features of transparency can also serve to bridge the 'trust deficit' and put pressure on governments to improve services to citizens, forcing them to become more accountable and eliminating the need for decades of institutional development.

For example, in 2016 the Dubai Government established a Global Blockchain Council to assist governments and industry on how to best leverage the technology to improve services to citizens.

Recent developments

Although it is still too early for definitive conclusions, 2016 saw a trend in terms of the flow of capital and investments in the blockchain industry, according to data provided by research firm CB Insights. There were signs that the sector is moving beyond hype and toward an inflection point, with a consolidating interest from large corporates and venture capitalists into more complex financial applications, as well as global diversification:

- Investment into the sector remained flat with respect to 2015 (at \$550 million) but still significant (it stood at \$5 million in 2012), with capital concentrated into fewer deals, signifying perhaps an end to the investment bubble.
- Corporate venture capitalists entered the market dynamically, with investments rising 24 percent in 2016, to \$52 million, a sign that industry is mobilizing seriously around the technology.
- Financial services remained the most active corporate investors, with major banks joining.
- While the United States still dominated the sector with a 54 percent deal market share, its relative proportion diminished as Asia's share increased threefold to 23 percent; Asia emerged as a global venture capital investor in major deals.
- The sector matured with blockchain companies emerging beyond financial services, to the Internet of Things, identity management, and content distribution and supply chain, including Mediachain, BitMark, Filament, SatoshiPay, and Cambridge Blockchain.

Blockchain (r)evolution: What's next?

Distributed ledgers technology is evolving rapidly, driven by internal forces aimed at correcting some of the technology's limitations, with easy-to-use alternatives like Ethereum and other disruptive technologies that are shaping the Fourth Industrial Revolution.³⁷ The combination of these innovative forces, including cognitive computing, robotics, the Internet of Things, and advanced analytics, will combine to create ideal conditions for altering the current economic infrastructure.³⁸

Smart contracts: With the advent of Ethereum, the "smart contract" concept was introduced, embodying a second-generation blockchain platform dissociating the digital representation of assets on the chain from digital currencies such as bitcoin. In addition to the speed and efficiency achieved through distributed ledger technology, smart contracts provide the ability to execute more complex and sophisticated tasks among parties.³⁹

Unlike traditional contracts, smart contracts are embedded in code and can receive information and take actions based on predefined rules. They can be used in numerous scenarios, including the transfer of property titles, settlement of financial derivatives, and royalty payments for artists. The biggest impact is anticipated to be a combination of smart contracts and the Internet of Things.⁴⁰

Internet of Things (IoT): Internet of Things platforms tend to have a centralized model in which a broker or hub controls interactions between devices, an arrangement that can be expensive and impractical. Blockchain can alter that by decentralizing secured and trusted data exchanges and record keeping on IoT platforms, serving as a general ledger that maintains a trusted record of all messages exchanged between smart devices. It thus provides transactional capability for both person-to-person and machine-to-machine transactions in an increasingly interconnected world of multiple, enabled devices such as sensors and smart devices.⁴¹

This transactional capability among intelligent devices can facilitate the emergence of new business models. For instance, devices could also be used as *miners*, earning cryptocurrency rewards for the blockchain verification process. By dedicating computing cycles

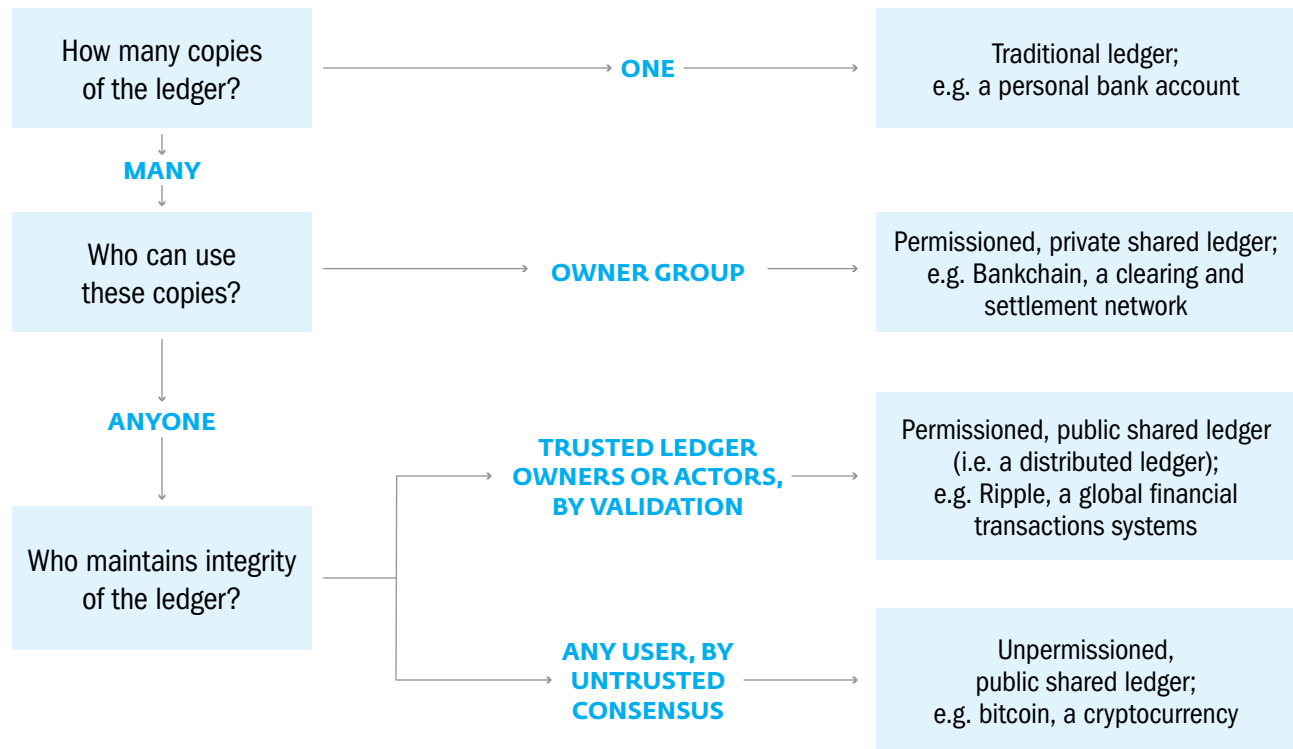


FIGURE 6 Distributed Ledger Taxonomy

Source: [Consult Hyperion](#)

during idle time to securing a digital ledger, a cellular phone plan, for example, could be partially subsidized through its mining chip.⁴²

A blockchain-enabled Internet of Things can be applied to various scenarios, from industry to government, energy, agriculture, health, science, education, and the arts. IBM makes a compelling case in its report, *Device Democracy: Saving the Future of Internet of Things*, in favor of blockchain as the catalyst for rebooting the Internet of Things. It describes blockchain as “the framework for facilitating transaction processing and coordination among interacting devices. ...Devices are empowered to autonomously execute digital contracts allowing them to function as self-maintaining, self-servicing devices.”⁴³

In collaboration with Samsung, IBM revealed a successful proof of concept in 2015, combining the Internet of Things with blockchain to develop the Autonomous Decentralized Peer-to-Peer Telemetry, a distributed IoT network that aims to provide a low-cost, secure way for devices to interact.⁴⁴

Distributed autonomous organizations: Distributed Autonomous Organizations are, in effect, virtual distributed firms. They consist of collections of smart contracts written on the Ethereum blockchain, which together define the corporate governance of the organization without resorting to a traditional vertical managerial structure.⁴⁵

Taken collectively, smart contracts amount to a series of bylaws and other founding documents that determine how an organization’s constituency—including anyone around the world who possesses DAO tokens bought with ethers—votes on decisions, allocates resources and, in theory, create a wide-range of possible returns.⁴⁶ Decisions are made through collective voting.

The decentralized nature of a Distributed Autonomous Organization’s “management structure” is revolutionary, striking at the heart of traditional hierarchical organizational models, the firms that have been the foundation of our economic system since the First Industrial Revolution. Blockchain technology

blurs the lines between the market and the firm since it creates a more efficient way to manage the high transaction costs of economic coordination.⁴⁷

The emergence of network-centered models based on blockchain technology can challenge the preeminence of existing digital platform giants and provide the underlying framework for a shared economy and reconfigured economic activity.

Potential setbacks

Despite the enormous potential that blockchain technology presents, technical, organizational, and regulatory challenges remain that stand in the way of its widespread adoption.

Can the network grow? The consensus based nature of blockchain validation mechanisms requires significant computational power and can delay transaction speed as the demand for data storage increases. This poses a serious technical obstacle to the scalability of the blockchain system and to attaining economies of scale.

Is it secure? The 2016 cyber-attacks on Distributed Autonomous Organizations, the result of a vulnerability of smart contracts, highlights cybersecurity as a concern for blockchain and indicates that the technology has not yet reached its maturity.

Can different blockchains work together? In order to benefit from a distributed system, the establishment of industrywide collaboration and common standards for interoperability is critical. However, the technology is still in its pilot phase and a certain period of prototyping will be necessary before industry standards emerge, suggesting that industrywide standards are not likely in the near term.

In the financial services sector, consortia initiatives are currently underway to provide space for coordination among stakeholders, such as Fabric by Hyperledger and R3 Corda.

Is data privacy guaranteed? Several ambiguities and concerns remain unresolved concerning data protection in the context of blockchain applications, including choice of applicable law and jurisdiction, right-to-be-forgotten inapplicability, and the availability of data to all parties. On the last issue, there are concerns regarding the vulnerability of personal data that could

potentially be cross referenced and deciphered, despite the ‘anonymity’ on the blockchain.

Can regulation adapt quickly enough? This is arguably the most important hurdle preventing rapid adoption of blockchain. The existing regulatory framework has not been able to keep up with the rapid pace of digital innovation. Unclear or hostile regulations and a lack of government recognition of digital assets can deter the onboarding of any new technology, including blockchain.

For distributed ledgers technology to be accepted in the financial services industry, it will need to comply with existing Know Your Customer/Anti Money Laundering regulations. Some countries, including the United Kingdom, China, and Singapore, have taken a hands-on approach to understanding the new regulatory needs, appointing special task forces to advise the government on its strategy or forming public-private partnerships, while others have adopted an arm’s-length approach, awaiting developments from the industry.

What is it going to cost? Another critical challenge is the potentially high costs, both financial and organizational, associated with the implementation of blockchain technology, even for a pilot phase. Companies need to weigh the potential but uncertain benefits that may result from the adoption of blockchain against the present and real costs of testing use cases. These costs include issues of integration with legacy systems as well as the limited a pool of qualified human capital needed to bring a blockchain project to fruition. Firms in the financial sector are forming consortia with a view to mutualize costs so that the blockchain infrastructure can serve as an interoperable industry utility, yet issues of alignment and conflicts of interest among the various players remain.

These roadblocks, while not insurmountable, indicate that blockchain most likely will not have an immediate disruptive effect across industries. Adoption is likely to be gradual over the next five to ten years, and widespread onboarding will be necessary to attain full economies of scale and leverage the full network effects.⁴⁸ The financial services sector is the first to mobilize in a concerted manner, as they are currently investing and are adopting a try, learn, and adapt approach.

CONCLUSION

On the road to blockchain implementation, two important risks should not be underestimated. First is the legislative and regulatory environment and how it may affect distributed ledger technologies in the jurisdictions in question, including compliance and data privacy. Second is an organization's capacity for change and the talent pool available for dealing with the shift in the operations and culture of the organization.⁴⁹

The decision-making process needs to originate in the company's value proposition and its strategic vision and direction, moving to an analysis of how blockchain is affecting that space and how it could provide improvements in the company's value proposition, or even create new markets for the business.

A review of key assessment criteria should link any investments to the value proposition, and should focus on providing business partners and customers with improvements in speed, convenience, and control over the product or service involved. Depending on the complexity of the process and the degree of trust

required by participants and compliance requirements, firms will decide what blockchain tools to deploy (choice or private, semi-private or open networks) and whether they will be better served by developing the project in collaboration with external partners.

This process should lead to the selection of one or two pilots to render quick wins, to learn from the experience, and to provide informed feedback on how to adjust longer-term efforts. Whatever their choice and degree of involvement, companies must seriously consider the far-reaching implications of blockchain by conducting their own research to determine how it may impact their market and future value proposition, and then plan accordingly.

In doing so, companies will need to strike a balance between developing internal competencies and experimenting, while effectively managing potential risks and costs. To hedge exposure to risk, they may wish to pursue partnerships with industry peers and start-ups to mutualize costs of infrastructure building, as well as consider the regulatory threats and anticipate the governance complexity of consortia. ■

CHAPTER 3

Can Blockchain Technology Address De-Risking in Emerging Markets?

By Vijaya Ramachandran and Thomas Rehermann

Blockchain, or distributed ledger technology, has the potential to address many problems in emerging markets. In this note we consider whether blockchain can be used to mitigate the problem of de-risking by financial institutions, which affects receivers of remittances, businesses that need correspondent banking relationships, and charities working in conflict countries. Blockchain is an evolving technology, and understanding its scope and limitations will be critical to employing it to address these and related issues.

At its simplest, blockchain is an online database for the exchange of information that takes place on a digital network to form a secure, transparent, and easy-to-use platform. This technology can be used to send money between countries, verify land ownership, share electricity across grids, and reduce the cost to banks of verifying customers and transactions.

Blockchain allows data to be stored securely and accessed by multiple users without recourse to a trusted third party such as a bank. Instead, a network of users verifies and stores the information.

What is blockchain or distributed ledger technology?

The term ‘blockchain’ refers to the way that data are stored. Transactions are recorded in time-stamped “blocks” and each block is connected to previous blocks, forming a chain of transactions. This chain is stored by all users on a network; every time a new block is verified and added, the entire chain is updated simultaneously across users.

Currently, when buying, selling, or verifying the ownership of an asset, individuals must rely on institutions such as banks, credit card companies, or governments. Blockchain technology provides an alternative to that method by making use of cryptography and computer code to generate the trust that would otherwise be provided by an institution.

Blockchain is a shared digital ledger

Let us now consider a more technical definition. A ledger is a book or computer file that records transactions. Blockchain technology is a **shared digital ledger** wherein transactions can be **recorded and verified** without recourse to a central authority to oversee the transaction.

Shared: Traditionally, computing services run on centralized networks in which a central server distributes information to computers (clients) on a network. A digital ledger is different—it is replicated and distributed across nodes—several computers around the world that compete to verify transactions in a peer-to-peer network—where information is shared by all parties engaged with the transaction.

Unlike a centralized network where there is one hub or server and every other node is a client, blockchain has smaller mini-hubs where a peer-to-peer network, consisting of equal peer nodes, functions as both client and server. Each peer on the blockchain provides computing power and stores a replicated version of the ledger, thereby creating consensus and sharing the responsibility of governance.

Recorded and verified: Transactions on the blockchain are confirmed by all participants on the network, and once they are recorded they become secure from revision and tampering. Banks spend significant resources to reconcile records with counterparties.

By contrast, blockchain technology updates and stores information in real time, and has the potential to vastly reduce the costs of reconciliation.

The problem of de-risking in the financial sector

De-risking is a common response to regulations related to anti-money laundering or combating the financing of terror (AML/CFT).⁵⁰ Although financial crimes such as money laundering, terrorism financing, and tax evasion are serious offenses which may have negative repercussions for both wealthy and poor nations, anti-money laundering regulations intended to counter these types of financial crimes may sometimes serve to hinder capital flows, especially to individuals in poorer countries. They may also reduce the transparency of financial flows.

Tougher banking regulations require banks to assess the risks of doing business in countries with weak anti-money laundering regimes or customers who might be engaged in illicit activity. Failure to do so could cost banks heavy penalties. However, regulatory guidance on how to manage these risks is often vague and contradictory. As a result, to reduce their own risks banks have become more conservative and less discretionary when evaluating customers.

Available evidence suggests that some banks are denying services to firms, market segments, and entire countries that appear to have higher risk and lower profit, and that could cause costly future fines or legal issues. In short, banks are engaging in de-risking entire segments of customers rather than judging the risk levels of clients on a discretionary basis.⁵¹

Who loses from de-risking?

The poor and economically vulnerable—and organizations that serve them—stand to lose the most from this type of de-risking. They include:

- Migrants who remit money across borders to their families and therefore require a healthy money transfer sector. Money transfer organizations that are denied services by banks are often forced to use services that carry higher transactional fees or that are based in less transparent jurisdictions.

In 2013, Barclays Bank informed over 140 United Kingdom-based remittance companies that their accounts would be closed. Following this and similar de-banking episodes in the United States and Australia, only larger money transfer organizations have had access to bank accounts. Reports from industry associations indicate that several smaller players in the money service sector have had to close, become agents of larger businesses, or even disguise the true nature of their operations in order to obtain or keep a bank account. De-banking of money service businesses can impact global remittances, a vital source of finance for poorer countries that totals some \$440 billion a year—over three times the amount of foreign aid disbursed.

- Nongovernmental organizations (NGOs) delivering humanitarian assistance to vulnerable individuals in post-disaster or conflict situations. These organizations are affected by de-risking because they can fall outside of a bank's narrowed risk appetite.
- Small to medium-sized firms in poor countries. Their ability to apply for credit often depends on the rating of local banks vis-a-vis larger international financial institutions and the global financial system. Rich-country banks increasingly report withdrawing correspondent banking services from banks in high-risk jurisdictions, including those in poor countries.

How can blockchain help?

Blockchain technology can help with de-risking by reducing regulatory compliance costs while increasing the transparency of transactions. In particular, blockchain has the potential to reduce compliance costs associated with “Know Your Customer” requirements.

Lower customer verification costs and greater transparency can mitigate de-risking by financial institutions while also benefiting senders and recipients of remittances, businesses needing trade finance, and charities operating in conflict areas.⁵²

Financial institutions dedicate a significant amount of resources to complying with Know Your Customer requirements. They must meet these requirements when taking on a new customer even if the customer's

identity and credentials have already been verified by another financial institution. A Thompson Reuters survey found that Know Your Customer costs are, on average, \$60 million per year for financial institutions.⁵³ Some institutions spend up to \$500 million a year on procedures to verify customers that can take several months.

Blockchain has the potential to improve this situation. As discussed earlier, each block of information contains a record of valid transactions with time stamps, and carries the history of all transactions on the network by including a reference to the previous block. And while the blockchain can replace a centralized authority or trusted third party, its multiple users can also ensure that any data stored is extremely difficult to change or tamper with. This feature, combined with biometric identification or Know Your Customer utilities, can be an effective, inexpensive way to verify customers and their transactions.

Blockchain is not a perfect technology; nor is it impervious to hackers. While it enables the protection of confidential information, the level of anonymity it allows can be problematic, leaving it open for bad actors to conceal their identities and making the tracking of individual payments difficult.

Yet blockchain could also bolster anti-money laundering efforts, according to the Bipartisan Policy Center. “Blockchain could give banks and regulators access to far more detailed transactional and cross-institutional data than is currently available, allowing them to peer deeper into financial networks to identify bad actors. Furthermore, the distributed nature of blockchain technology makes it difficult for criminals to falsify transactional data to cover their tracks. All of this could take place in real-time, giving law enforcement the precious time they need to identify terrorist plots before they happen. However, this additional speed would need to be balanced against privacy concerns that could arise depending on how such a system were implemented.”⁵⁴

Given the technology’s enormous potential, regulators should fully explore how blockchain can improve the current anti-money laundering system. There should also be room for experimentation. For example, the UK Financial Conduct Authority’s Project Innovate has

created a “regulatory sandbox”⁵⁵ to allow institutions to test new products and services.⁵⁶ A new report from the United Nations Economic Commission on Latin America and the Caribbean argues that, with the appropriate enabling environment, there are blockchain-based solutions that might be used to address the problem of de-risking in Caribbean countries.⁵⁷

The use of blockchain for remittances

Blockchain might also be used to conduct transactions between two fiat currencies. A local currency can be converted to bitcoin and transferred between customers across countries in a manner that is cheaper and more secure than traditional methods of sending and receiving remittances.

Seamus Cantillon of Marino Software Insights argues that blockchain combined with biometric ID can lower Know Your Customer costs. He outlines six steps by which financial institutions can identify customers and/or transactions:⁵⁸

1. A customer is onboarded to the blockchain
2. A customer’s personal information, Know Your Customer documents and biometric data is added to the blockchain with appropriate encryption
3. A customer’s biometric data along with a PIN would act as a key for transactions
4. A customer’s transaction is recorded and validated by a consensus algorithm on the peer-to-peer network
5. With customer authorization, a financial institution can access a customer’s record for verification
6. Further changes to the record would be validated by the network

Cantillon paints an optimistic picture, yet there are concerns about storing personal identification information on a blockchain. Nonetheless, blockchain-based businesses are emerging, including Kenya’s BitPesa, a remittance service that allows customers to send money across countries using the cryptocurrency bitcoin.

Customers can send money in a fiat currency (such as Kenyan shillings) to BitPesa, which converts it to bitcoin and transfers it to designated mobile money accounts, to then be converted back into another fiat currency. BitPesa charges a 3 percent remittance fee

for this service. By contrast, BitPesa’s main competitor M-Pesa charges fees up to 30 percent for registered users and 66 percent for unregistered users. BitPesa’s website says that it can now transfer money from Nigeria, Tanzania, and Uganda to any bank in China.

BitBond, a German firm that offers peer-to-peer loans using bitcoin blockchain, announced that it is teaming up with BitPesa to provide financing for small businesses in Kenya, Nigeria, Uganda, and Tanzania. New borrowers can have financing from BitBond paid into a local currency mobile money account or bank account in as little as 20 minutes.

The use of blockchain for trade finance

While many financial institutions are embracing blockchain, others remain skeptical. Some are opposed to making large investments in a technology that they argue may not be profitable.⁵⁹ Others are making significant investments in building blockchain-based networks. Hyperledger, an open source collaborative effort created to advance cross-industry blockchain technologies, is an example. Hosted by The Linux Foundation, it includes ABN-AMRO, ANZ Bank, Deutsche Borse Group, BNP Paribas, BNY Mellon, State Street Bank, Wells Fargo, and other financial institutions.

In October 2016 the Commonwealth Bank of Australia, Wells Fargo, and international cotton producer Brighann Cotton announced the first global trade transaction between two independent banks combining blockchain with smart contracts and the Internet of Things. The transaction involved financing a shipment of cotton from Texas, in the United States, to Qingdao, China, using a distributed ledger algorithm known as the Skuchain’s Brackets system.

According to the Commonwealth Bank’s press release, this trade “involved an open account transaction, mirroring a letter of credit, executed through a collaborative workflow on a private distributed ledger between the seller (Brighann Cotton US); the buyer (Brighann Cotton Marketing Australia) and their respective banks (Wells Fargo and Commonwealth Bank).”⁶⁰

The parties involved in this transaction introduced a physical supply-chain trigger to confirm the geographic location of goods in transit before a notification was sent to allow for release of payment. This tracking

Category	Traditional process	Blockchain, Internet of Things, and Smart Contracts
TRANSPARENCY: All supply chain partners update data in real time within one system	No	YES
COST EFFICIENCY: No physical documents or transportation. No risk of duplication or loss.	No	YES
CUSTOMIZABLE: Tailored, individual insurance policies.	No	YES
CONVENIENT: All parties work off same ledger, all online and instant	No	YES
SECURE: Verifiable and immutable data to reduce fraud risk	No	YES

TABLE 1 Traditional process vs blockchain proof of concept

Source: [Commonwealth Bank of Australia](#)

feature provided all parties with greater certainty compared with traditional open account and trade instruments such as letters of credit, which focus on documents and data.⁶¹

According to the Commonwealth Bank, the use of blockchain technology created transparency between buyer and seller, a higher level of security, and the ability to track a shipment in real time. Advancing from paper ledgers and manual processes to electronic tracking on a distributed ledger reduced errors and transaction times from several days to a few minutes.

Commonwealth Bank and Wells Fargo indicate that they will continue to collaborate with trade finance clients, financial institutions, fintech companies and consortiums, and businesses in the insurance and shipping industries to explore the potential of distributed ledger technology. Table 1 above shows a schematic of costs and benefits of traditional processes versus blockchain, as seen from the perspective of the two banks.

Barclays Bank provides an additional example. In 2016 it enlisted Wave, an Israel-based fintech, to develop a blockchain-based system for settling trades. A letter

of credit was generated between Seychelles Trading Company, a food distributor, and Ornuu, an Irish agriculture co-operative, through Wave’s blockchain platform, guaranteeing the shipment of dairy products worth nearly \$100,000 from the Seychelles to Ireland. The transaction was settled using smart contracts.⁶²

Traditional trade finance requires an enormous amount of paperwork—in bills of lading, insurance certificates, certificates of origin, letters of credit, bills of exchange, and invoices—to transport goods around the world (see Figure 7 below for an example of a traditional transaction between institutions located in Tanzania and Germany).

The most inefficient step, according to Jeremy Wilson, vice-chairman of corporate banking at Barclay’s Bank, is the bill of lading, which he notes “can take weeks to get to the other side of the planet.”⁶³ A standard bill of lading (of which there are over 12 common types), includes the description of goods, quantity, weight, freight details, port of loading and discharge, final destination, shipper name, and so on. If issued incorrectly, the forwarder could lose the shipment.

A blockchain system allows individuals to undertake instant and transparent global transactions, and quickly correct documentation errors, while avoiding delays for the importer receiving the original bill of lading.

Many banks are considering the potential of blockchain technology. Natixis, HSBC, KBC, Société Générale, UniCredit, Rabobank, and Deutsche Bank have signed a memorandum of understanding to develop a Digital Trade Chain, a new product based on a prototype tool that allows cross-border trade for small businesses using blockchain.⁶⁴ Alfa Bank and S7 Airlines have also tested blockchain technology by recording a letter of credit on a blockchain platform and settling the transaction using a smart contract.⁶⁵

Although examples of NGOs using blockchain to transfer money are not readily available, it is not difficult to see the potential of a platform such as BitPesa. There remains, however, the problem of ensuring transparency when the cryptocurrency is converted to fiat currency. But in the interim there is scope for business-to-business transactions in the NGO sector. Blockchain-based applications are currently being tested by NGOs for purposes other than financial transactions.



TRADE FINANCE

FIGURE 7 Traditional Model of Trade Finance

Source: IFC

Can blockchain be truly transformational?

Blockchain and distributed ledger technology have tremendous potential in various sectors. There are several examples of blockchain technology being used in the electricity sector, including a startup called Grid Singularity, which explores “pay as you go” solar power with financial transactions recorded on a blockchain.

It is still too early to tell if blockchain will become a widely used technology. Marco Iansiti and Karim Lakhani at Harvard Business School argue that blockchain is a foundational technology, similar to TCP/IP technology that was introduced in 1972 and powers the Internet as we know it today.⁶⁶ They argue that “single use” applications that are low in novelty and complexity, such as payments made with bitcoin or blockchain-based Know Your Customer credentials, are already appearing in the financial sector and will likely spread across at least some parts of the sector. Innovation that is quite novel but needs only a few users—such as private distributed ledgers or peer-to-peer networks—appears to be underway. As discussed above, some banks are testing blockchain technology as

a new way to process transactions in trade finance and cross border settlements.

But other applications, such as self-executing smart contracts, may take a while—perhaps decades—to gain wide use. Iansiti and Lakhani caution that as the scale and impact of blockchain transactions increase, adoption of the technology will require significant institutional change and will pose very real challenges to governments, regulators, and financial institutions.

CONCLUSION

Blockchain is an exciting new technology that has the potential to reduce the costs of verifying customer transactions, thereby widening access to financial services in emerging markets. The examples discussed in this note describe significant changes in the way transactions are made and recorded. It is likely that the major players in the financial sector will continue to make investments in blockchain technology. We do not yet know whether blockchain will become a technology that is widely used. At the very least, this will take time and will involve significant changes to the regulatory regimes and institutions that govern economic activity. ■

CHAPTER 4

Blockchain in Financial Services in Emerging Markets—Current Trends

By Marina Niforos

Financial institutions around the world find themselves continually barraged by external innovations they are often unable to absorb and internalize. The emergence of innovative digital financial technologies has challenged traditional players in the sector by demonstrating new ways to deliver value across the entire financial value chain. Blockchain, or distributed ledger technology, is just such a disruptive—and possibly game-changing—innovation.

Emerging markets are in general characterized by low banking penetration, the exit of financial players from certain markets, strong demand for financial inclusion both from individual consumers and small businesses, high levels of mobile penetration, and less developed business infrastructure and financial sector incumbents. These conditions in combination can be a powerful catalyst for the adoption of blockchain-based financial solutions and can provide the basis for a technological leap forward and a boost to financial inclusion and growth.

Blockchain, or distributed ledger technology, is a digital, distributed, immutable transaction ledger that replaces a central authority (or ‘middleman’) with algorithms. By doing so it offers numerous opportunities for cost savings while opening new market segments for existing financial institutions and new players alike.⁶⁷

Distributed ledger technology is still in an early stage of development and deployment, yet it is widely thought to have the potential to deliver a new wave of innovation to the financial technology, or fintech, ecosystem by providing a ‘trustless’ distributed system to exchange value.

This does not mean that the new system is not trustworthy. Instead, blockchain’s unique technology eliminates the need for ‘trusted’ intermediary to guarantee the authenticity of and register a transaction, and thus could have the same transformative impact for the transfer of value that the Internet had for the transfer of information. As described by the World Economic Forum, it is the future “beating heart” of

the financial sector.⁶⁸ (See Figure 8 for Blockchain basic functionalities).

Bitcoin, a cryptocurrency that emerged in 2009, provided the first widespread use of blockchain. Since then, the technology has been synonymous with digital currencies. Yet the early abuse of bitcoin by criminal enterprises may have hindered the development of blockchain. Many other digital currencies have since emerged, including ether, the crypto-currency token used on the Ethereum distributed applications platform, the closest challenger to Bitcoin.

Today a number of experiments are taking place in the financial industry that attempt to broaden the use of blockchain beyond its use as a digital fiat. These range from relatively straightforward solutions such as money transfers, to more complex financial instruments enabled by the introduction of ethereum and smart contracts, such as trade clearance and settlement.

Based on research conducted by Catalini and Gans (2016), EMCompass Notes 40 and 41⁶⁹ detailed a conceptual framework that assesses the evolution of

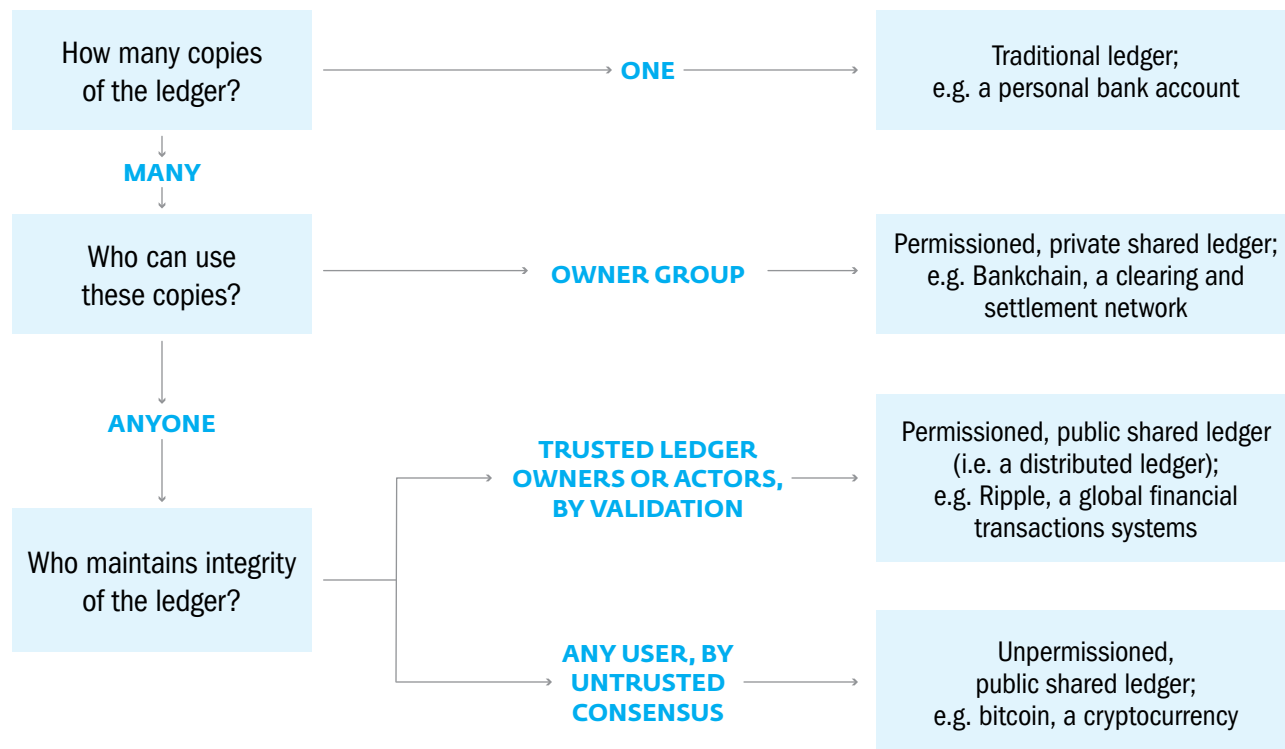


FIGURE 8 Blockchain basics

Source: *Consult Hyperion*

blockchain adoption across markets based on (i) the market power of incumbents; and, (ii) the complexity and associated costs of the solutions proposed. It predicts that future developments will be propelled by the drive to create new markets, where competition and barriers to entry are lower, or to target process efficiencies in existing operations, where current players maintain considerable market power. Additionally, value-added applications built on top of existing blockchain functionalities would be the early use cases of blockchain by financial institutions, according to the research.²⁰

The framework also makes supports the idea that blockchain technology could have a strong impact in markets currently neglected or underserved by financial institutions, with a less competitive market structure and high verification costs. These conditions are typical in emerging markets.

Current developments show that use cases that are relatively simple to design and implement are appearing. For instance, digital wallet AliPay is adding a bitcoin option for its customers. Visa has partnered

with blockchain company Chain to build Visa B2B Connect, an enterprise blockchain infrastructure to facilitate international financial transactions for their corporate clients.

Established financial institutions are more likely to use blockchain for intra-organizational projects intended to reduce organizational complexity, improve efficiency, and reduce costs. Banks and major financial institutions are working both collaboratively and independently to develop blockchain technology, as seen in the proliferation of global consortia (see below).

Emerging markets, despite getting a later start on blockchain than the United States and Western Europe, have been catching up, with strong performances in 2016–17, in particular by Asia (see EMCompass Note 44). And governments and regulators are taking notice, and trying to fashion appropriate responses.

In India, the legalization of bitcoin is a hotly-contested policy issue between the Ministry of Finance, which would like to tax it, and the Reserve Bank of India,

which has declared bitcoin illegal and in breach of anti-money laundering provisions.⁷¹ The Indian situation is an example of how distributed ledger technology has the power to act as a disrupter, but also as an enabler to market players, changing business models and influencing the governance of the global financial system.

Recent venture capital developments also indicate that the financial industry is mobilizing around the potential impact of blockchain on their business, and is beginning to invest in related research and development and is testing applications.⁷² Investment in blockchain is gaining momentum, with approximately \$1 billion of venture capital investment over the last 24 months (\$500 million in 50 venture capital deals in 2016 alone) and the trend is expected to grow rapidly.

A 2017 McKinsey survey found that the global banking industry is expected to spend \$400 million on blockchain related projects by 2019. Some 70 percent of financial organizations are in the early stages of experimentation with the technology and most executives expect to see material impact in mainstreaming it in the next five years. A first rough estimate of limited applications, driven mostly from a cost reduction perspective, suggests significant value creation on the order of \$70 to \$85 billion.⁷³

This note seeks to: examine current macro trends of the blockchain ecosystem in the financial services industry and areas where the technology is being actively tested; analyze the implications of the technology on business models; and identify use cases with the most dynamic uptake, from the perspectives of both efficiency in existing processes, and of market creation.

EMCompass Note 44 will provide a brief overview of specific regional developments in emerging markets with regard to blockchain.

Potential Impact of blockchain on the financial services sector—Current developments and trends

The drive for efficiency in existing businesses. Most of the attention surrounding blockchain has centered on the United States and Western European countries, particularly on the financial services industry, where the technology is expected to have a major impact due to its ability to reduce transaction costs.

As a result, blockchain innovation has been closely linked to the efforts of large financial institutions that focus on process efficiency initiatives. These firms have started testing distributed ledger technology solutions to address specific problems or improvements in their business processes, including data reconciliation, clearance, settlement, regulatory compliance, and entry into new segments or markets.⁷⁴

Consistent with the conceptual framework mentioned above, major global banks and financial intermediaries are working closely with blockchain companies to explore use cases that are relevant to their business and learn how the new technology may impact their legacy systems and infrastructure. They are also entering into consortia (some more than one) to mutualize development and potential transition costs, as well as race to establish standards for the emerging technology.

Most corporate initiatives so far have taken the form of enterprise or permissioned (private) blockchains, as companies attempt to manage a trade-off between leveraging the new but still unproven innovation and preserving the integrity of their existing business concerns. Post-Trade Distributed Ledger Group brings together global banks, custodians, central securities depositories, clearing houses, exchanges, regulators, government agencies, and central banks from all continents to share information and ideas about how distributed ledger technologies can transform the post-trade landscape.

The newly launched (February 2017) Enterprise Ethereum Alliance (EEA) aims to leverage large corporate investments in the private Ethereum blockchain, bringing together Fortune 500 companies, startups, and other stakeholders.

Interest in comparing alternatives to blockchain is also great, evidenced by broad industry participation to the R3 consortium, an alternative distributed consensus ledger.⁷⁵ This group has grown to include more than 70 global banks, despite the highly publicized departures by Goldman Sachs and Santander in 2016, which reportedly were due to governance conflicts. Corda, its underlying protocol, is technically more of a messaging protocol. Ripple, which offers a blockchain-like technology and network for faster settlement of international payments, has more than 75 banking clients globally.

In addition, financial services firms have also entered the blockchain space as investors, with corporate venture capitalists becoming the most active investors in bitcoin and blockchain technology in 2016–17.

Create new markets. On the other end of the spectrum, blockchain is a disruptive technology that offers the possibility of reengineering economic models and enabling the development of markets and products that were previously unavailable or unprofitable.

A great number of these new market opportunities that distributed ledger technology makes possible are related to: (i) its offer of an alternative to fiat money, addressing in a new manner challenges of currency instability and political risk and, (ii) its ability to establish a digital identity in a rapid and cost-effective manner and thereby allow the financial inclusion of previously underserved consumer segments.

This development also creates opportunities for new startups and entrepreneurs or established players from non-financial industries with a strong customer base,

such as telecommunications or ecommerce companies. Such actors are rapidly moving to introduce new business models and services, and are transforming in the process the value chain and challenging traditional players such as banks. Consistent with the framework mentioned in EM Compass notes 40 and 41, the majority of these initiatives focus on value-added yet fairly simple design applications.

These efforts have originated mainly with new companies entering established markets, targeting emerging markets directly or indirectly. They are not exclusively based in developed markets, although the best funded ones are, for now, U.S.-based. A huge portion of the total venture capital investment has been captured by a handful of startups in the digital wallet and capital market services space (\$625 million).⁷⁶ Regardless of their origin, these new players are targeting segments closely related to the economic activity of developing markets, such as remittances and trade finance.

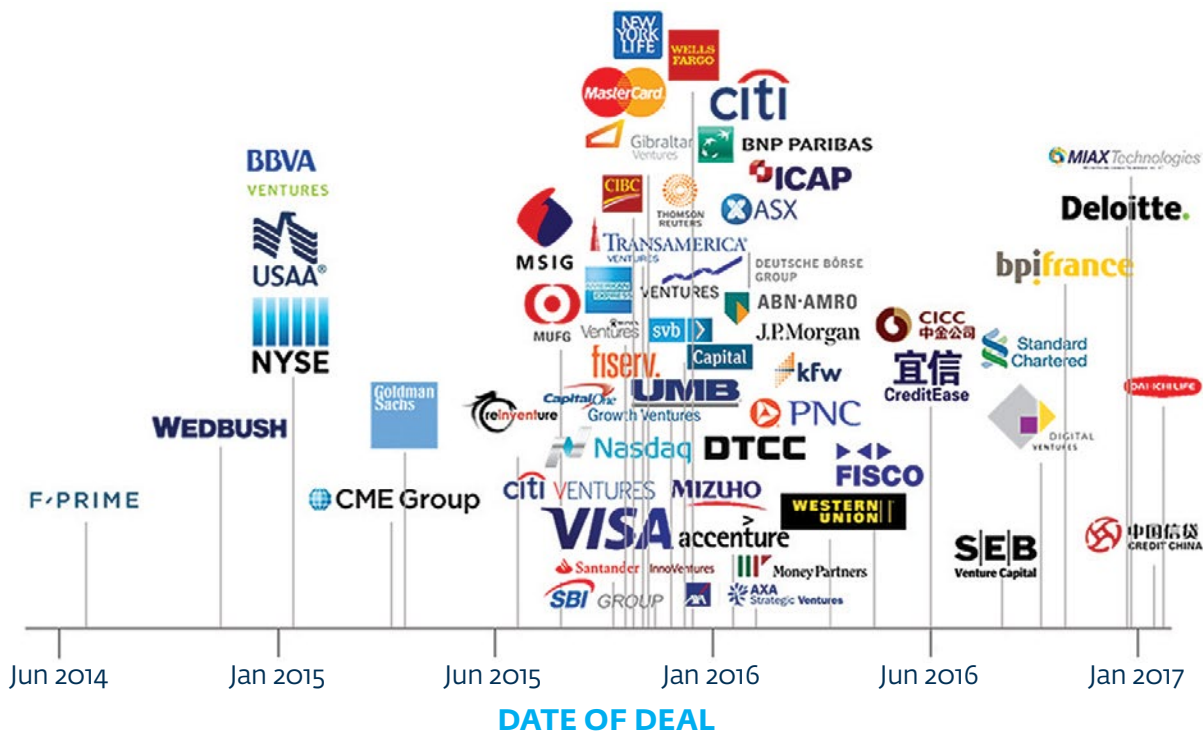


FIGURE 9 The march of financial services firms into bitcoin and blockchain start-ups, 2014 to February 2017

Source: CBInsights, cbinsights.com

This is a significant phenomenon, indicating that emerging markets can become a dynamic testing ground for new business models, where a high demand for financial inclusion and a relative absence of entrenched legacy systems can accelerate the adoption of new technologies—and specifically of blockchain. The potential for extending banking services in these markets is huge, with two billion adults worldwide lacking access to financial and credit services.²⁷ Global payments and remittances is a case in point: it is a \$4 trillion market with transaction fees that range from 5 to 30 percent.

Blockchain potential use cases and applications in financial services industries. Blockchain’s potential to disrupt the financial services ecosystem has been widely discussed, including its capacities for operational simplification, regulatory efficiency improvement (real-time monitoring of financial activity between regulators and regulated entities), counterparty risk reduction (agreements are executed in a shared, immutable environment), disintermediation for clearing and settlement of transactions, and transparency and fraud minimization in asset provenance and capital raising. Given the wide range of potential use cases, we have chosen to focus on three dynamic and well documented subsectors, where use cases are being tested and have concluded or are in the process of concluding a proof of market, including in the context of emerging markets.

Anti-money laundering and customer identification programs. The reinforced regulatory framework that followed the financial crisis has significantly increased the costs of compliance for banks (anti-money-laundering compliance costs have risen 53 percent since 2011²⁸). This has forced banks to exit certain markets and segments and has left emerging markets in a derisking downward cycle. In 2015, European banks reduced their cross-border lending to emerging markets by \$700 billion, according to the Bank of International Settlements.²⁹ In addition to the financial costs, Know Your Customer requests can delay transaction, stretching them to 30 to 50 days to complete.

A blockchain-based automated compliance system can provide an innovative and cost-effective alternative to managing regulatory requirements by acting as a decentralized public key infrastructure to establish

and secure digital identity. The blockchain can be viewed as a decentralized certification authority that can maintain the mapping of identities to public keys. Smart contracts can add sophisticated logic that helps with key revocation and recovery, decreasing the key management burden for the end user. The potential positive impact of this innovation in reliable digital identification has broad implications for a host of financial services, including trade finance and cross border payments and digital wallets (see below), and also for the future evolution and mainstreaming of blockchain technology beyond fintech, into industrial applications and Internet of Things integration.

Using distributed ledger technology to store financial information can eliminate errors associated with manual auditing, improve efficiency, reduce reporting costs, and potentially support deeper regulatory oversight in the future.

Currently there is no standardization in the identifying information customers must submit to financial institution, and these institutions often duplicate efforts in performing Know Your Customer checks, with burdensome transaction costs on both banks and customers. With a distributed ledger technology, a rigorous professional validation is done once and this verified identity document can be used for all subsequent transactions. On a blockchain, that identity can develop over time as a person accrues attestations, property, and other types of licenses and authoritative powers. As the U.S. Financial Crimes Enforcement Network regulations and European Anti Money Laundering directives move toward stricter customer due diligence and data collection, blockchain-based Know Your Customer systems are likely to help government and financial institutions simplify Know Your Customer syndication.

A blockchain identity system will allow end users to own and control their personal identity, reputation, data, and digital assets; securely and selectively disclose their data to counterparties; log in to and access digital services without using passwords; digitally sign claims, transactions, and documents; control and send value on a blockchain; and interact with decentralized applications and smart contracts.

Companies can establish a corporate identity, easily onboard new customers and employees, reduce liability

by not holding sensitive customer information, and increase compliance.

Sample use cases. Several startups from around the globe are taking the concept to market. U.S.-based UPort has developed an Ethereum-based digital identity management product to deliver a ‘self-sovereign identity’, targeting both end-consumers and enterprises. Cambridge Blockchain LLC is developing digital identity software with several leading global financial institutions, with a deployment planned for late 2017. Gem focuses on getting companies within the same industry to share information on Know Your Customer via blockchain technology, where banks would be able to vet a customer by relying on the work another bank has already done.

London-based CreditsVision is looking to create a blockchain of blockchains, connecting various permissioned and public systems so that a digital identity could be truly universal. Singaporean investment portal KYCK! has partnered with IBM to develop a secure blockchain network to enhance identification validation, shared between banks and government organizations. Indian startup Elemental provided the blockchain technology for a Know Your Customer data trial in a collaboration with the National Stock Exchange of India and several banks—ICICI Bank, IDFC Bank, Kotak Mahindra Bank, IndusInd Bank and RBL Bank—as well as HDFC Securities, a Mumbai-based brokerage.

This represents an opportunity for incumbent financial institutions to adapt their traditional banking models and to gain a competitive advantage vis-a-vis new entrants, by positioning themselves as ‘the stewards of identity’, in effect serving as authenticators.⁸⁰

Trade finance

Trade finance is the lifeline of global trade. The International Chamber of Commerce estimates that the global trade financing gap is around \$1.6 trillion, with particularly dire consequences for small and medium-sized businesses and for growth in emerging markets.⁸¹ In this segment, financial institutions bridge the gap between exporters, who need guarantee of payment before they can ship, and importers, who require data on whether goods have been delivered. Roughly \$18 trillion of annual trade involves some form of finance,

be it credit, insurance or guarantee.⁸² The size of the trade finance market itself exceeds \$10 trillion per year.⁸³ However, its supply chain system is cumbersome and time-consuming, creating potential risks for the parties involved, where Anti-Money Laundering and authenticity issues weigh heavily.

Exporters use invoices to secure short-term financing from multiple banks, which increases the consequences should the delivery fail. Parties use different platforms, raising the odds of miscommunication, fraud, and problems with version compatibility. Multiple checkpoints delay payment and slow the shipment of goods. Additionally, trade finance is particularly affected by increased compliance requirements and de-risking, as outlined in the previous section.⁸⁴ Respondents to 2016 IIC Global Survey on Trade Finance identified anti-money laundering and Know Your Customer requirements as the largest impediment to trade finance.⁸⁵ The consequences for global trade and emerging market growth are enormous.⁸⁶

Blockchain can positively transform a number of industries by introducing transparency, traceability, and immutability to their supply chains. Using distributed ledger technology to store financial details can prevent documentary fraud, facilitate the real-time approval of financial documents, unlock capital tied up in the process of waiting for clearance, reduce counterparty risk, and enable faster settlement.

With blockchain, multiple copies of the same document no longer need to be stored on numerous databases across various participating transaction entities, and the approval process does not need to be sequential. Since each participant on the network quickly updates the chain to reflect the latest transaction, it removes the need for multiple copies of the same document of information stored on numerous databases.

A single blockchain has all the necessary information in a single digital document, simultaneously accessible to all members of the network. Documents on the distributed ledger allow all parties to conduct diligence for credit adjudication, check for anti-money laundering and trace the location and ownership of goods. Banks no longer need intermediaries to assume risk, and compliance officials can enforce anti-money laundering and customs activities without delay.

Additionally, using smart contracts (self-executing digital contracts) to codify agreements could lead to new products for alternative financing, securitization of trade obligations, and downstream factoring.

Sample use cases: If banks and incumbent institutions do not seize the opportunity, upstart innovators probably will. This rationale seems to be the motivation behind some early live trials conducted by global banks in partnership with innovators in trade finance blockchain applications to provide a proof of concept.

The Society for Worldwide Interbank Financial Telecommunication (SWIFT) has announced an initiative exploring the use of blockchain in trade finance. Seven major European banks (KBC, Deutsche Bank, HSBC, Natixis, Rabobank, Société Générale and UniCredit) are partnering on a new blockchain-based permissioned trade finance platform, Digital Trade Chain, to manage open account trade transactions for both domestic and international commerce, from initiation to settlement. DTC allows authorized parties to track the progression of those transactions.

The goal is to cut transaction costs for European businesses, particularly those of modest-sized firms. Similarly, Standard Chartered is leading the Distributed Ledger Technology Trade Finance Working Group (formed under the Hong Kong Monetary Authority's Fintech Facilitation Office) to deliver a proof of concept, developed in collaboration with the Bank of China, Bank of East Asia, Hang Seng Bank and HSBC and Deloitte Touche Tohmatsu.⁸⁷

In another pilot, HSBC joined forces with Bank of America Merrill Lynch and the Infocomm Development Authority of Singapore (IDA) to develop a prototype solution built on blockchain for letters of credit in a smart contract. The consortium used the Linux Foundation open-source Hyperledger Project Fabric (whose development was supported by IBM). In the United Arab Emirates, Infosys has partnered with Emirates NBD and ICICI to deliver the first blockchain based trade finance (and remittances) solution in the region.

Global payments (remittances). Cross-border payments is a sector ripe for disruption. Currently, both individual consumers and small- and medium-sized enterprises face high transaction fees, long delays and

uncertainty in making cross border payments. Money Transfer Organizations including Western Union, MoneyGram, and Euronet Worldwide spent decades building franchise businesses across the globe. The size of the market is also considerable, with 2016 remittances estimated at over \$601 billion.⁸⁸ Today, the global remittance industry takes out \$40 billion annually in fees.⁸⁹ Such fees typically stand around two to seven percent of the total transaction value, depending on the volume of the corridor, and foreign exchange fees represent 20 percent of the total cost.⁹⁰ Bank wire transfers are even more expensive, with fees of 10 to 15 percent. Banks also tend to focus only on specific corridors with a strong branch network, leaving some corridors without access to the money transfer services they need.

The market segment is already being unbundled by a number of dynamic fintech start-ups such as Transferwise and Remitly (see EMCompass Note 22 on remittances).⁹¹ Blockchain technology can drive efficiency in the process and reduce associated costs for financial intermediaries and customers by: (i) providing a cost-efficient process to establish digital identity and by extension Know Your Customer verifiability; and (ii) providing a digital fiat for currency conversion. With distributed ledger technology, the sender's digital identity profile sufficient for banks and Money Transfer Operators.

BOX 2 BitPesa

Kenyan start-up Bitpesa, a company providing foreign exchange and business-to-business bitcoin based payment services in Kenya and several African countries, has been able to leverage the existing financial ecosystem by connecting to the M-Pesa money network, a subsidiary of telecom company safari.com and provider of mobile payments and a major incumbent player (more than half of Kenya's adult population has an M-Pesa wallet).

Despite a legal confrontation with the mobile money network in 2015, BitPesa has raised additional financing from several venture capital firms in 2016 to move forward with its international expansion across East Africa.

A smart contract containing the remittance information delivers the funds directly to the beneficiary's institution while simultaneously notifying the appropriate regulator. Distributed ledger technology could enable new business models (for example micropayments) and institute newer models of regulatory oversight.

Sample use cases: There are numerous startups proposing crypto-based global payments and peer-to-peer digital cash solutions: Abra and Ripple in the United States, BitPesa in Kenya, BitSpark in Hong Kong, OkCoin in China and OkLink/Coinsense in India, CoiNnect Mexico/Argentina, Rebit and Coin.ph in the Philippines. In addition, large banks are in the process of testing different applications as consortia and in partnership with technology providers to reduce transaction costs in their value chain. Financial giant SWIFT is participating in the Hyperledger Fabric Project; South Korean bank KB Kookmin is partnering with CoinPlug, Indian ICICI's blockchain is developing a blockchain remittance project with Emirates NBD Bank and others.

Challenges Ahead

Distributed ledger technology is still evolving and will face numerous hurdles, some technical, some regulatory, and some institutional, as it moves toward maturity. Concepts are being market-tested but they will not be able to reach their full network potential without industry collaboration, common standards, and significant transition costs to enable the migration from the existing financial infrastructure.

On the technological side, concerns relate to the (i) scalability and transaction speed of distributed ledger systems, for permissionless blockchains such as bitcoin (ii) the interoperability of different ledgers and those with the existing legacy systems and transition costs; (iii) network security and resilience of the system against potential cyberattacks (a recent setback for Ethereum); (iv) the protection of data privacy.

The recent rise of customer acquisition costs for crypto payment solutions providers and their continued dependence on traditional networks to reach customers indicates that the market will require the coexistence of both traditional and digital players for some time in order to build bridges to the broader economy.

From the regulatory and governance perspective, we are far from having a clear framework and industry-wide standards that stakeholders will need for full adoption of the new technology. According to a 2017 study by the Cambridge Center of Alternative, less than half of payment companies based in Asia-Pacific, Europe, and Latin America hold a formal government license, and forty percent of companies surveyed would like to see more regulatory clarity.⁹²

Regulation will have to reflect and accommodate the novel features of blockchain and recognize their legal validity (digital identity, Know Your Customer, dispute resolution mechanisms, smart contracts), particularly for open distributed ledger technologies where there is no entity in control of the ledger.

Recent defections from the R3 blockchain consortium have highlighted the governance and design complexities of collectively designing a globally relevant and adoptable solution.

CONCLUSION

Financial institutions, fintech technology companies and even governments are still experimenting and participating in proofs of concept to better understand the possibilities and limitations of blockchain. As financial markets evolve with respect to distributed ledger technology, companies will face game-theory-type decisions. Being early adopters of distributed ledger technology across the ecosystem may provide them with a competitive advantage but it may also derail their ongoing business interests.

If they are too late to enter the market, they may irreversibly lose ground to competitors. This dilemma is exacerbated by the fact that the biggest impact from distributed ledger technology will be achieved only when a critical mass of the ecosystem participates and network effects are realized.

The most valuable distributed ledger innovations cannot be developed in isolation; they require collaboration among participants, exchanges, and regulators. The adoption process will not be smooth and there will be winners and losers.

With respect to emerging markets, the ecosystem seems fertile for adoption, propelled by high demand,

particularly in serving financially excluded segments, as well as a hedging strategy through bitcoin and other crypto currency in conditions of currency instability and political risk, as is the case in parts of Latin America and Africa.

Less financially developed markets are focusing on financial inclusion initiatives with blockchain-run digital wallets and mobile payments. In addition to the factors identified in the predictive framework based on market structure (see EMCompass Notes 40 and 41), three additional critical success factors can weigh heavily on the penetration of the technology. These are: (i) the degree of development of the general technological ecosystem and the availability of the requisite skill pool; (ii) the ability to mobilize capital for innovators; and (iii) a regulatory environment that encourages experimentation and public-private collaboration to establish standards and resolve related issues.

“Experiment patiently, accept failures, plant seeds, protect saplings, and double down when you see customer delight.”

—JEFF BEZOS, CEO, Amazon.com,
Letter to Shareholders, 1997

Innovation is only as good as the effectiveness and profitability it can deliver. This is the promise that distributed ledger technology-associated initiatives will be called on to deliver in a sustainable fashion, whether in the form of creating/growing a market or generating cost savings through greater transparency and efficiency. Only then will move beyond the pilot stage to full-scale industry adoption, thereby leveraging the full network effects and triggering the tipping point of the transformation process. ■

CHAPTER 5

Blockchain in Financial Services in Emerging Markets—Selected Regional Developments

By Marina Niforos

Blockchain, or distributed ledger technology, is now disrupting the financial services industry as part of a larger wave of external innovations by digital financial technologies. Emerging markets—due to their higher banking risks, lower bank penetration, and greater presence of digital financing—are an ideal backdrop for the adoption of blockchain-based financial solutions, and benefits could include a technological leap forward and a boost to financial inclusion and growth. This note focuses on selected regions in emerging markets where distributed ledger technology is already affecting the provision of financial services, including Africa, Latin America, and Asia.

The blockchain innovation landscape is still dominated by the United States and Europe. The United States represents 54 percent of the blockchain global deal share, followed closely by Western Europe.²³ This dominance is, however, being challenged by Asia, according to a 2016 CB Insights analysis of venture capital financing. It shows that Asia, driven by China, increased its share of the pie from 14 percent in 2015 to 23 percent in 2016, a remarkable rise (see Figure 10).

Africa

Sub-Saharan Africa, with its 70 percent unbanked population, provides enormous potential for the adoption of blockchain-based solutions as an alternative to traditional payment options. Economies with a history of frequent political turbulence or those with high currency risk and capital controls are also fertile ground for individuals and households to embrace a solution that permits them to bypass the system's inefficiencies, overcoming fears of potential risks in the execution of transactions.

The overwhelming presence of alternative payment solutions in Africa could potentially pave the way for blockchain, since households may be less resistant to new technology. Seventy percent of all transactions in Kenya are already digital and over half of the

country's adult population holds a M-Pesa digital wallet.²⁴ With relatively small legacy systems in the region, the adoption of blockchain becomes easier due to lower transition costs and less cultural resistance.

This provides the backdrop for the disruption in the remittances and payments segment, described in EMCompass Note 43. Peer-to-peer payments with digital currencies have started to become an alternative to local currencies, with a number of growing blockchain African-run startups, including Kenya's BitPesa and Bitsoko, Ghana's bitcoin exchanges BTCGhana, and South Africa's Luno and Ice3X and GeoPay, BitSure and Chankura. South African mobile money network PayFast

ABOUT BLOCKCHAIN IN AFRICA

“The opportunity is to produce new constructs that bring together unique opportunities and competencies—things like the blockchain and mobile-money movement on the phone, and mesh networking. It's a matter of using Africa's unique potential right now to come up with things that defy Western logic in many terms or just don't fit that classical model.”

—BRETT KING, co-founder of Moven

recently integrated bitcoin payments options and now provides access for bitcoin payment to 30,000 merchants outlets across the country.²⁵

Prospects for rapidly developing blockchain technology into a full range of financial services, beyond just digital payments, are considerable, due to strong support from financial players and local governments. In Nigeria, the central bank approved an industry-wide e-payment incentive scheme and awareness campaign to encourage Nigerians to embrace the use of e-payments by consumers and commercial agents.

Similarly, Senegal announced plans to introduce a cryptocurrency (eCFA) overseen by the West African Economic and Monetary Union, which can be used in Benin, Burkina Faso, Cote d'Ivoire, Niger, and Togo. South Africa is also home to a friendly regulatory environment and a vibrant fintech ecosystem, a necessary precondition for blockchain innovation.

In 2014 South Africa's central bank indicated that it will have no supervisory obligations over virtual currencies, giving stakeholders relative 'carte blanche' to conduct cryptocurrency transactions in that country. Furthermore, the South African Reserve Bank, along with the Payments Association of South Africa and top banks, circulated Africa's first ever private Ethereum-based smart contract among several of the country's financial institutions in an attempt to test the technology for potential future implementation in its financial system. They are also participating in a regional consortium of leading banks, including ABSA, Standard Bank, Nedbank, and others, to develop a blockchain based solution for loan syndication and securitization.

South Africa also boasts a blockchain-curious and active financial sector looking to improve existing company operations through process re-engineering and cost reduction. Rand Merchant Bank has launched a blockchain initiative to develop blockchain solutions

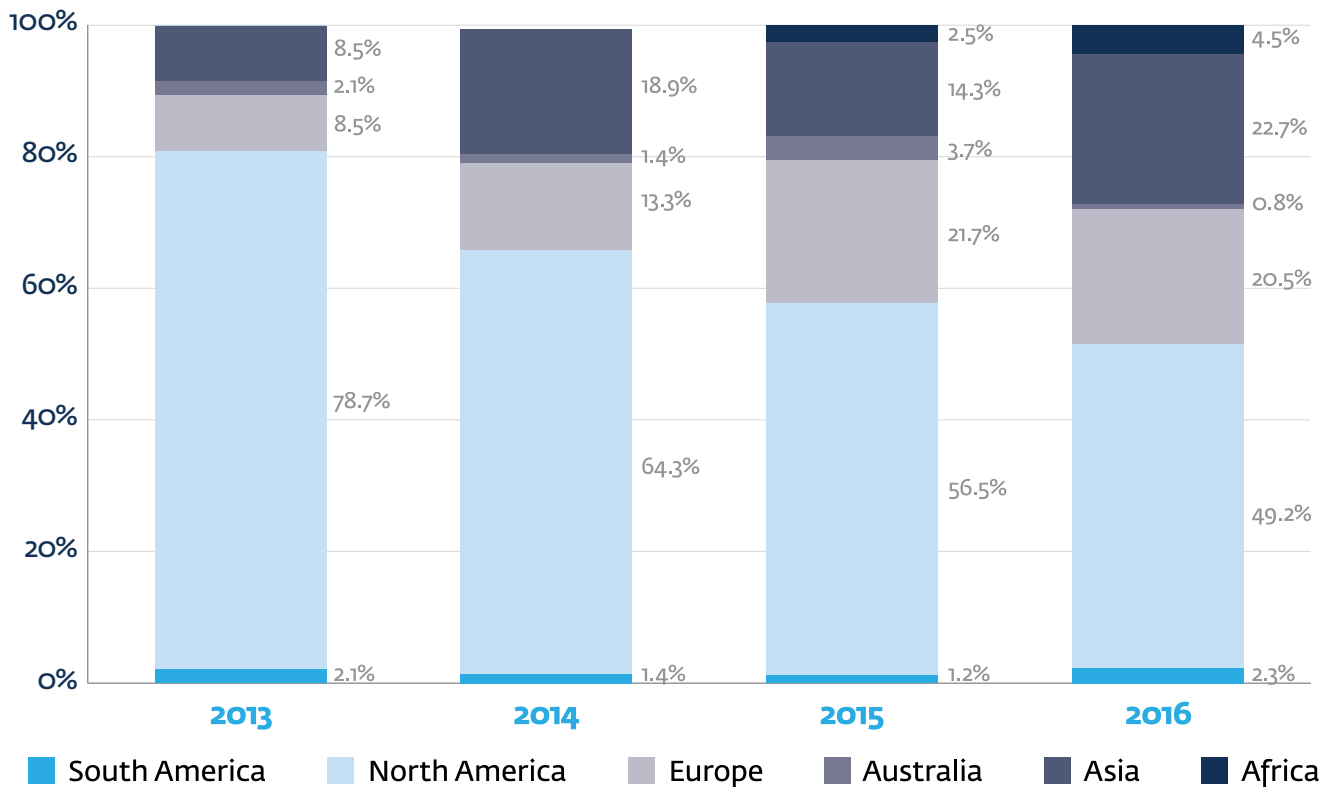


FIGURE 10 Bitcoin and blockchain annual deal share by continent 2012-2016

Source: CBInsights, cbinsights.com

for its business, while Absa Bank, Barclays Africa and Standard Bank have joined the R3 Consortium to collaborate with other international financial institutions in the development of blockchain systems for the banking sector.

Insight: Bitcoin and blockchain have the potential to leverage pre-existing mobile penetration to create a cross-border and decentralized system of alternative finance in sub-Saharan Africa. This system can reach previously underserved and unbanked population segments and has the potential to provide the infrastructure for inclusion of Africa's largely unbanked population. Governments and regulatory authorities are compelled to adapt quickly to these emerging trends as digital financial services account for up to 85 percent of volumes in certain geographies. Many have started strategic initiatives to provide regulatory sandboxes and encourage public-private collaboration. Stakeholders are increasingly recognizing blockchain as an emerging disruptor and enabler, and they are studying and fostering the technology to ensure they are not excluded from its future developments and potential benefits.

Latin America

While Latin America has a smaller percentage of unbanked population than Africa (49 percent, according to World Bank Findex⁹⁶), it has been subject to cyclical political and currency fluctuations that have undermined trust in local currencies. Additionally, the penetration of illegal activity (including drug trafficking and related money laundering activities) have intensified the de-risking effect on economies in the region, as traditional financial institutions have exited markets due to increased compliance requirements and costs.

Smaller and more vulnerable economies, particularly those in the Caribbean, have been the hardest hit, according to the Economic Commission for Latin America and the Caribbean.⁹⁷ This phenomenon could provide fertile ground for blockchain adoption and its corollaries to deal with de-risking's impact, both through its automated compliance with Know Your Customer requirements and through digital currency platforms and cross-border payments systems that

avoid the transaction costs associated with traditional financial services. Several early experiments are under way, both at large institutions as well as new digital finance players.

Brazil, a country with solid banking penetration, has seen the industry mobilize with the participation of Banco Itaú and Banco Bradesco in the R3 consortium. Banco Bradesco is launching pilots, including a new digital wallet using blockchain technology in partnership with startup eWally, as well as Bit.One, to address cross-border payments. In Mexico, under threat from a potential block on remittances by the Trump administration, startup Bitso received \$2.5 million in funding in early 2017, while Mexican venture capital fund INGIA invested in Abra, the US blockchain mobile payments startup. In Argentina, Rootcamp provides smart contract solutions for bitcoin technology, while SatoshiTango and Xapo provide bitcoin based payments solutions.

Insight: In Latin America, political uncertainty and the impact of de-risking are driving cryptocurrency adoption and blockchain-based financial products, but the region as a whole still lacks robust technological ecosystems, sufficient access to venture capital funding, and the regulatory clarity to boost wide adoption levels.

ARGENTINA: THE CASE OF RIPIO

Ripio's (formerly BitPagos) bitcoin financial services suite utilizes the blockchain and traditional payment rails to allow Latin America's unbanked and underbanked population (as high as 70 percent in some areas) to buy and sell bitcoins using local currencies, and to pay for goods and services through a simple, direct transfer to peers and merchants.

The platform currently has over seventy thousand users across Argentina and Brazil, and is in the process of expanding to other countries in the region, including Mexico and Colombia. It raised close to \$2.4 million in 2017 to expand internationally.

Asia

Asia is becoming a global leader for venture capital investment and testing of blockchain solutions.⁹⁸ There are nevertheless stark differences across Asian nations, with China, Hong Kong, and Singapore leading the way (consistent with the Fintech trends outlined in EM Notes 34 and 42.⁹⁹ Asia is also home to the most forward-looking regulatory environments. Japan and South Korea have regulated cryptocurrency environments and their central banks are in the process of licensing exchanges.

Singapore and Malaysia have set up regulatory sandboxes for developing blockchain solutions by partnering with industry and technology providers. Similarly, China's government strongly supports adoption of blockchain technology, as announced in its most recent five-year plan, and is providing a flexible regulatory environment. The government is piloting a sovereign blockchain digital currency, led by the central bank, the People's Bank of China.¹⁰⁰

Asia's venture capital financing community has taken notice, with deal activity rising to an all-time annual high in 2016, at \$119 million, up from \$37 million in 2015. This is in contrast with North America and Europe, which each saw decline in deals during that period.¹⁰¹

China. With the largest banking system in the world, China is the world's dominant bitcoin trader, in terms of global transactions. Its bitcoin transactions are close to 98 percent of market volume, up from 10 percent in 2012.¹⁰² China's strong appetite for blockchain goes beyond cryptocurrencies, and is anchored in its enormous demand for financial inclusion.¹⁰³ Since China aims to develop a robust Internet finance industry, the strong support to blockchain-enabled alternatives is a natural development.

Fintech and blockchain-specific start-ups are springing up across many segments: brokerage, digital wallets and money services, exchanges, post-trade clearance and settlement, middleware, infrastructure, and base protocols. Capital markets are aggressively pursuing opportunities in the industry, with significant funding going into the payments sector.¹⁰⁴ Supported by strong profit margins, Asia's traditional banking institutions are also adopting a 'prototyping' approach to blockchain

INDIA

"Blockchain Technology (BCT) provides tamper-evident recording of the linked transaction in a distributed network, and has the potential to disrupt the financial business applications. The nature of BCT addresses risks and inefficiencies in multi-party systems, and that is where the benefits will be most widely received."

—R. GANDHI, Deputy Governor,
Reserve Bank of India

Regulators in India have been among the first to promote financial inclusion initiatives for banking and remittances, triggering strong adoption of electronic payments and the rise of new market entrants (M-banking transactions tripled between 2012 and 2014). New entrants, offering m-wallets, have attracted consumers and have motivated banks to invest in their own digital payment offerings. Building on this momentum, blockchain-based startups launched exchanges and digital wallets, such as Unocoin and Coinsensure.

Source: PwC, Emerging Markets—Driving the Payments Transformation, 2016

and piloting initiatives, sometimes partnering with startups and other financial service providers.¹⁰⁵

Driven by the prospect of cost reduction, the Postal Savings Bank of China has tested a blockchain-based asset custody system—a core business—in collaboration with IBM and Hyperledger. Large Internet players are incorporating blockchain into their business models, such as AntFinancial (subsidiary of Alibaba) that is introducing a bitcoin mobile wallet and Tencent, which is planning to use the technology to offer digital asset management, authentication, and "shared economies" through a new platform, TrustSQL.¹⁰⁶ The Chinese Internet giants and banks are also active venture capital investors on a global scale: Baidu recently invested in U.S.-based bitcoin payments startup Circle, Huiyin Blockchain Ventures

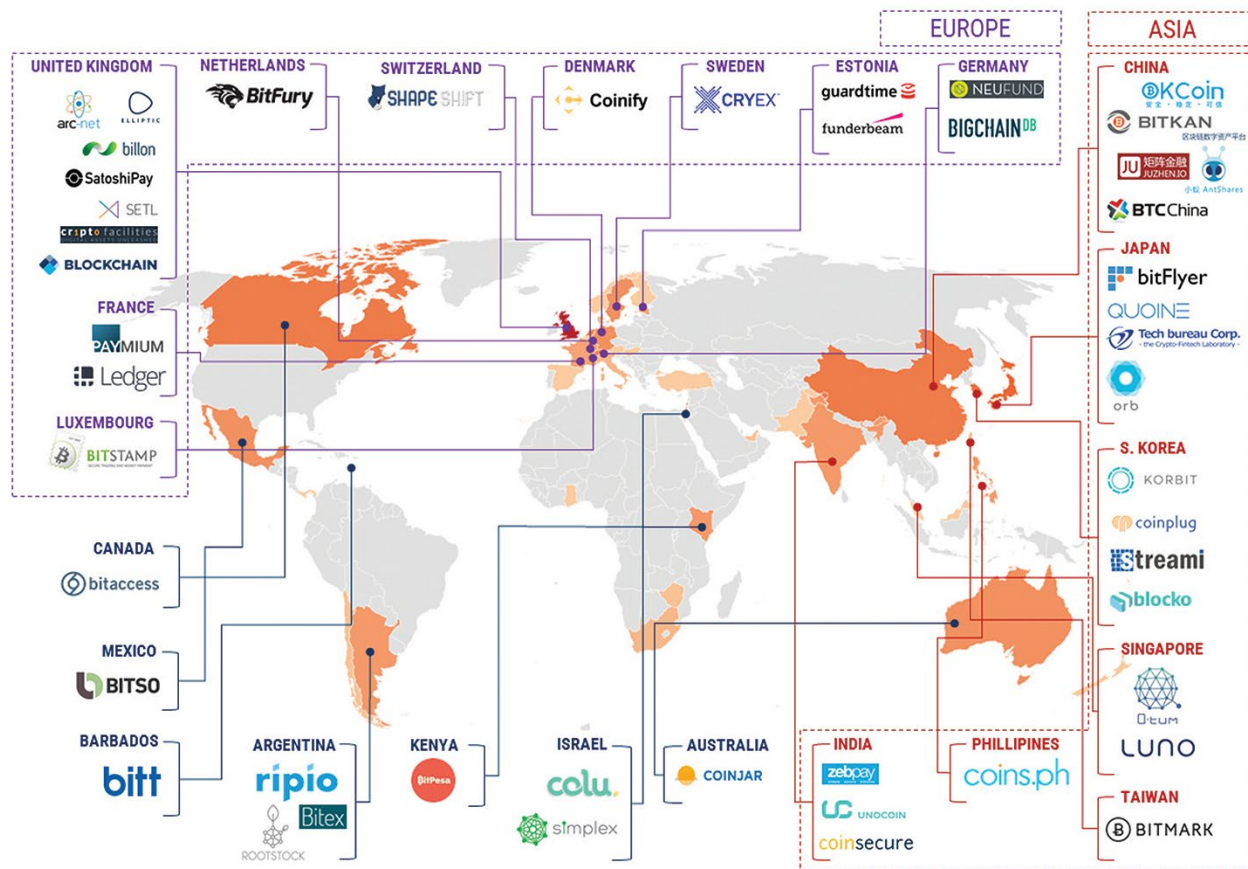


FIGURE 11 Global bitcoin and blockchain companies 2012 to Feb 13, 2017

Source: CBInsights, cbinsights.com

invested in US-based Purse.io and Indian UniCoin, and Crefir China FinTech invested \$30 million in US/Dutch BitFury. Several Chinese blockchain/bitcoin based startups raised significant funding in 2016, including Juzhen Financials (\$23 million), OkCoin (\$10 million), BTC China (\$5 million), and AntShares Blockchain (\$4.5million).¹⁰⁷

Key stakeholder collaboration is well under way, bringing together financial institutions, innovators and government actors to establish standards and develop the institutional framework of the ecosystem. The China Ledger comprises regional exchanges to create an open source Blockchain protocol to support an eventual ‘Internet of Everything’ for China.¹⁰⁸ Financial Blockchain Shenzhen Consortium intends to collaborate on research and group-wide Blockchain projects, with a focus on capital markets technology, securities exchange, trading platforms, banking and

life insurance. And Qianhai International Blockchain Ecosphere Alliance aims to combine Mainland China and international talent, technology, and capital to accelerate the commercialization of blockchain research and development, and promote its application to support China’s social and economic development.¹⁰⁹

Insight: Asia can be the global emerging markets leader in blockchain-based solutions for the financial services industry. The technology’s adoption in the region has been facilitated by the massive digitalization of payment solutions, particularly in China, which onboarded the unbanked and shaped consumer behavior in the process.

Asia has evolved to become the most comprehensive ecosystem for blockchain development due to a combination of strong government and regulatory support, and mobilization of capital from both industry players and venture capitalists.

Cryptocurrencies are being adopted and integrated into mature and well-functioning financial systems (both private and public) and innovative solutions are being tested for trade finance and securities trading, as well as for non-financial processes such as e-proxy voting, land registry management, and supply chain management.

This combination of these factors, coupled with Chinese companies' global ambitions, will most probably guarantee that China will be a global hotbed for blockchain innovation in the financial services sector and beyond.

CONCLUSION

The adoption of any new technology is often difficult to discern in real time and nearly always unpredictable in

the path that it will take. However, developments seem to indicate that a proof-of-concept phase is underway across emerging markets, in varying degrees of intensity and orientation, and that policymakers in these countries are keen observers of and participants in the evolving policy demands surrounding blockchain.

While blockchain can have a decisive impact for an innovation 'leapfrog' for all emerging market regions, Asia appears to be a rising champion for blockchain implementation, as it brings together regulatory activism, a vibrant technological/fintech ecosystem, supportive governments, collaboration of industry and entrepreneurial players, and sustained access to venture capital. And China and Singapore are emerging leaders in developing articulated global blockchain development strategies that combine all critical success factors. ■

CHAPTER 6

Beyond Fintech: Leveraging Blockchain for More Sustainable and Inclusive Supply Chains

By Marina Niforos

One of the most noticeable and important developments of the advance of free trade over the last half century has been the emergence of global value chains. These production and supply networks cross multiple borders and connect advanced and emerging economies. They are vehicles that can deliver on many of the promises of globalization. Yet operating them is complex and costly. Global trade since the great recession has slowed, in part because of a lack of transparency and interoperability within these networks. Blockchain, a technology with unique abilities to record, track, monitor, and exchange assets without need of an intermediary, may be the solution to many of the logistical, cost and transparency issues that plague the growth and operation of global value chains, especially in the case of food, agribusiness, and pharmaceuticals. It also has potential to address issues of inclusion.

Globalization has made supply chains significantly more complex, involving multiple players from around the world and a great deal of coordination. This increases the cost of operating these global networks—with goods and services channeled across emerging and advanced economies. Imagine the complexity of a product sourced in Ethiopia or Indonesia, assembled in China, and sold in the United States.

The cost of operating supply chains makes up two-thirds of the final cost of traded goods. Seven percent of the global value of trade is absorbed in documentation costs alone, according to the Global Alliance for Trade Facilitation.¹¹⁰ Faced with a dynamic and volatile environment, companies are increasingly turning to technological innovation to make their supply chains more cost-effective, resilient, and responsive to potential market disruptions.

Between the late 1980s and early 2000s, the emergence of global value chains—which were to become the main vehicle of international trade—was enabled in large part by advances in information technology that drastically reduced the cost of coordinating production stages carried out in different countries.¹¹¹ Today

international trade is facing a global slowdown¹¹² and industries have signaled several critical challenges to global value chains, including: (i) a lack of transparency due to inconsistent or not readily available data; (ii) a high proportion of paperwork; (iii) a lack of interoperability; and (iv) limited information on the product's journey in the chain.¹¹³

Experts have called for trade facilitation measures, including a simplification in the movement of goods along global supply chains, in order to reduce companies' governance costs, increase speed, and reduce uncertainty.^{114,115}

While digitization of supply chains is already underway with technologies such as cloud computing, artificial intelligence, and the Internet of Things—which allows physical objects to communicate—blockchain appears to be the missing element in the mix. Beyond providing innovative financial services, blockchain—a digital distributed ledger—can provide a platform that offers contracting parties the ability to verify that every link in a supply chain network is authentic, without need of an intermediary such as a clearing house or banking institution.

Blockchain can be used to record, track, monitor, and transact assets, both physical or digital, in a cost efficient and transparent manner. By doing so, the technology can act as a ‘plug and play’ trust mechanism that enables other emerging technologies to achieve scale. These include artificial intelligence, machine learning, drones, and 3D printing, among others. In addition, the combination of Internet of Things, smart contracts and blockchain could provide a new model to reengineer supply chain logistics and the business models they support, and by doing so render them more efficient and transparent—and ultimately more inclusive. Hence, Blockchain promises to:

- Provide faster and more affordable payment and finance options
- Leverage distributed-ledger capabilities to remove third-party intermediaries, streamlining processes and promoting increased security across the value chain in multiple industries, with a focus on lowering the barriers to entry for small and micro-enterprises
- Provide solutions for increasing transparency across supply chains.

EMCompass Notes 43 and 44 highlight the positive impact that blockchain could have on the financial

services industry, with a special look at trade finance and payments systems. Meanwhile, this paper examines blockchain’s ability to integrate data flows and processes and to provide efficiency and transparency across digital supply chain networks and to allow for the inclusion of previously underrepresented economic groups. The paper further examines two sectors with significant economic and social impact on emerging economies, food and agribusiness, and pharmaceuticals, and also discusses the inclusion of women in global supply chains.

Food and agribusiness: Cost-efficiency and transparency of the supply chain. Global food and beverage manufacturers, retailers, and service companies want to reduce supply chain costs while also reducing their carbon footprint, meeting consumer demands to sustain the environmental quality of farmland, improve and maintain high quality food standards, promote health and safety, and maintain the economic viability of farming and farmers’ wages. With roughly 40 percent of the global workforce,¹¹⁶ agriculture is one of the leading job providers worldwide and a critical sector for boosting economic growth in developing economies. For emerging markets and their industry leaders with global market ambitions

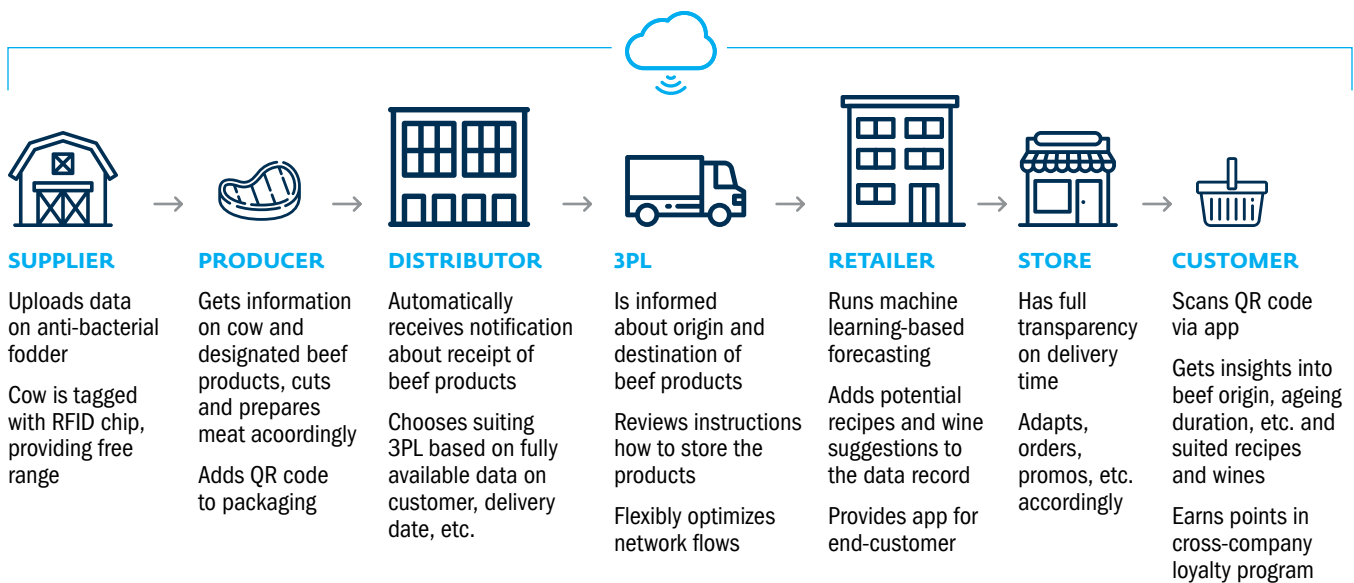


FIGURE 12 The efficiency dividend—Re-engineering processes

Source: *End to End Blockchain-Enabled Supply Chain*, Oliver Wyman

and footprint, adherence to sustainable supply chain practices will become more and more important in the years to come.¹¹⁷ In this quest for efficiency and transparency, blockchain offers the ability to:

1. Integrate and manage supply chain transactions and processes in real-time; and
2. Identify and audit the provenance of goods in every link of the chain.

EMCompass Notes 39 and 43 examine how blockchain can provide more cost-efficient trade finance solutions, one of the levers to innovate the financial aspects of supply chain management. In the context of agriculture, this Note underlines how it can diminish risk and boost efficiency for all stakeholders in the supply chain through real-time settlement of physical commodities in a secured environment.

Automated blockchain supply chain finance and know-your-customer systems can reduce the need for agents, brokers, and reduce physical documentation. For growers and suppliers, blockchain could shortcut cumbersome procedures and facilitate faster and more secure payments.

For example, payment terms in the Australian grains industry range from two to five weeks, and these terms pose counterparty or credit risk to growers.¹¹⁸ The elimination of this risk means growers can be secure in their cash flow, liberate working capital, and better manage their businesses. For buyers, there are both back-office and liquidity benefits. A blockchain-enabled workflow automation (via smart contracts and integration with key machinery and data collection points) and auto-reconciliation for inventory can reduce cost and risk to buyers. Additionally, the distributed ledger model could also improve access for regulators and authorities with respect to collecting taxes and customs duties.

A number of blockchain-based projects are now coming to life. A European Union consortium of seven banks called the Digital Trade Chain is collaborating with IBM to develop a supply chain management and trade finance platform using blockchain technology. The goal is to make cross-border commerce easier for European small and medium enterprises (SMEs).¹¹⁹

Similarly, U.S.-based SkuChain aims to connect financiers in advanced economies with clients in emerging and developing economies, despite their lack of history of trade or data with these emerging market firms. The venture proposes ‘a collaborative commerce platform,’ combining payments, including a letter of credit or wire transfer; finance (operating loans or short-term trade loans); and visibility (integration with back office systems such as Systems Applications and Products in Data Processing or an Enterprise Resource Planning system).¹²⁰

Another U.S. startup, Hijro, develops a blockchain-based financial operating network for global commerce, featuring real-time business-to-business payments, supply chain financing, and a peer-to-peer working capital marketplace that provides banking partners and non-bank lenders alike—including alternative finance providers, asset-based lenders, and hedge funds—with an alternative platform for lending to actors along the global supply chain.

Meanwhile, Memphis-based Seam—partly owned by trading giants Cargill, Olam, and Louis Dreyfus—is working with IBM to “lead an industry-wide collaboration initiative” to create a supply chain and cotton trading ecosystem based on blockchain. The company claims to have smart contracts that can reduce the time needed to settle a trade from the standard three days to just a few minutes.¹²¹ And China Systems is working with the Emirates Islamic Bank to develop a blockchain solution that allows them to share information on a distributed ledger with Islamic banks on sharia-compliant halal goods.¹²²

Blockchain promises to make the supply chain leaner, simpler, and more cost-effective—not just providing financing but integrating know-your-customer, inventory management, and traditional legacy systems to work seamlessly with existing supply-chain technology. This element provides an enforcement mechanism. It can identify where the goods came from and who was paid for them. This can help avert fraud, such as the Qingdao scandal in 2014, where volumes of copper, alumina, steel, and other metals were used as collateral for multiple loans. With blockchain, all actors along the supply chain are visible and accountable.

The transparency dividend: Enforcing sustainability and safety standards

Research by the Organisation for Economic Co-operation and Development indicates that “green trade” is rising in political and economic importance, “with a global market of \$1 trillion a year for environmental goods¹²³ and services close.”¹²⁴ At the same time, the Sustainability Consortium’s 2016 Impact Report found that the majority of consumer goods manufacturers lack visibility into the sustainability performance of their supply chains. The ‘greening’ of global supply chains requires traceability and transparency. The former is necessary to track hazardous products and materials, allocate responsibilities, and monitor environmental compliance. The latter is a precondition for achieving credibility, legitimacy, and fairness, and to avoid “green-washing” or shifting polluting activities to developing countries.”¹²⁵

In food and agriculture, transparent supply chains are vital to ensuring quality and conformity to the expected standards of production (bio, fair-trade, circular economy), meeting environmental standards and combatting fraud, as well as monitoring supplier inclusion mandates. A 2016 survey on the investment priorities of industry leaders, conducted by the consultancy the Boston Consulting Group and AgFunder, an investment marketplace for the agriculture industry, found that supply chain and logistics was a top-five priority for 40 percent of their respondents, with food security and traceability cited most often as a priority.¹²⁶ Food safety is a major concern for consumers, and companies are feeling the impact after some notable incidents such as the Chipotle norovirus and salmonella outbreaks in 2015 that caused its profits to plummet by 44 percent.¹²⁷

In contrast to inefficient labelling systems that are easily manipulated, blockchain provides businesses and consumers with a system that cannot be tampered with. It can provide much more reliable information on where food originated, the date it was created, and how it was produced. Blockchain quickly traces contaminated products to their source and ensures safe removal from store shelves.

Some of the largest players in the industry are taking notice and are experimenting with blockchain to provide proof of concept, using the technology to improve visibility into their supply chains. IBM and a group of leading food companies, including Dole, Driscoll, Golden State Foods, Kroger, McCormick and Company, Nestlé, Tyson Foods and Walmart, formed a consortium in 2017 to test IBM’s blockchain solution, which aims “to identify and prioritize new areas where blockchain can benefit food ecosystems.”¹²⁸ This follows a successful pilot that IBM launched with Walmart earlier in 2017. Through this program Walmart discovered that, while it normally takes more than six days to trace a package of mangoes from the supermarket back to the farm where they were grown, blockchain can reduce this time to seconds.¹²⁹ Blockchain not only identified the farm where the mangoes were harvested but also the exact path they took on the way to the retail shelves. IBM’s blockchain solutions are also being adopted by Everledger, a firm that is pushing transparency into the diamond supply chain network, with the aim of addressing a market fraught with forced labor and violence across Africa.¹³⁰

In Asia, Chinese retailing giant Alibaba is launching a similar initiative in partnership with PricewaterhouseCoopers, Blackmores, and the Australia Post to fight counterfeit food products being sold across China. Similarly, China’s second-largest e-commerce platform, JD.com, is working with Kerchin, a Mongolian-based beef manufacturer, to use blockchain to track the production and delivery of frozen beef.

A number of innovative startups around the world are also entering the space. UK based Provenance launched a successful pilot program in Indonesia using blockchain-enabled smart-tagging to track tuna fishing in Indonesia. German startup Slock aims to provide the benefits of the transparency, security, and auditability to real-world objects by integrating blockchain nodes in connected objects. US-based RipeIO’s algorithms crunch data to calculate sustainability scores, as well as scores for spoilage and safety levels.¹³¹ California’s Filament is working to develop ‘smart farming’ solutions with a decentralized network allowing Internet of Things sensors to communicate with each other. By encrypting down to the hardware level

and leveraging blockchain technology, Filament's decentralized network allows any device to connect, interact, and transact independently of a central authority.¹³² And Bext360, a coffee-supply platform, uses blockchain, artificial intelligence, and the Internet of Things to support fair trade for coffee growers in developing nations.

Addressing a public health challenge: Blockchain and the pharmaceuticals supply chain

Over the past two decades, the pharmaceutical industry's supply chain networks have become globally diversified and complex, resulting in several new actors being introduced into the value chain—from development, manufacturing, and packaging to delivery. The industry has been under phenomenal pressure to fight counterfeit products and to check abuse in its supply chain. Medicines constantly change hands and undergo multiple transactions between production and end-user patient, with each transaction increasing the risk of falsified and substandard products infiltrating the supply chain.¹³³ The growing number of e-commerce platforms creates more channels for fake medicines to enter the market. A 2014 report by American Health & Drugs Benefits estimated that counterfeit drugs provide approximately \$75 billion in annual revenue to illegal operators (U.S. Department of Commerce estimates are \$75-200 billion¹³⁴), and have caused more than 100,000 deaths worldwide. The profit loss to pharmaceutical companies is estimated at \$18 billion annually.¹³⁵

For developing countries, the problem is dire. The World Health Organization estimates that 50 percent of drugs consumed in developing countries are counterfeit, the majority of them anti-malarial medicines and antibiotics. These fake drugs can harm patients while failing to treat the disease, and may create a resistance to the original product. The problem of counterfeit drugs is exacerbated by the opacity of the global pharmaceutical industry's supply chain. Existing solutions to detect fake drugs, including radio frequency identification tags, have been largely ineffective due to the disaggregated nature of the industry supply chain and the high cost of adoption.

Blockchain could intervene to provide greater transparency, help detect fake drugs and, ultimately, reduce tracing costs by:

- Tracking and tracing pharmaceutical raw materials and finished products, from manufacturer to end-user, in a distributed ledger that is tamper-proof
- Requiring participants to verify the authenticity of data
- Integrating anti-counterfeit devices into the 'Internet of Things' to authenticate genuine drugs and detect fakes.
- Serving as an open-source platform for drug standards to enhance information-sharing across unrelated databases, and among different actors in the drug supply chain.

Blockchain's distributed ledger technology presents an innovative alternative to existing systems: It can provide a record of all transactions, including location, data, quality, and price; it is visible to all involved entities, in real time; and it minimizes record tampering.

Several initiatives are currently underway to develop blockchain-based solutions that can provide more visibility into the pharmaceutical industry's supply chain. Rubix, a spinoff of Deloitte, is working in Canada with pharmaceutical companies to build applications for drug safety, drug channels, and public safety. And U.S. based startup iSolve has developed BlockRx, a private-blockchain solution for the life-sciences industry that provides traceability in drug supply chains.

BlockRx's goal is to connect systems that do not readily communicate, establish data provenance that satisfies regulatory and business requirements, and create a network of trading partners that are incentivized to facilitate the transfer of information within a secured environment. Blockverify, a UK startup, has developed anti-counterfeit solutions that may make the verification of a drug's authenticity as easy as scanning a bar code with a mobile phone. Each product will have its own identity on the blockchain to record changes of ownership, and will be accessible to everyone.

Similarly, Chronicled, a California company, builds open protocols and hardware and software solutions that incorporate blockchain's cryptographic technology

with the Internet of Things, to ensure that transactions and actors cannot be falsified. It recently launched CryptoSeal, a platform that provides tamper-proof adhesive seal strips containing a Near-Field Communication chip to seal and track shipments of drugs. Meanwhile, French startup Blockpharma has developed a private blockchain application that creates a bridge between existing programs and the blockchain consortium. The laboratories release medicine boxes with bar codes that can be traced throughout the supply chain via a smartphone.

A case for inclusion: Women in the global value chain

Women represent a significant portion of workers in many value chains. However, informal roles and comparatively low access to credit and identification are an obstacle to women's access to jobs and assets, as well as to the creation of productive, sustainable markets. Blockchain technologies can help address some of these challenges. In terms of business ownership, there are approximately 10 million women-owned small and medium enterprises (SMEs) around the globe, representing around 30 percent of all SMEs in emerging markets. Seventy percent of these women-owned enterprises are unbanked or underbanked, which represents a finance gap of roughly \$300 billion per year.¹³⁶ Access to financial services such as credit, savings, and insurance are considered one of the major barriers to growth for women-owned businesses.

Laws and cultural norms that restrict women from opening a bank account are common causes of exclusion.¹³⁷ Women comprise just over 40 percent of the agricultural labor force in the developing world, a figure that ranges from about 20 percent in the Americas to almost 50 percent in Africa and Asia.¹³⁸ At a global level, one fourth of all economically active women were engaged in agriculture in 2015.¹³⁹ Supporting women's roles in agricultural value chains can increase productivity, profitability, and sustainability for actors along the chain.

Blockchain offers the potential to address some of the barriers to women's financial inclusion and economic empowerment, both as individuals and as business owners. It could provide a cost efficient digital

identity (see EMCompass Note 42, 43), which can help overcome women's comparatively low access to formal identification¹⁴⁰ and offer an entry to formal roles and remuneration in supply chains. It could also help women establish ownership of disputed land titles. Finally, it could promote financial inclusion by helping women establish credit scores through alternative credit data sources, bypassing traditional intermediaries and banks. Finally, blockchain's auditability and traceability can provide a tool for the monitoring and enforcement of supplier inclusion and gender empowerment initiatives that are currently difficult to monitor and enforce.

Investors and credit agencies are now paying greater attention to non-financial performance issues, including human rights and gender equality. Development-finance institutions such as IFC require their clients to adopt performance standards on environmental and social sustainability issues, which include a commitment to inclusion.¹⁴¹ A series of similar standards has been established by private sector institutional investors.

And consumers are also paying more attention to environmental and social standards. As a result, companies are increasingly aware of the importance of these issues to their brands and reputations.

While blockchain technology alone is not sufficient to address the cultural and structural issues underlying the challenge of gender equality, it does present a strong toolkit to tackle significant facets of the issue. The potential benefits of even marginal change can be significant for both the private sector and entire economies.

Challenges

As discussed in previous EMCompass notes, blockchain needs to overcome multiple challenges in order to become a mainstream technology. One key challenge is linked to the development and governance of the technology.¹⁴² Without a set of standards that can ensure the interoperability of systems across industry and supply chains, it will be difficult for the technology to achieve scale. Coexistence with legacy systems, as well as that of private and public blockchains in supply chains, will need to be negotiated. The blockchain development community also needs to provide a

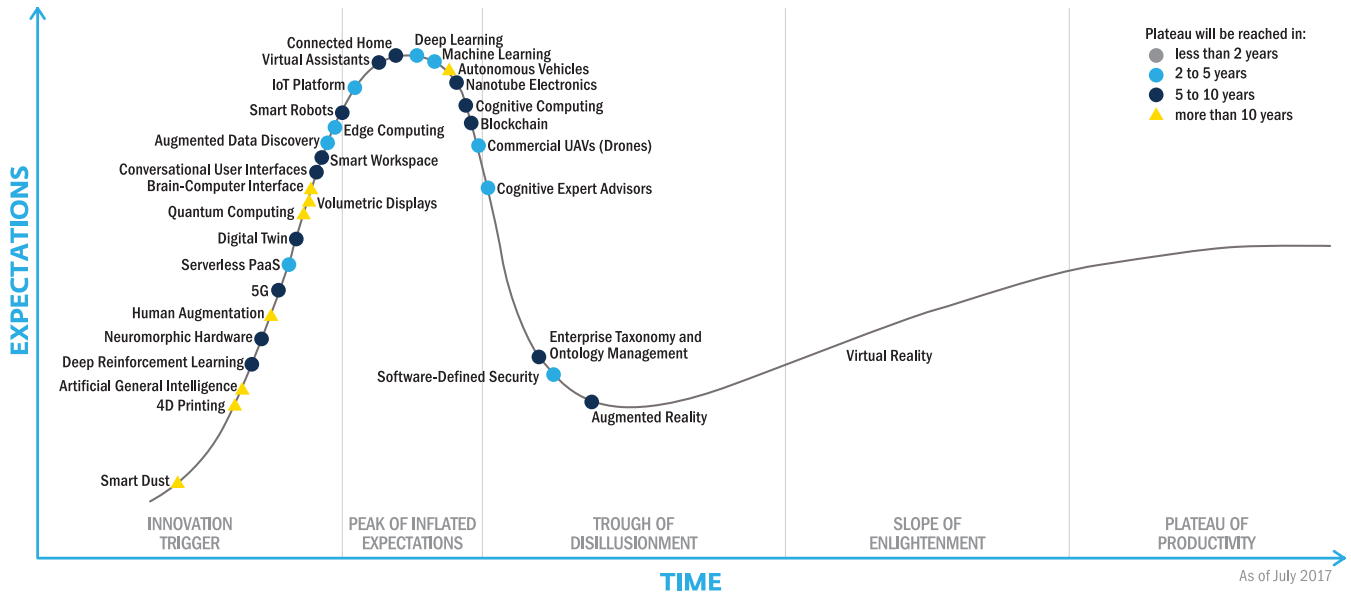


FIGURE 13 Blockchain Maturity Cycle

Source: [Gartner](#)

roadmap for continued blockchain innovation, particularly in rendering smart contracts more agile and ensuring scalability and security. Full network benefits will not be realized without widespread adoption by industry, an issue that renders blockchain's takeoff more difficult.

This will take time, as blockchain is a relatively new concept and the number of people able to use it is small. While companies in advanced economies will attract the best talent in the global workforce, those in developing countries may require more time to catch up. A lack of sufficient digital skills will be an obstacle to adoption, especially for SMEs and micro-enterprises that do not have the financial means to attract talent. Large players that act as hubs would have to require their supply chain partners to align accordingly. Failing to do so may lead to their eventual exclusion from the supply chain. In the case of SMEs, the digital skills gap may intensify their marginalization from the digital supply chain instead of advancing their inclusion.

Moreover, with the growing number of regulators concerned about potential risks, the regulatory framework for the technology is uncertain and unpredictable. Supply chains are currently governed by a highly complex, overlapping nexus of

legal and regulatory jurisdictions. In a recent industry survey, 56 percent of participants identified regulatory uncertainty as a major barrier to adopting the technology, followed by a lack of alignment among stakeholders, and of technological maturity.¹⁴³

CONCLUSION

Blockchain technology is still at a nascent stage of development, but there are signs that it is exiting the hype-cycle of inflated expectations and entering a more pragmatic phase of exploration (Figure 13). Educating key stakeholders, both in the private and public sectors, about the technology's benefits remains a big challenge. Supply chains are an ecosystem that prefers conservative innovation and is dominated by industrial players with complex business models that are not easy to reengineer. However, companies cannot afford to sit out the evolution of blockchain. They must be realistic about their expectations and use pilot schemes to learn and adapt their strategies. The closer the use case is to a real business challenge, the better the chances of productive feedback will be. Companies will also need to weigh the risks of adopting the technology against the numerous opportunities it has to offer. ■

CHAPTER 7

Blockchain Governance and Regulation as an Enabler for Market Creation in Emerging Markets

By Marina Niforos

Developing a proper governance and regulatory framework for blockchain-based applications will be essential to providing market participants the stability they need to fully engage with the technology, and allowing innovation to flourish. Given the global, multi-sectoral reach of blockchain, regulators and industry will have to work in a collaborative manner to ensure they can both experiment and learn, and so shape the future of the technology in a way that benefits all parties and society as a whole.

Blockchain has the potential to enhance competitiveness and increase connectivity across markets, increase inclusion of underserved market segments, boost sustainability and transparency of global supply chains, and build resilience against external attacks—all of which are necessary to the creation of markets.¹⁴⁴ The global regulatory environment has been slow to adapt to the technology, hindering its growth.

Previous EMCompass Notes (Notes 40, 41, 43, 44 and 45) argued that blockchain, a distributed ledger technology, can create new markets and products across emerging and developing economies, and thereby presents an opportunity to leapfrog the developmental cycle.

Blockchain promises to make peer-to-peer (P2P) transactions more transparent, global, and inclusive. This, in turn could empower a sharing economy that challenges powerful digital platforms such as Google, Amazon, Facebook, and Apple,¹⁴⁵ as well as Baidu, Alibaba, Weibo, and Tencent. Market incumbents see blockchain as both an opportunity and a threat, and so are moving into the space, as witnessed by the proliferation of blockchain initiatives by these firms.

Yet leapfrogging requires a proper regulatory environment to stimulate competition, investment, and innovation.¹⁴⁶ If blockchain-enabled markets are to come to life, regulators and businesses must work together. Regulators should think more like innovators

and adapt quickly to the fast-paced nature of the ecosystem, while businesses should strive to think more like regulators and assume governance responsibility, creating ground rules to protect the reputational integrity and the value of the ecosystem.

The 2017 exuberance surrounding cryptocurrencies and Initial Coin Offerings (ICOs) has led to greater scrutiny due to the fraudulent nature of many ICOs. This has marred the reputation of cryptocurrencies in particular and blockchain by association, mobilized a defensive response from regulators against potential risks, and detracted attention from the efforts of serious players developing useful applications.

As a result, some investors will be hesitant to significantly finance new blockchain-enabled business models. Moving forward, if blockchain-enabled markets are to mature, policymakers and businesses must create the rules of engagement together. Regulators should provide guiding principles to attract private-sector investors, ensure consumer protection and citizens' rights, and provide safeguards against anti-competitive practices.¹⁴⁷ The private sector can undertake initiatives to ensure industry-wide interoperability and compliance with existing legislation and overall public-sector objectives such as the collection of taxes and the prosecution of illicit activities.¹⁴⁸

For burgeoning technologies such as blockchain, finding a balance between risk mitigation and innovation will

not be straightforward. As long as distributed ledger technology (DLT) is applied by businesses to marginally improve existing processes, current legislation should suffice, as those processes are already subject to regulatory requirements. By contrast, highly disruptive use cases springing out of the blockchain ecosystem, with new and at times unpredictable technology and business models, will be far more difficult to regulate through current legislative frameworks.

Adopting definitive legislation at this early stage may be premature and hamper future innovation. And yet, legislators can't afford to do nothing in the face of blockchain's growth. They will need to think outside the conventional legislative toolbox and innovate, as happened in the early days of the Internet.¹⁴⁹ Collaboration will be key, with participation by public authorities and industry to accommodate the multi-sector, cross-border nature of the technology.

Regulation and self-governance

There are two primary ways to regulate a market: regulation and private rule-making or self-governance.¹⁵⁰ The first occurs through public regulators enacting legally binding statutes, also known as "hard law." The second is through private actors that self-regulate or co-regulate, or "soft law." National and supranational entities exercise statutory oversight with a wide or specific mandate in their jurisdiction. Actors may prefer "soft law"¹⁵¹ or rulemaking by private parties, as a more flexible approach to dealing with uncertainty and finding compromise among different actors.¹⁵² In the finance industry, an example of the latter is Visa's Core Rules, where the rules govern the actions of participants using the Visa payment system.¹⁵³ A hybrid example is the Basel Committee on Banking Supervision and the Financial Stability Board bringing policymakers from around the world to reach accords that can be translated into legislation in specific jurisdictions.¹⁵⁴

Public policy perspective: Key regulatory challenges

Until early 2017, actors in the blockchain ecosystem operated with little regulatory oversight.¹⁵⁵ The second half of that year saw an exponential rise of dubious

ICOs and bitcoin speculation, forcing regulators to take action due to the possibility of cryptocurrencies being used for tax evasion, fraud, and other illicit ends. Although regulators have become more vocal, issuing warnings to industry players as well as investors, blockchain's terminology is still evolving, complicating the legal classification of its assets.¹⁵⁶

Attempting to regulate a permissionless system like bitcoin, where there is no controlling legal entity, is a complicated task. Consequently, regulation so far has targeted cryptocurrency business applications such as exchanges and wallet providers.¹⁵⁷ In contrast, for permissioned DLTs where access is conditional and the participants are pre-screened, the existing regulatory framework should be able to provide sufficient oversight since the actors already submit to regulatory obligations (see EM Note 40 for a description of

- 1 Anonymity reduction through KYC, AML and CFT Directives
- 2 Legal nature of DL including territoriality and liability
- 3 Recognition of DL as immutable tamper-proof sources of truth
- 4 Conciliation of "Right to be forgotten" and DL immutability
- 5 Legal validity of documents stored in a DL as proof of possession or existence
- 6 Legal validity of financial instruments issued on a DL
- 7 Real-world enforceability, territoriality and liability of smart contracts
- 8 Treatment of shared information in DL from the perspective of cross-border flow of data and data protection
- 9 Use of DL as a valid ruling register for the IoT
- 10 Regulatory reporting information standards definition on the blockchain
- 11 Definition of a regulatory sandboxes approach to test

FIGURE 14 Distributed Ledgers' Main Regulatory Challenges

Source: BBVA Research, 2016. CIT = Combating Financing Terrorism; DL = Distributed Ledger; IoT = Internet of Things.

permitted and permissionless networks). According to international law firm Hogan Lovells, “arguably, supervisory oversight is less necessary in regards private blockchains (notwithstanding antitrust and competition matters, or powers necessary to supervise possible illegal activities).”¹⁵⁸

Regulatory authorities are thus faced with different challenges, depending on the sector and their mandate (Figure 14), and whether the blockchain is public or private. The paradox is that the same features of distributed ledger technology that can be forces for improvement and efficiency can also engender risks, depending on how the technology is used. This makes clear-cut answers on regulation extremely difficult. While deliberation on these issues is taking place in many forums, a consensus around some key guiding principles has yet to emerge. Nevertheless, there are cross-cutting challenges that require guidance and potentially regulatory oversight. These include (but are not limited to):

Cross-jurisdictional harmonization. Distributed ledger technology has by its very nature a global, cross-jurisdictional deployment. It requires regulators and lawmakers to collaborate across national borders to harmonize legal and regulatory regimes, while managing potential risks, including issues of monopolies and market manipulation.¹⁵⁹ Addressing these would require significant legal and organizational changes and a mechanism for collaboration to ensure alignment.

Security and data privacy. The distributed nature of public blockchains provides greater safeguards against potential external attacks and promises enhanced security. However, regulators fear that the system’s anonymity for users could encourage illicit activities such as money laundering and terror financing. Another concern is the compatibility of blockchain with the ‘right to be forgotten’ in the EU General Data Protection Regulation (GDPR), given the immutability of data on a public blockchain.

These are some of the frictions emerging between the potential benefits and risks associated with the technology, for which there is no immediate policy recommendation. In private blockchains, accessibility can be controlled by design and participants can ‘opt in’ to the desired level of disclosure and shared access.

Hyperledger Fabric and R3’s Corda, both examples of permitted DLTs, allow participants to control who can see what information about transactions submitted to the ledger.¹⁶⁰

Anti-money-laundering and illicit financing. Well-designed distributed ledgers could improve compliance with anti-money-laundering (AML) and know-your-customer (KYC) requirements, provided they include a secure identity system.¹⁶¹ However, given that false identities can hide behind the anonymity of open blockchains, and their past use for illicit activities, authorities in 2015 began to provide specific anti-money-laundering guidance and crack down on illegal activity linked to digital currencies.

The U.S. Financial Action Task Force (FATF) has urged virtual currency exchanges to comply with AML legislation by recording customer identities and conducting enhanced due diligence. European governments, in coordination with the Organisation for Economic Co-operation and Development, are pushing for global coordination on this issue. The European Union’s fourth anti-money-laundering directive requires interconnected registries to record beneficial ownership of companies and trusts, and to share with local tax authorities (OECD-BEPS Action 12).¹⁶² Japan has also amended its primary anti-money-laundering law to bring virtual currency exchange services within scope.¹⁶³

Scalability and interoperability. Setting technology standards could provide genuine interoperability between nascent protocols and legacy computer systems, thus promoting the scalability of distributed ledger technology. To this effect, the International Standards Organization, with the participation of 33 nations, is already working on standards for distributed ledgers that might remedy some of these issues. While scalability is not an issue of regulatory oversight, it addresses concerns that the sustainability of the system is in question and could lead to market failure in the long run.¹⁶⁴

Risk to fair competition. The development of blockchain-enabled applications, in particular by consortia in a permitted system, could potentially give rise to concerns about unfair competition issues in a number of areas.¹⁶⁵ These include: (i) the

prospect of market dominance by some participants, with negative consequences for cost and quality of services; (ii) a gating effect that may exclude new entrants; (iii) the adoption of technical standards that prevent participation by competitors; and (iv) the risk of collusion and market manipulation between participants. Companies collaborating with competitors through a consortium will have to consider the nature of the information they make available to competitors through a shared ledger, to avoid potential price fixing and exposing participants to potential antitrust liability.

Early responses from policymakers

A result of this fluctuating environment is that regulatory reactions have varied widely across different jurisdictions. The only consistent reaction has been that no jurisdiction has recognized bitcoin as legal tender.¹⁶⁶ A few have taken the step of enacting relevant legislation. For example, the U.S. state of Arizona passed legislation that qualifies blockchain-enabled signatures secured as valid electronic signatures. Similarly, Delaware voted to allow blockchains for corporate record-keeping. Russia has created a legal framework to legalize initial coin offerings, while France has authorized debt-based crowdfunding recorded on distributed ledger technology. Most jurisdictions, however, have maintained a wait-and-see approach to the underlying technology and have avoided comprehensive legislation. This approach gives regulators time to observe how blockchains develop. Experts are advocating for regulators to focus on regulating specific use cases of blockchains rather than the technology itself, a practice that has been adopted with other disruptive technologies such as the Internet and digital platforms.

Public authorities around the world have adopted different approaches:

Europe: The European Union has opted for a balanced approach.¹⁶⁷ The European Commission is actively monitoring related developments, and in February 2018 launched the EU Blockchain Observatory Forum to gather information from EU members on use cases and engage experts and practitioners before formulating concrete policies.¹⁶⁸ Also, the European Central Bank

formed a task force on distributed ledgers and launched a joint research project with the Bank of Japan.¹⁶⁹ For financial services, the European Securities and Markets Authority has recognized the need to strike a balance between ensuring safety in transactions and preventing unnecessary complexity, so as not to discourage participation by new entrants.¹⁷⁰

United States: The response from regulators has been fragmented since regulatory authority crosses agencies (the Securities Exchange Commission (SEC), the Commodity Futures Trading Commission, and the Treasury Department, among others), as well as federal and state jurisdictions. While the tax authorities treat virtual currencies as property, the SEC has refrained from providing a legal definition for bitcoin and virtual currencies,¹⁷¹ preferring to consider developments on a case-by-case basis, a “facts and circumstances analysis.”¹⁷² The SEC Chairman has suggested that ICOs¹⁷³ seem to fall in the realm of securities.¹⁷⁴ He also sent a clear message to market participants: “*those who would use distributed ledger technology to raise capital or engage in securities transactions must take appropriate steps to ensure compliance with the federal securities laws.*”¹⁷⁵

Singapore: Singapore is a major player in Asia’s innovation ecosystem. The Monetary Authority of Singapore is taking a collaborative, “risk

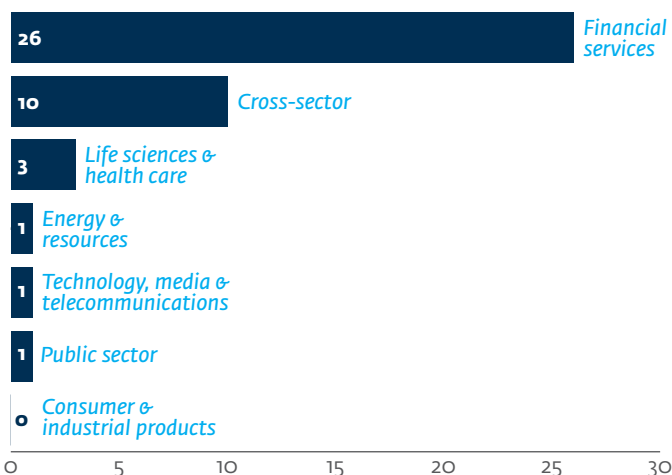


FIGURE 15 Consortia Distribution

Source: Deloitte analysis; see also Gratzke, Peter, David Schatsky and Eric Piscini. 2017. “Banding Together for Blockchain - Does it Make Sense for Your Company to Join a Consortium?” August 16, 2017.

proportionate”¹⁷⁶ approach to blockchains, and has launched a regulatory sandbox where fintechs, banks, and regulators work together. The regulator is collaborating on an international scale with other regulators, including the Hong Kong Monetary Authority, to develop a cross-border blockchain-based trade finance system. It has issued a public notice to qualify token sales as securities and has announced that it would develop a new payments service framework to ensure anti-money laundering compliance for companies involved in the dealing or exchange of virtual currencies.¹⁷⁷

Private sector governance challenges: The case of consortia

Technology industry analyst Gartner predicts that the value added for blockchains will grow to more than \$176 billion by 2025, and exceed \$3.1 trillion by 2030.¹⁷⁸ To capitalize on the opportunity, industry players are forming consortia to co-develop applications with innovators, while finding ways to minimize costs and potential risks. Blockchain technologies have a major impact when network effects can be realized and consortia provide a vehicle to leverage them.

A blockchain consortium is a hybrid, semi-private blockchain that allows organizations to establish ‘compartmentalized trust’ relationships and to condition access to the network accordingly. “A consortium platform provides many of the benefits affiliated with private blockchain—for example, efficiency and transaction privacy—without consolidating power with only one company.”¹⁷⁹ Participants involved in a blockchain consortium may have different priorities and may even be in direct competition with each other. Consortia can have a functional objective, such as solving a specific business problem. They can also be technical, seeking to develop universal interoperable and modular blockchain platforms across multiple industries. At present, there are over 40 blockchain consortia across the globe, which have attracted significant funding, mostly from the financial sector (Figure 15).¹⁸⁰

Governance is critical to running an effective consortium, given the volatility of blockchain

innovation and the divergent interests of participants. Trust is introduced through an entity, acceptable to all, that exercises control over access and makes decisions about membership and management of the alliance. As the size of consortia increase, however, so do the governance challenges of each group, which essentially consist of classic organizational problems of cooperation and coordination. A 2017 CoinDesk survey on digital innovation in financial services found that over 70 percent of respondents considered industry consortia as vital to the development of solutions.¹⁸¹ Yet a similar percentage had serious reservations about the format, from the system of incentives to the lack of control. Smaller, use case-focused consortia start to emerge and even large consortia are segmenting into different working groups to facilitate governance.

Establishing clear rules for engagement, decision-making, and accountability is critical. Participants must address how rules will be changed in the future after the distributed ledger technology is implemented. An important consideration for participants is the question of intellectual property, particularly if one or more of the participants come to the table with pre-developed technology, as there might be a risk of vendor lock-in (although open source is most likely the appropriate route for many consortia).¹⁸² During the early stages, most of the focus will be on converging around a technical solution. But as the business rationale adapts to changes in market conditions, decisions will have to be made about which course to pursue and how to effect changes to the code. Dispute resolution, sanctions for violations, and appropriate enforcement mechanisms need to be foreseen to address potential conflicts.¹⁸³

Self-governance and regulation: The importance of public-private collaboration

While computer codes by default are self-regulatory, they should not operate in isolation from a legal framework.¹⁸⁴ Regulations create legal certainty, allowing entrepreneurs to innovate without fear of breaking the law. Blockchain-based systems need robust governance mechanisms even though regulators are hard-pressed to keep up with the technology’s unpredictable nature. ICOs exploded onto the market

with such speed that regulators were unprepared for the outcome.

Michele Finck of the Max Planck Institute proposes a collaborative effort between regulators and innovators to account for the specificities of the technology and provide stability.¹⁸⁵ Given the still experimental phase of blockchain, businesses and regulators alike are struggling to learn quickly and define regulatory boundaries. At this stage, it is important to maintain flexibility and encourage engagement from both policymakers and industry to work on specific use cases.

Initiatives for engagement can be advanced by either party, such as regulatory “sandboxes” (see below) from public authorities or industry-led public private partnerships. An industry-led example is the U.S.-based Blockchain Alliance, which brings together stakeholders from the blockchain industry with law enforcement agencies from the United States and around the globe. The European Commission has launched two initiatives, the EU’s Blockchain Observatory and the European Blockchain Partnership, to coordinate the actions of Member States in the context of a digital single market.¹⁸⁶

Regulatory sandboxes: Toolkits for public-private dialogue

Sandboxes and similar government-backed initiatives are useful approaches that allow startups and regulators to learn together in practice and in a controlled “safe space,” so that they may make more informed decisions about the boundaries of their respective responsibilities. These are also a way to attract innovation to one’s jurisdiction without committing a priori to a binding legislation.

Sandboxes typically have the following features:¹⁸⁷

- Customizing rules for each firm/business proposal, rather than a one-size-fits-all approach.
- A small number of customers/clients, testing for a limited time-period, and safeguards for consumer protection (such as requirements of informed consent).
- Restricted authorization/licensing, individual guidance, waivers/modifications to rules for that project, and no enforcement action letters.

The model is already being tested in various jurisdictions. The UK Financial Conduct Authority (FCA) was the first to introduce a sandbox specific to blockchain. While the most experienced and firm-focused sandbox, its attractiveness may diminish with Brexit, a potential loss of a “passport” regulatory approval into other EU markets. Other countries have followed the UK’s example: Singapore, Abu Dhabi, Australia, Canada, Denmark, Hong Kong, Switzerland, Malaysia, and South Africa have all launched some form of a sandbox.

The main drawback of regulatory sandboxes is that they are limited to a single jurisdiction and do not accommodate the global reach inherent in the technology. While a global process of multi-stakeholder co-regulation has been proposed, it is unlikely to emerge any time soon.

An intermediate step could be the creation of a multi-jurisdictional sandbox. The FCA has proposed a global regulatory sandbox, uniting regulators from several jurisdictions and firms with multi-market ambitions to work together on policy and regulatory challenges. As a first step, the initiative proposes to create an international “college” of regulators, each with its own mandate or sandbox models, giving firms access to multiple regulators. It is a pragmatic, go-to-market approach that aims to provide firms with some guiding principles rather than a full-fledged set of standards across participating jurisdictions. Other experts have put forth a long-term vision of a full multilateral sandbox, perhaps under the mandate of a global multilateral institution such as the World Bank Group or the IMF. Entities like the European Commission may be in a position to encourage and coordinate such projects among member states. The recently signed European Blockchain Partnership is a promising start “to exchange expertise in technical and regulatory fields and prepare for the launch of EU-wide blockchain applications across the Digital Single Market.”¹⁸⁸

Corporate governance disrupted: The impact of blockchain on the role of the firm

Blockchain’s distributed trust mechanism has far-reaching implications for governance. Yet there has been limited research on how new crypto-corporate

governance models may emerge and challenge the board-centric existing model.

Decentralized Autonomous Organizations—also known as DAOs—operate without a corporate hierarchy. The evolution of smart contracts has the potential to revolutionize economic activity, displacing the firm as the primary organizational vehicle. A DAO promises to self-govern, with bylaws and decision-making codified into algorithms, and potentially little or no human mediation. Such a structure may be able to address an inherent agency problem in existing governance structures, where the interests and risk preferences of board members and shareholders may diverge.¹⁸⁹ DAOs are organized around the concept of a “town hall,” with the potential to give voice to all investors.¹⁹⁰ The original DAO, which was launched by Slock.it in 2016 on the Ethereum platform and raised \$150 million, was the first example of a such a structure. It had no directors, managers, or employees and the governance structure was built with software, code, and smart contracts.

Yet, the 2017 hacker attack on the original DAO that stole \$55 million exposed the vulnerability of the network and raised issues of liability for loss of value. The decision by the majority of shareholders to recapture the siphoned funds by breaking the immutability of the code splintered the community of developers/shareholders and undermined trust in the system and in the concept of “Code is Law.” This reputational damage of blockchain was compounded by the fraudulent use of ICOs, in the absence of clear rules.

The model of “crowd” blockchain governance is being tested. The question becomes whether the technology can and should fully replace a transparent democratic debate on governance, essentially a political process, with a technical rule-making system defined by elite developer communities.¹⁹¹ The more distributed ledger technology penetrates business use, the more it will be confronted with existing legislation. Blockchain will need to evolve and provide a clearer governance structure to guarantee transparency, accountability, and the protection of investors and shareholders. It will also need to recognize the socio-political context in which it operates and ensure that technical solutions

do not have unintentional effects in marginalizing segments of participants or undermining the freedom of individuals.

In response to these pressures, the corporate governance of companies stands to be disrupted as much as their business models, as they attempt to adopt and adapt to the technology. Traditional structures are already experimenting with blockchain and smart contracting applications to take advantage of potential efficiency gains from its auditability, immutability, and digital identification. Specifically, blockchain initiatives are underway to address some of the procedural flaws and costs for small shareholders of the Annual General Meeting by facilitating voting and registration of shareholder lists. The Nasdaq announced a successful pilot for e-voting in Estonian Annual General Meetings in 2017 and similar initiatives have been undertaken by the Abu Dhabi Securities Exchange, the Russian National Settlement Depository, and the Toronto Stock Exchange Group. Eventually, corporate actions such as the payment of dividends and coupons could be distributed through a fully automated process. This could result in lower costs for trading, faster transfer of ownership, and greater accuracy and transparency throughout the process.¹⁹² At present, experiments are marginal. But with the prospect of further automation through smart contracts, the question arises as to whether DAOs should have a legal corporate charter and what form these should take.

Corporate governance under a blockchain system can profoundly alter the power relations among managers, shareholders, regulators, and other stakeholders. The transition from a centralized world of corporate hierarchies to a distributed one still defies our established notions of economic production around the vertical firm. Disintermediated corporate governance structures and practices can perhaps offer a more cost-effective and efficient way for management to access market information and shape strategy. However, efficiency gains may be hampered by the ability of the platform and the nodes to extract rent for their efforts, proportionate to their market power. In any case, such changes will require significant reform and legal adaptation of the existing rules as well as a shift in the incumbent organizational culture.¹⁹³

CONCLUSION

Despite the exuberance surrounding cryptocurrencies, the distributed ledger technology is still at an early stage of development and remains a marginal economic phenomenon. Blockchain faces challenges of scalability, security, and mass adoption. With respect to its governance, the system is struggling to transition from a techno-libertarian model to one that can accommodate friction with the real economy. Yet for optimal governance, the deliberation process cannot take place in isolation. Innovators and regulators need to engage with each other to learn and shape the future of the technology in a way that benefits all parties, and society as a whole. Aware of the potential and the magnitude of the challenge, regulators in emerging markets, whether in Asia, the Middle East or Africa are actively observing the space and testing policy options (see discussion on regulatory sandboxes above).

Ideally, a global multi-stakeholder process should be put in place to pursue a uniform, rules-based system across national jurisdictions. But as the Internet has shown, implementing a global coordination mechanism can become mired in geopolitics, making the prospect of a global arbiter seem distant. Less ambitious scenarios for transnational cooperation are underway to develop public standards for the code, with international agencies working on some aspects of standards harmonization and for regulatory sandbox coordination. Whatever the process selected, a purely technological, amoral model cannot ensure the governance and sustainability of the blockchain ecosystem without acknowledging the real political and social pressures surrounding any change as fundamental as the one blockchain promises to bring about. ■

CHAPTER 8

Using Blockchain to Enable Cleaner, Modern Energy Systems in Emerging Markets

By Douglas Miller and Peter Mockel

Emerging markets must attract significant international financing to meet their goals for mitigating carbon pollution and increasing access to clean, affordable, reliable, and resilient energy. The authors of this note examine how blockchain technology can—if paired with smart, interconnected devices—promote needed investments by both improving investment processes and promoting the adoption of modern energy systems and business models. Given the nascent status of both blockchain technology and blockchain applications specific to the energy sector, this note offers guidance to better assess where and how to apply blockchain technology to achieve a modern, clean, energy future including in emerging markets.

The Paris Agreement (“the Agreement”)¹⁹⁴ on climate change indicates greater appetite by emerging markets (EMs) to deploy and track new methods of generating and delivering electricity in order to meet their commitments to reduce greenhouse gas emissions.¹⁹⁵ However, to tackle climate change and increase people’s access to reliable, clean energy, emerging markets must mobilize trillions of dollars from various sources.¹⁹⁶

Also, rather than operate centralized one-way, energy generation systems to meet inflexible demand, energy providers should use renewable, distributed, and responsive energy resources¹⁹⁷ that manage themselves through bi-directional¹⁹⁸ communication, and enable investors and other stakeholders to easily track and evaluate the impact of energy investments.

Given the opportunities and challenges involved in meeting the goals of the Agreement, and increasing people’s access to affordable electricity, to improve the investment process and bolster the impact of their energy sector investments,¹⁹⁹ policy makers, regulators, and investors could increase the use of blockchain technology, in combination with “smart” devices, Internet of Things (IoT), and big data.

Applying Blockchain Technology to Energy Sector Investments in Emerging Markets

Blockchain’s ability to establish greater trust and support more automated transactions may allow it to transform sectors and solve the pain points of emerging market investments.²⁰⁰ Such investments can lend themselves to blockchain-based solutions because they typically involve a shared repository of information, multiple sources and contributors of information to that repository, minimal trust between parties, one or multiple intermediaries, and various dependencies across energy infrastructure and management.²⁰¹

Blockchain is compelling as an enabling technology for scaling energy systems powered by renewable energy and responsive distributed energy resources. Energy sector stakeholders believe blockchain technology may in fact be the critical additional ingredient to smart IoT-enabled devices and big data that unlocks the new business models necessary for this energy sector transformation where millions (or even billions) of customer devices are being managed.²⁰²

Historically, electric utilities and energy companies produced value through energy generation, transmission, and distribution in order to meet inflexible energy demand from ratepayers. However,

the opportunity to generate value in the energy sector is shifting as ratepayers become prosumers²⁰³ and provide greater demand flexibility on electric grids.²⁰⁴ For example, in order to balance electricity loads, commercial, industrial, and residential customers can now use smart, interconnected devices that can automate the powering down of their electricity-consuming systems, battery storage, and other grid services in response to variability in renewable (or conventional) generation.

This shift toward focusing on devices at the grid-edge (e.g., smart thermostats, appliances, and batteries) also implies strong growth in the number of market participants that electric utilities manage—from thousands of ratepayers today, to millions or billions of customer devices in the future. Blockchain technology offers great promise for value because it can automate and reduce the costs of managing this growth in market participants.

As electric utilities manage the grid from the device level, they can automate operational decisions and maximize efficiencies across electric grids by using smart contracts. These run on blockchain to trigger, track, and settle the various grid services that smart, interconnected devices enable. The adoption of this leaner management of electric grids by utilities and system operators is expected to reduce operational costs and unlock revenues from new services. It is also expected to help meet policy mandates for implementing cleaner grids through the combined use of variable renewable supply, and responsive demand-side resources.

To better understand how this manifests in real-world applications, consider the following blockchain applications using smart contracts. In both scenarios, the grid services provided through demand response and battery storage are tracked, and any associated compensation is settled with customers for their grid services in real time on blockchain and system operators gain confidence about these demand side resources actually delivering valuable services to the grid:

Demand response to address undersupply of electricity generation: To avoid turning on a natural gas-fired peaking power plant on a hot summer day when there is a gap between electricity supply and demand, a

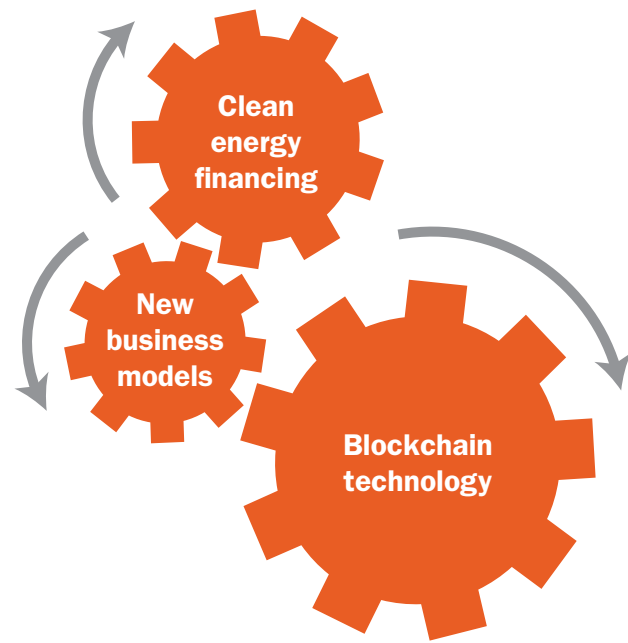


FIGURE 16 Convergence of Opportunities

Source: Authors

demand response “event” is signaled to power down smart devices based on the specifications written into the smart contracts governing them.

Battery storage to address oversupply of electricity generation: To store excess generation from wind power resources during evening hours when electricity consumption is low, a battery storage “event” notifies electric vehicles and other battery storage systems to store excess capacity, based on the specifications written into the smart contracts governing them.

Key Blockchain Application Domains in the Energy Sector

There are many application domains for blockchain technology in the energy sector that can deliver billions of dollars in global value annually through cost reductions—driven by greater automation and disintermediation—and revenue growth. Investors should consider application domains such as the following that offer the promise of value creation across the energy sector:²⁰⁵

- **Certificate-of-origin systems for renewable energy markets:** any application that documents the

provenance of renewable energy generation, issues certificates about the green attributes of each unit of renewable generation, and tracks ownership transfers between market participants for their green energy claims, and related voluntary or compliance reporting needs.

- **Utility billing systems:** any application where customers transact using cryptographic identities to manage metering, customer settlement, advanced rate implementation, or customer switching.
- **Demand response programs:** any application that conducts aggregation, real-time measurement and verification (M&V), settlement, and trading associated with participation in a given demand response event.
- **Electric vehicle charging networks:** any application that manages customers, vehicles, and charging infrastructure using cryptographic identities.
- **Transactive energy systems:** any market design where electric grids are balanced and controlled through intelligent software agents that perform grid communication and control functions for physical assets by responding to temporal and locational price signals.

Some additional applications that could deliver billions of dollars in global annual value to the energy sector include wholesale clearing and settlement, regulatory compliance, metered energy efficiency programs, grid asset procurement, and direct (energy-specific) climate finance.

Investors financing energy sector projects in emerging markets that overlap with these application domains should consider using blockchain technology to maximize private returns and broader social impacts.

The landscape of companies, consortia, and startups developing energy sector-specific blockchain platforms and applications is growing.²⁰⁶ The suite of blockchain-based solutions being developed and tested now—and those coming in the future—can enhance the vision, financial transfer, project implementation, and tracking associated with emerging market investments in the energy sector. Below are a few examples of promising blockchain applications that are testing commercial viability through existing or upcoming pilots, and

explanations of how these can support energy sector investments in emerging markets, which can provide a greenfield for introducing leapfrog technologies compared to existing markets:

- **LO3 Energy** builds on its existing Brooklyn Microgrid project in New York City with various products and applications such as Exergy and the Quantum Hedging System. Exergy offers a system for managing the physical characteristics and transactions for decentralized electric grids, which will help enable the adoption of transactive energy and new relationships between utilities, prosumers, and consumers—especially in cities and communities worldwide that already have independent grid edge projects. The Quantum Hedging System, which is being implemented in partnership with Direct Energy, enables enterprise customers to micro-hedge their energy purchases on an hourly basis to automate energy management and reduce costs.
- **Electron** promotes the adoption of smart grid infrastructure by developing products for energy sector market participants. Its various applications offer tools to register meters, trade demand response event actions, and coordinate distributed energy resource management—all of which help create new energy sector business models in emerging markets. Work to date has been in the United Kingdom (UK).
- **OLI** enables transactive energy systems by optimizing and automating the management of decentralized renewable generation and energy consumption with modular design. This application provides utilities with a new set of open-source hardware and software that enables a shift in their business model—thus, increasing the viability of decentralized, digital utilities. Work to date has been in Germany.
- **Share&Charge** is a decentralized protocol for electric vehicle (EV) charging, transactions, and data sharing, and was developed by MotionWerk to promote EV usage. The protocol simplifies access to EV charging stations, participation in demand response events and other grid services, and proof that electricity used to charge EVs comes from renewable generation. This application helps

harmonize fragmented EV charge point markets and grid service offerings to improve the experience of existing EV owners, and increase the appeal of EVs to prospective owners. Work to date has been across Europe, and includes a pilot in the UK.

- **Slock.it** enables transactive energy systems through its “Economy of Things” technology that allows for any object to be rented, sold, or shared securely. Its applications, including Incubed Client, allow machines to operate and respond to different energy sector scenarios autonomously, which offers a solution for emerging markets to implement transactive energy systems. Work to date has been across Europe.

- **Sun Exchange** increases solar power access for schools and businesses specifically in emerging markets through an innovative fundraising approach that creates rental income for those who buy solar cells and lease them to those using electricity from successfully funded projects. This application combines aspects of crowdfunding and “as-a-service” business models to pool funding from multiple sources, and deliver solar power to solar cell lessees. This approach increases the viability of solar access by eliminating upfront cost barriers to prospective solar electricity users, and creates a long-term revenue stream for solar cell investors. Several of these projects have been implemented in South Africa.

BOX 3 CERTIFICATE-OF-ORIGIN SYSTEMS FOR RENEWABLE ENERGY MARKETS

Renewable energy markets have experienced significant growth over the past decade and are positioned to continue expanding due to enabling policies, increasing consumer demand, technological advancements, and cost reductions.²⁰⁷ However, to catalyze investments to meet the goals of the Paris Agreement and unlock access to renewable energy, the process of tracking and reporting renewable energy investments must be simplified, disintermediated, and modernized.

Currently, renewable energy markets depend on certificates-of-origin, including the guarantees of origin (GOs) used in the European Union, renewable energy certificates (RECs) used in the United States, and international renewable energy certificates (I-RECs) in about 25 countries. These certificates of origin provide detailed proof for each megawatt-hour (MWh) of renewable generation,²⁰⁸ and are required because once electrons enter the shared electric grid, it is impossible to distinguish whether they were generated by renewable or fossil fuel resources.²⁰⁹

There is need to improve the operation of existing renewable energy markets, and the certificate-of-origin markets underpinning them that, for example, better enable smaller renewable energy generators and buyers to aggregate their supply and demand to gain greater market access.²¹⁰

To achieve their Paris Agreement nationally determined contributions (NDCs),²¹¹ emerging markets must improve

their systems for tracking and reporting on their carbon emission reductions. Because renewable energy generation assets lead to carbon emission reductions when they displace polluting energy sources, countries in emerging markets want to promote renewable energy investments as part of a portfolio of options to reduce their carbon emissions. While there is a parallel opportunity to develop separate blockchain applications for carbon markets due to shared pain points,²¹² investors should consider collaborating with emerging market stakeholders to determine how blockchain applications developed for certificate-of-origin systems can streamline documenting the carbon mitigation impacts of new renewable energy projects.

EWf is developing EW Origin, an open-source and blockchain-based toolkit for certificate of origin trading and tracking systems, and running tests of real-world scenarios in several countries with various energy sector market participants.²¹³ EW Origin can be used to build dApps that record the provenance, support direct trading, track ownership, and create reports for the green attributes of renewably generated electricity at the kilowatt-hour (kWh) level, as well as the associated avoidance of carbon dioxide emissions.

By adopting new technological tools that increase trust, simplify investment tracking, and reduce administrative costs, blockchain-based solutions like EW Origin should enable countries to leapfrog existing energy systems by encouraging more renewable energy investments.

- **Swytch** encourages more sustainable behaviors and the broadening carbon markets by providing a financial reward for those engaging in a range of behaviors, and aggregating their collective impact. This application encourages people, companies, and other organizations to adopt sustainable behaviors—starting with renewable energy production. It also tracks the execution of any sustainable actions with an open-source oracle that acts as a distributed authority—offering a means by which to motivate and prove dispersed sustainable actions. A pilot has been carried out in Germany.
- **WePower** enables financing for new renewable energy generation projects by using tradable smart contracts to establish digital power purchase agreements (PPAs) between parties. For renewable energy projects in emerging markets, this application gives renewable energy developers greater ability upfront to secure financing, and demand for energy from buyers such as multinational corporations, cities, and universities. It also offers buyers greater liquidity with these digital PPAs. The app is expected to become available for projects in Australia, Estonia, and Spain in the last quarter of 2018.

These and other applications are setting the stage for a suite of blockchain-based solutions that will promote investments in renewable energy, demand response, EVs, transactive energy, and other application domains where blockchain plays an important role in maximizing investor value and social impacts. Accelerating and coordinating these currently-dispersed blockchain applications, is the Energy Web Foundation (EWF)—a global nonprofit based in Switzerland that is accelerating blockchain adoption in the energy sector. EWF is developing an open-source, energy sector-specific blockchain and convening an ecosystem of users, developers, and regulators to inform the development of EWF’s digital infrastructure and promote the development of new energy sector applications.

Key Assessment Criteria for Blockchain-based Solutions in the Energy Sector

Emerging market investors who are planning to deploy financing in any energy sector application domain where blockchain technology provides value, should compare the viability and quality of different blockchain solutions before selecting one. Some of the criteria and associated questions for investors to use in their assessment include:

- **Technical architecture:** How is the technology stack structured—from the underlying blockchain platform to the specific applications running on the blockchain? How do applications interface with the blockchain itself? What components are executed on-chain versus off-chain?
- **Governance:** Is the blockchain public or private? What is the blockchain consensus protocol, and what are the resulting implications for throughput on the blockchain? Who are the governing and administrative bodies? What is the protocol for permissioning, system improvements, emergencies, and other actions? What controls and liabilities do users, governing bodies, and administrative bodies have? Who are the key stakeholders to engage who do not have a direct governance role, and at what junctures should this occur?
- **Features:** What are the users’ key functional requirements? Does the blockchain solution meet users’ business and regulatory needs?
- **Data collection and reliability:** What are the data sources? What is the methodology for sending data from these data sources to the blockchain? What data are stored on-chain versus off-chain, and how is this managed? What are the protections and processes in place to ensure data security, privacy, and reliability?
- **Throughput:** How much throughput can the blockchain solution handle? What are the gas limits and gas fees, where gas is the computational effort a given transaction needs in order to be executed on blockchain? What is the average block time? How do users pay for transactions, and how are transaction costs minimized?²¹⁴

- **Development process:** What methods are programmers using to develop the blockchain solution? Who is managing this development process, and how transparent is it? Who owns the intellectual property, or does the solution use an open-source license? How is the solution being audited and how are any identified issues or shortcomings resolved? How is the development funded, and what (if any) funding needs remain?
- **Ecosystem:** Who are the current or potential users of the blockchain solution? Who advised on its development? How extensive and available is the community of programmers who can support and build on the particular solution?
- **Innovation:** What are the licensing rules? To what extent does the solution promote further innovations? What programming languages can be used? To what extent is the solution interoperable with others?
- **Regulatory alignment:** What are the relevant regulations? What is the extent of regulators’ oversight over the solution? To what extent do regulators understand and support the solution?

Because blockchain is a nascent technology, additional assessment criteria for investors to consider will continue to emerge. Depending on the solution’s maturity level, investors should also evaluate its performance and suitability, based on its existing use in the market, and consider testing through pilots before promoting or adopting a specific solution. Nevertheless, the authors of this note recommend that investors and policymakers prioritize open-source, public blockchains with permissioned consensus protocols, as these can be expected to maximize participation, innovation, and throughput.

Emerging market investors, and any regulators and market participants with whom they work, can use the key assessment criteria listed above to evaluate the suitability of applications and platforms such as EW Origin, and the Energy Web blockchain infrastructure on which it runs. They can also use these key criteria to assess other applications promoting clean energy investments that also run on the EW blockchain, or others in the fast-growing energy sector landscape.

TOP APPLICATIONS	KEY ASSESSMENT CRITERIA
<ul style="list-style-type: none"> • Certificates of origin • Utility billing • Demand response • Electric vehicles • Transactive energy 	<ul style="list-style-type: none"> • Technical architecture • Governance • Features • Data collection and reliability • Throughput • Development process • Ecosystem • Innovation • Regulatory alignment

FIGURE 17 Top Applications and Key Assessment Criteria for Blockchains in the Energy Sector

Source: Authors

Given the regulated nature of energy markets across the globe, regulatory support is especially critical to scaling blockchain applications. Regulators, who are still deepening their understanding of how this technology works, identifying concerns, and the regulatory oversight that may be needed—should be engaged early and often so that they can increase their understanding of particular blockchain platforms or dApps, provide input, and draw on this experience to identify best practices and regulatory implications. For example, EWF is collaborating with a national certificate-of-origin issuing body (or registry) to develop a national reference on the implementation of EW Origin that meets regulatory needs. After the target completion date of October 2019, this will serve as a freely available open-source technology “template” for use by national regulators for issuing, trading, claiming, and reporting on certificates of origin in their markets.

Both before and after running simulations or pilots, and based on existing regulations, this engagement could include proactively seeking early feedback from regulators about the platform or dApp’s technical architecture, governance, and data sources. Also, to develop best practices for adopting blockchain solutions for different markets, investors should share their insights with regulators about their own blockchain assessments and pilots.

CONCLUSION

Investors have a tremendous opportunity with the Paris Agreement to accelerate and scale the adoption of clean, affordable, reliable, and resilient energy access in emerging markets. To tackle the challenges associated with deploying financing in emerging markets, and capture the opportunity presented as the energy sector modernizes, investors should leverage blockchain technology when they invest.

Provided that blockchain applications meet business and regulatory needs, in combination with smart devices, blockchain technology can deliver significant value across a range of energy sector application domains. Moving forward, investors and emerging market policymakers and regulators should use the assessment criteria provided above as a starting point to evaluate different blockchain solutions. Ultimately, these solutions can help unlock greater financing across the globe for democratized, decentralized, digitized, and decarbonized electric grids. ■

CHAPTER 9

Blockchain and Associated Legal Issues for Emerging Markets

By John Salmon and Gordon Myers

Blockchain, or distributed ledger technology (DLT), is a tamper-evident and tamper-resistant digital ledger implemented in a distributed fashion.²³⁵ This emerging technology, which enables direct transactions within a ledger without need for a central authority or trusted intermediary, has the potential to re-engineer economic models and enable the creation of markets and products previously unavailable or unprofitable across emerging markets. However, in considering the potential benefits of blockchain, organizations must also consider the associated risks and how they can be managed.

These risks include jurisdictional challenges, crypto assets, privacy and data protection, double spending, and distributed denial-of-service (DDoS) attacks. Several risks have been identified and overcome at similar innovative leaps in the recent past, including the commercialization of the Internet and cloud computing. It is essential that enterprises understand all risks inherent in blockchain systems, including being able to clearly identify who is accountable and legally responsible.

Blockchain's key characteristics present challenges to the existing legal and regulatory framework. It is comprised of digitally recorded data in "blocks" that are linked together in chronological order in a manner that makes the data difficult to alter once recorded, without the alteration of all subsequent blocks and collusion of a majority of the network.

Each node on the network generally contains a complete copy of the entire ledger, from the first block created—the genesis block—to the most recent one. Each block contains a hash (a fixed length alphanumeric string generated from a string of text) pointer as a link to a previous block, a timestamp, and transaction data. By its nature, distributed ledger technology allows for transactions and data to be recorded and shared across a distributed network of participants without the need for a trusted intermediary. The original instance of blockchain (bitcoin) was to enable peer-to-peer transactions without the requirement for, or cost of, a central party.

Organizations wishing to develop a decentralized application on a blockchain therefore face a new set of risks and issues to manage. Most of these stem from the fact that we live in a world where centralized governance and control is the norm. Accordingly, the vast majority of countries' laws and regulations envision centralized businesses or structures with a singular seat of control and responsibility. Deviating from this arrangement poses a challenge from a legal and regulatory perspective and raises enforcement issues.

This is particularly the case when it comes to regulated sectors such as financial services. In this sector there has traditionally been some form of central counterparty, which often is regulated. Within a particular system or process, that central party is accountable and takes responsibility for the provision of the services to all of the other participants through a contractual framework underpinned by the legal and regulatory structure. An example of this would be the

			Read	Write	Commit	Example
BLOCKCHAIN TYPES	Open	Public permissionless	Open to anyone	Anyone	Anyone*	Bitcoin, Ethereum
		Public permissioned	Open to anyone	Authorized participants	All or a subset of authorized participants	Sovrin
	Closed	Consortium	Restricted to an authorized set of participants	Authorized participants	All or a subset of authorized participants	Multiple banks operating a shared ledger
		Private permissioned ("enterprise")	Fully private or restricted to a limited set of authorized nodes	Network operator only	Network operator only	Internal bank ledger shared between parent company and subsidiaries

*Requires significant investment either in mining hardware (proof-of-work model) or cryptocurrency itself (proof-of-stake model)

FIGURE 18 Main types of blockchains segmented by permission model

Source: Hileman, Garrick and Michel Rauchs. 2017. "Global Blockchain Benchmarking Study." Cambridge Centre for Alternative Finance.

role of a central bank or other institution in clearing and settlement processes.

However, in many blockchain use cases there is no such centralized party that takes responsibility for the provision of services or controls associated data sets. Instead, each party in the blockchain network holds a copy of the data, rather than relying on a single central party to hold and maintain a master copy. For example, blockchain technology is being used to simplify cross-border payments, removing the need for transfers to pass through multiple parties (with associated charges) before reaching their destination.²¹⁶ While such decentralization can bring benefits, it also poses a legal and regulatory challenge if there is no central party that is responsible and can be held accountable.

The key issues that present risks to firms using blockchain, which are explained further below, are: blockchain systems spanning multiple jurisdictions; crypto assets; data protection; privacy compliance; and cyber attacks.

JURISDICTIONAL PROBLEMS

As the nodes of a decentralized ledger can span multiple locations around the world, it is often difficult to establish which jurisdictions' laws and regulations apply

to a given application. There is a risk that transactions performed by an organization could fall under every jurisdiction in which a node in the blockchain network is situated, resulting in an overwhelming number of laws and regulations that might apply to transactions in a blockchain based system.

In a public blockchain system it will be important to consider what law might apply to transactions and consider appropriate risk management that should apply. However, with a permissioned or private system it is easier to create some form of legal framework and internal governance structure that will dictate the governing law that will apply to transactions. In private systems it would also be beneficial to consider some form of agreed dispute resolution process.

Crypto assets

The difficulties of applying the existing regulatory regime can be seen clearly when it comes to the use of crypto assets. We currently see a huge range of opinions from regulators on crypto assets, from outright scepticism and bans in some countries,²¹⁷ to more cautious investor warnings from others,²¹⁸ while yet other countries have introduced regimes to attract more crypto activity.²¹⁹ These divergences of opinion and the resulting pitfalls are well documented in the example

of Initial Coin Offerings, or ICOs. The popularity of selling tokens via ICOs as a means of start-up fundraising has exploded in the last few years. Figures show approximately \$21.7 billion has been raised through some 935 ICOs over the period from January to November 2018 alone, dwarfing the amounts raised for blockchain projects via traditional venture capital during the same period.²²⁰ However, given the divergence of regulator opinion on the specific legal implications of a token sale, organizations that fail to consider at the outset whether their token sale may be compliant in the jurisdictions in which they plan to offer tokens may face an uncertain future.

Organizations may also have to ensure that the sale of tokens is limited to buyers in their desired jurisdictions in order to remove the risk of the offer extending to jurisdictions that are more heavily regulated or have outright bans on ICOs. In the United States, the Securities and Exchange Commission (SEC) has expressed concerns that many ICOs are either scams or attempts to raise money without complying with investor protection laws. Other countries' policy makers and regulators have sought to clarify the position by agreeing that not all ICOs would be required to comply with the same investor protection laws as would be the case with an initial public offering.

This has led to real difficulties for organizations that wish to use tokens in a legitimate way and are committed to complying with the regulatory regime wherever the token is made available. These organizations must deal with varying approaches across different countries, and the position also looks set to change—potentially very significantly—over the next few years.

These problems are particularly stark when one considers the reasons organizations wish to adopt cryptocurrency as part of their infrastructure. The traditional methods of raising capital to fund the growth of a business are debt financing and equity financing. This is clearly seen by both sides as a transaction in which the lender or investor should expect some form of return if the business is successful, but with an appreciation of the risk involved, particularly with early stage businesses.

An organization wishing to sell tokens may be seeking investment, yet it may also be attempting to build a user base through a network effect. If the organization is looking for an investment, it is perfectly reasonable for regulators and policy makers to expect it to comply with the usual investor protection laws; it would not seem equitable for an organization using cryptocurrency to circumvent these laws where the money raised from the tokens is an investment.

However, it is often the case that organizations using a token model want to build a network of users by offering cryptocurrency to use within the particular ecosystem being built. The objective in this case is to encourage people to become users of the organization's services, with the cryptocurrency used to pay for their provision. If the organization proves successful, the value of the token should increase accordingly, as usually there is a finite amount of the new currency sold. In this way, it is the users of the ecosystem who can contribute to and benefit from its success (and popularity), rather than equity investors. These types of tokens are often referred to as utility or consumer tokens, in that they are designed not as an investment but rather a device (or currency) to consume or use a particular service.

In many jurisdictions, regulators have acknowledged that there is a place for such tokens, and that they may not be regulated as an investment. A difficulty arises when organizations wish to sell tokens both to potential users of the system (utility tokens) and to organizations that do not intend to use the prospective service (for example, an investment bank or a venture capital company). Other challenges arise when the purchaser of the token buys many more tokens than the purchaser could possibly use or where there is no usable service at the point when the token is issued. Utility tokens that are sold as investments blur the line between what is regulated and what is not regulated, making it uncertain which regulations an organization must comply with in each jurisdiction in which a token is offered for sale.

These issues, together with the lack of a consistent global regulatory environment, can make it very challenging for those organizations that wish to benefit from the creation of their own crypto asset. There

are many reasons why such organizations may want to create their own crypto asset, such as the payment and settlement systems example and the benefit of the network effect mentioned above.

PRIVACY AND DATA PROTECTION

The issue of privacy and blockchain technology has been intensely debated. Many practitioners and academic commentators have claimed that blockchain technology is incompatible with privacy laws such as the EU General Data Protection Regulation, or GDPR.²²¹

As mentioned above, the original purpose of blockchain was to facilitate peer-to-peer transactions without the need of a central party. In a permissionless public blockchain system, no single party takes responsibility for the availability or security of a particular blockchain network, and all users of the system may have access to the data on the network. These attributes conflict with the thrust of privacy laws, which require the party controlling personal data of an individual to safeguard the security and privacy of that data on behalf of the individual or “data subject.”

Both a controller (the party that determines the purposes and means of processing particular personal data) and a processor (a party responsible for processing personal data on behalf of a controller, such as an outsourced service provider) have distinct obligations under the GDPR, making it important to determine whether a party qualifies as a controller or a processor when processing personal data. With a cloud computing system, typically those uploading personal data to the cloud environment are the controllers and the operator of the cloud system is the processor. This is a key area in which blockchain systems differ. Many blockchain systems are operated by all the users in a peer-to-peer network environment, which makes it difficult to define whether users are controllers or processors. It is necessary to consider to what extent the different participants in the blockchain network are controllers based on their respective activities.

Participants who submit personal data to the blockchain are more likely to be considered controllers

under GDPR, as they determine the details of processing, whereas nodes that only process personal data are more likely to be processors, as they simply facilitate the blockchain network’s operation. However, this determination is not straightforward, as not all blockchain systems operate in the same way, and there can be different types of participants carrying out various activities.

The nodes in a blockchain system might be compared to autonomous systems on the Internet. Each autonomous system receives packets and routes them autonomously to another node, repeating until the packets reach their destination. The kind of processing that blockchain nodes perform is arguably similar. The only purpose of the nodes is to ensure the integrity of the blockchain and to validate the addition of supplemental blocks. Privacy can be further protected through blockchain systems that use zero-knowledge proofs. This allows nodes in the system to verify transactions without the details of the transaction or the public key, ensuring personal data is not processed by nodes.

In the same way that a cloud service provider may not know what data a customer uploads to its cloud environment, administrators of a blockchain will not necessarily know whether personal data is present on the blockchain. Generic blockchains can be put to a wide variety of uses, and there can be different data and configurations, making it very difficult for the developer to build in privacy protections adapted to the nature of the data processed on the blockchain.

At best, governance rules can regulate users of the blockchain to respect privacy laws when they upload personal data to the blockchain. For private or permissioned blockchains, for particular purposes, governance rules can be much more developed, for example, by prohibiting users from uploading particular types of data to the blockchain.

Transfer of data

There have been debates in the cloud industry about when personal data is “transferred” overseas for privacy law purposes, and blockchain is likely to raise similar questions. For example, if a copy of a hash derived from personal data is made in Singapore, does this mean that data has been “transferred” to

Singapore for the purposes of privacy law? In the sense that data may be transferred to a node in any location, data put on a public blockchain is similar to data posted to the public Internet.

The reasoning of the European Court of Justice (ECJ) in the *Bodil Lindqvist* case may apply to the question of transfer, although this case was in respect of the European Data Protection Directive, which preceded GDPR.²²² The ECJ held that it cannot be presumed that the word “transfer,” which is not actually defined in the Directive, was intended to cover the loading by an individual of data onto an Internet page. A similar pragmatic approach is required for data on a blockchain to ensure that it is not “transferred” to every jurisdiction in which a node is present, causing unnecessary breaches of privacy regulations. As there is no single model for blockchain systems, each project will have to be analyzed on its own distinct merits.

Data security on blockchain

Blockchain technology is often referred to as “tamper proof.” This is generally because each new digital ‘block’ containing a record of transactions is connected to all preceding blocks. In order to tamper with any of the records contained in a block, a dishonest participant would need to change all subsequent blocks in the chain to avoid detection.

Given that blockchain is a decentralized ledger, there is no single point of failure that dishonest participants can override. Instead, they would require a huge amount of power to override and alter every node simultaneously. This is especially prominent in public blockchains where there can be any number of nodes existing anywhere in the world. Blockchain therefore presents a lower risk of attack than with centralized systems, in which key servers can be targeted and altered without trace.

Blockchain also uses advanced public key cryptography to secure its data, which relies on users having two cryptographically matched keys. When someone wants to send a user a file, they send the file to a user’s public key. The file can then only be opened by the user’s correlating private key. Together these features make blockchain a very secure method of recording data. There is relatively low risk of data tampering or data

being intercepted compared to traditional methods of transfer and storage, making blockchain a risk management system.

Risk of cyber-attack

Despite the high level of security that blockchain systems provide to the data recorded on them, there are some key cybersecurity risks that remain.

The unique challenge to decentralized systems, particularly public blockchains, is that data input can be from any number of nodes, meaning there is a risk of tampering at each node. The benefit of using a ‘tamper proof’ technology is negated if the information stored on the ledger is compromised to begin with. This type of attack is not aimed at the blockchain itself, but at external systems such as cryptocurrency wallets. There is a risk that individuals might target the data input point (rather than the ledger itself), leading to the dissemination of inaccurate information. Users operating on the blockchain would then unknowingly rely on misleading or false information. A 15-year-old boy from the United Kingdom proved this attack possible by developing a proof-of-concept code that allowed backdoor access into hardware wallets sold by Ledger.²²³ Using this approach, it would be possible to change wallet destinations and amounts of payments. An attacker could divert payments to his own account while making it appear to be the intended destination, ensuring the attack is undetectable to verifying nodes.

Another way data on a blockchain can be compromised is by a targeted brute force attack on certain nodes. In some blockchain networks, a concentrated number of nodes carry out almost all of the processing. If someone were to identify and attack the nodes covering the required consensus level, the chain could be compromised. However, such an attack requires an enormous amount of computing power.

In some systems an attack would only need to control more than half of the computing power of all nodes. Such attacks are more likely to be successful if the attacker specifically attacks the nodes with the highest computing power in which most transactions are concentrated.

Double spending and DDoS attack

Double spending attacks occur when the same currency unit is assigned to multiple users, enabling them to use the same coin simultaneously.

A distributed denial-of-service, or DDoS, attack is a type of cyber-attack in which a perpetrator attempts to render a service unavailable to its users by overwhelming its bandwidth, often by flooding it with traffic. Blockchain systems are less susceptible to these kinds of attacks than are traditional centralized systems, given the lower numbers of potential points of failure and ability to include denial of service prevention. However, where ledgers are concentrated on a few high-performing nodes, the likelihood of a successful DDoS attack is increased.

Smart contracts

Smart contracts are self-executing software code that runs on a blockchain. They are not in themselves contracts, and often are not particularly smart. Contract law will likely apply to the underlying transactions between the parties using smart contracts, assuming that the arrangement between the participants otherwise fulfils the requirements for contract formation.

The code in the smart contract defines the terms of an agreement on an “if” and “else” basis and then automatically enforces those terms if and when the specific criteria programmed into the code are met. For example, the execution of a smart contract can be verified by the network of users on a blockchain system, removing the requirement of a trusted third-party intermediary. Smart contracts therefore have the potential to reduce costs in areas that typically rely on an intermediary today, such as clearing and settlement.

As demonstrated in 2016 by the hack of the Decentralized Autonomous Organization (DAO) public blockchain, it is possible to target smart contracts that are run on blockchain systems.²²⁴ In the instance of DAO, the hacker was able to move approximately \$50 million in investor funds to a sub-contract that the hacker controlled. This type of attack is less likely to occur in private blockchain systems due to the number of users that have access to the smart contract; however, features should be built into the

smart contract to ensure that any hack can be corrected retroactively.

As mentioned above, traditional contract law may well apply to the underlying transactions embodied by smart contracts and, as such, the same liability issues apply to smart contracts. Software developers could therefore be liable for poorly written software code that results in a loss for their client, either through exploitation such as the DAO hack, or as a result of the code executing in a way not intended by the parties to the transaction.

GOVERNANCE IMPACTS

Accountability

In relation to decentralized systems, a key question for regulators is who should be held accountable for breaches of law and regulation. This is similar to the problem of determining accountability on the Internet before the emergence of blockchain. Accountability of the various parties carrying out relevant activities on the Internet has been a vexing problem since its inception. Prior to the Internet, information and other content, such as music and video, could only be published through existing publishers with an established distribution network. Where there were legal issues about content, for instance issues with copyright infringement and defamation, the publisher was clearly accountable.

In the case of *Google Spain v AEPD*, the Court of Justice of the European Union (CJEU) ruled that a search engine could be held accountable for the protection of personal data in respect of third party websites accessible through its service.²²⁵ It was emphasized in this case that the search engine’s activities could be clearly distinguished from those of the original publisher of the data. The harm to the data subject was not a result of the publication, but rather from the widespread availability of this information through a search engine.

In a public blockchain system, by contrast, there is no one easily held accountable in the same way as a search engine. In a private blockchain system, where there is clear ownership and responsibility, regulators might expect those running the system to be accountable for data added to the system by all the network users. The

system owner could be seen as enabling the distribution of data through the blockchain in a comparable way to a search engine. It would then be the system owner's responsibility to protect this data, despite not publishing the personal data itself. The owner would likely have to put in place a set of operating conditions on the private blockchain that comply with regulations, which all users would in turn agree to comply with.

Taxation challenges

The application of existing tax frameworks to a digitalized economy has posed significant challenges to national and global tax authorities. For example, digital economy concerns are at least partly within the scope of the OECD's Base Erosion and Profit Shifting (BEPS) concerns. In some cases, governments have suggested that broad-based "virtual" profit allocation rules, rather than existing permanent establishment concepts, should apply. India has introduced an "equalisation levy" on payments made to certain non-resident on-line service providers.²²⁶ The European Union has considered similar measures. Over the longer run, a "virtual permanent establishment" concept is envisaged.

These ongoing discussions may have significant implications for blockchain and distributed ledger technology platforms. For example, it seems evident that cryptocurrency transactions will be taxed as assets, that is, on a capital gains basis, without application of VAT. However, issuances of utility tokens, for example, to employees, may be more appropriately taxed as income. Similarly, for policy reasons, government authorities may prefer to defer revenue recognition until disposition, or provision of the underlying services, as is the case in Israel. These are complex matters that, even within a BEPS framework, may promote competitive tax practices that other authorities may view with concern.

In the case of non-cryptocurrency platforms, BEPS-type concerns may well influence industry and governance structures in unintended ways. For example, industry DLT platforms for supply chain management may tend towards centralization, so that they are owned and nominally governed (consistent with BEPS limitations) from low-tax jurisdictions.

Similarly, "smart contracts" more efficiently executed on-chain, may be moved off-line to centralized operations to ensure favorable tax treatment of ledger transactions. This solution may achieve compliance, however, at the cost of the efficiencies and certainty argued to arise from using a blockchain-only architecture.

Regulators working with the industry

To allow the financial industry to enjoy the full benefits of blockchain technology, it will be necessary for regulators to work with the industry to ensure that compliance with regulation can be achieved while still allowing blockchain technology to be used to maximum potential. In some jurisdictions, regulators may be required to move away from the use of detailed and prescriptive rules in favor of broadly stated principles that set the standards at which the industry must operate. This would allow regulations to be flexible enough to encompass the wide variety of systems that blockchain allows for. Even in these jurisdictions, however, regulators should work closely with stakeholders to ensure that their thinking on acceptable industry practices is transparent. As in Singapore and the United Kingdom, these efforts can support innovation by providing "bright line" certainty to new and non-traditional industry entrants.

One opportunity to adapt regulatory compliance to distributed ledger technology could be the use of regulatory sandboxes. These provide the ability to test services with real customers in a controlled environment without incurring regulatory consequences. Regulators can gain an understanding of the function of the blockchain systems and cooperate with the industry to identify and develop methods for compliance. This would help regulators develop a level of regulation that encourages and enables innovation while ensuring adequate protection for users—and would encourage development of technology solutions (such as electronic identification, authentication, and trust services that mitigate, for example, anti-money laundering and ultimate beneficial ownership concerns). One challenge of regulatory sandboxes is ensuring they are attractive to start-ups. Sandboxes should encourage innovation and allow for start-ups to grow, rather than merely offering value for the regulator.

Another opportunity to adapt regulatory compliance may lie in careful application of existing regulatory principles to the blockchain environment. For example, regulators will inevitably favor more centralized blockchain and DLT platforms that provide a “home” for regulatory supervision. Alternatively, in decentralized systems, they may take the view that all participants are liable for compliance issues. A more nuanced approach also may be possible. For example, in relation to regulation of privacy issues in unpermissioned systems, France recently took the view that only active participants—those actively inputting data into the system, and not mere “nodes” or “miners” providing verification of transactions to the platform—are responsible as data controllers.²²⁷ This approach may more effectively balance the public interest in large-scale “trustless” systems, by ensuring meaningful accountability for privacy and personal data practices.

Finally, tax issues may continue to challenge the industry. Absent global agreement on “digital economy” principles, one can surmise a fragmented global tax environment, consisting on one hand of aggressively low-tax environments targeted at attracting “producers,” and on the other hand, aggressively extraterritorial jurisdictions, targeted at realizing offshore income they believe has been derived from “consumption” in their home territory. Such a tax environment is uncertain for innovation, generating risky tax structures and deterring investors.

Meeting governance objectives

Blockchain system designers may seek to incentivize good behavior by participants in order to meet governance objectives and reduce the risk of non-compliance with regulation by the blockchain network. This may be done by setting rules that ultimately induce the right behavior. Bitcoin, for example, incentivizes miners to verify legitimate transactions by rewarding them with bitcoins. Bitcoin mining is difficult and inefficient by design, making it costly for any node that deviates from the correct protocol and fails to receive a reward.

Designers of blockchain systems could ensure compliance with the legal and regulatory framework by

building it into the system. For example, participants could be locked out of the system unless and until they had been through an appropriate anti-money laundering compliance check.

Beyond blockchain and DLT platform design, decentralized systems pose significant governance and capacity challenges for participants and platforms alike. Fortunately, the industry and regulators have coalesced around key principles for digital platforms and outsourced information technology operations, providing a strong basis for risk governance. Key elements include careful management of information assets; board oversight of resilience and business continuity; development of operational risk metrics and integration with robust enterprise risk management capacity; and considered protocols for management of data incidents.

The proposed European Banking Authority outsourcing guidelines for banks in Europe are a good example of how regulators expect banks to manage outsourced risk, whether based on new technologies such as the cloud or on more traditional models. It is inevitable that regulators will expect the same level of risk management, due diligence, and ongoing monitoring of suppliers of blockchain based systems. Where there is no “supplier” as such (as for a public blockchain), regulators may be hard-pressed to establish oversight responsibilities beyond assuring robust diligence, risk governance, and reporting by users.

We can safely assume that regulators will want to ensure that transparency and understanding of smart contracts are embedded into blockchain and DLT applications. We can similarly surmise that legacy entities participating in blockchain and DLT platforms will want to “flow down” their requirements to governed platforms with a single point of accountability. This would suggest at least that even open permissionless systems will require thoughtful user understandings and allocations of liability, perhaps resembling governing organizations for open source software, to attract commercial users. For the immediate future, it may also suggest that use of permissioned and limited applications is more likely.

Two other governance areas will require resolution if the opportunities inherent in open, trustless systems

are to fully emerge. First: decentralized autonomous organizations may present an entirely new mechanism for the organization of capital and commercial activity. Yet the structuring of these vehicles—with regard to risk management, minority protections, and transparency—remains an area for research and evolving practice. Second: there are concerns that the lack of a single point of accountability in a blockchain or DLT platform makes that platform an unincorporated joint venture in which all participants are jointly and severally liable for outcomes.

This is partly reflected, for example, in the French GDPR decision discussed earlier. While, as with the French decision, courts may ultimately limit this exposure to active participants and contributors, this will not be the argument made by plaintiffs' counsel. It is possible that some combination of a strict liability regime, together with statutory liability limitations and support of an appropriate insurance product, will be required. However, as in some public permissionless systems, this approach may be problematic when identity is not apparent, making apportioning liability difficult. This is yet another reason why we view entirely pseudonymous systems as unlikely to be acceptable to regulators, at least in regulated or sensitive settings.

A number of recent articles suggest that development of significant, impactful blockchain applications remains several years away. We do not believe this to be the case. At least for permissioned, governed systems, the regulatory and governance principles allowing public and private players to implement and operate these principles, on a risk assessed basis, are in place.

The more significant concern is that the continued relevance of these principles may deter realization of the full range of opportunities inherent in open, trustless systems. **Our discussion suggests that the application of these frameworks effectively requires a point of accountability for governance and liability, or in the alternative, some measure of joint and several liability by all participants.** More radical decentralization may require more interesting “compliance by design” elements, such as digital identifiers and ultimate beneficial ownership

verification; agreed risk reporting available to participants and regulators, embedded in the platform's information architectures; and perhaps some form of overarching liability allocation framework, possibly comprising strict liability principles paid from a pool established by participants and supported by insurance and liability limitations.

The alternative position is that—at least in the short term—an accountable intermediary will be required. One option is that industry foundations, similar to those that exist for key open source software and content licenses, can facilitate the transition to more comprehensive decentralization. Another option is that a private sector technology company takes responsibility for the provision of the blockchain system (some of which might be provided in a permissionless way) in the same way that private companies provide open source software. This option may defeat the entire purpose of using a decentralized blockchain system, as it effectively centralizes the platform and requires users to trust that the provider is acting honestly (and will likely require that they pay a fee for the provision of the system). A partially, but perhaps more effectively, decentralized model may include a consortium of private sector providers who share responsibility, cost, and allocation of liability.

CONCLUSION

It is clear there are a number of important risk management concerns for any organization wishing to adopt blockchain technology. However, we have seen many of these challenges before in the adoption of the Internet generally, as well as other technologies such as cloud computing. The key is for the organization to truly understand the risks inherent in the system and to ensure that these are adequately managed and mitigated where necessary. The critical remaining issue is that the structure of contractual frameworks and associated regulation was not designed for the decentralized data world of blockchain. In particular, understanding who is accountable and legally responsible is a major challenge. It is clear to us that the adoption of the technology would be treated like any other form of outsourcing. For those wishing to adopt

this new technology, there are three potential models to consider:

One. Private or permissioned models where a single party or group of parties takes responsibility for operating the system. This is the easiest path and would be no different from existing outsourcing/cloud arrangements. A node controlled by a regulator could also be included to act as a neutral party.

Two. Public blockchain systems where there is a clear contractual framework between the participants—one which reflects a more “joint venture” approach and which looks to allocate liability and accountability to the parties. This could be accomplished effectively by a kind of end-user license agreement that conditions use of the public platform on adherence; or perhaps even something that feels like an open-ended fund, where anyone can join but there is a clear legal structure and risk allocation. In general, it would seem that this model would have to be implemented on the inception of the system.

Three. Public blockchain systems where an organization takes on the responsibility and liability for running the system. This could be through open source systems such as Hyperledger, which has a core framework in place and the ability for organizations to alter the network according to their needs, grant permissions to those who need it, and keep out those who don't.²²⁸

It will likely be difficult for any organization that has to ensure effective risk management to consider a purely permissionless blockchain system without some additional protections. Of course, not all organizations have the strict requirements of financial services companies and other organizations in highly regulated sectors. Regardless of the model adopted by those seeking to use blockchain, it is important that regulators remain flexible in their approach to this emerging technology—and avoid viewing it through a lens designed for more traditional, centralized platforms. ■



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- ²¹⁰ Certificate of origin markets rely on third parties, outdated technologies, and multi-step processes that vary across geographies to indicate the proof of renewable generation. The resulting administrative costs, transaction costs, and other pain points, as well as the complexities of proving renewable energy generation or purchases, frustrate the current (mostly large) market participants, and discourage others from entering the market. For their renewable energy trades, certificate of origin systems should make it as easy as possible for market participants to obtain proof for their voluntary- or compliance-reporting requirements, which is based on secure, reliable generation data. The user experience associated with certificate-of-origin systems should also become more standard across markets to streamline investments for the multinational renewable energy developers and buyers who are enabling renewable energy developments across the globe.
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will make the full open-source EW Origin toolkit publicly available for reference and use as a template by other REC, GO, and I-REC trading and tracking systems so that application developers can build and deploy their own modernized technology services. In the context of emerging markets, which generally do not have robust renewable energy tracking systems in place, EW Origin can be used to build blockchain-based applications that reduce investors' administrative burden for tracking the impacts of their wind, solar, and other renewable energy investments. The regulators who oversee renewable energy markets can adopt and modify open-source blockchain applications such as EW Origin to deploy modern trading and tracking systems for certificates of origin that meet their markets' needs.

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About IFC and World Bank Group work on blockchain

The International Finance Corporation, or IFC—a sister organization of the World Bank and member of the World Bank Group—is the largest global development institution focused on the private sector in emerging markets. IFC collaborates with the Technology & Innovation Lab, which was launched by the World Bank Group's Information and Technology Solutions (ITS) in June 2017.

ITS provides advice and learning-by-doing guidance in a lab environment (both physical and virtual) for Bank Group stakeholders. The ITS Technology & Innovation playbook applies design-thinking methodology, which leverages rapid proof-of-values and prototyping to test new capabilities. This process expedites learning and understanding of the appropriateness of emerging technologies for development.

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Creating Markets, Creating Opportunities