University of New South Wales Law Research Series

DISTRIBUTED LEDGER TECHNOLOGY AND DIGITAL ASSETS - POLICY AND REGULATORY CHALLENGES IN ASIA

DOUGLAS W. ARNER, ROSS P. BUCKLEY, ANTON DIDENKO, CYN-YOUNG PARK, EMILIJA PASHOSKA, DIRK A. ZETZSCHE AND BO ZHAO

(2019) Asian Development Bank
[2019] *UNSWLRS* 60

UNSW Law
UNSW Sydney NSW 2052 Australia

E: unswlrs@unsw.edu.au
W: http://www.law.unsw.edu.au/research/faculty-publications
AustLII: http://www.austlii.edu.au/au/journals/UNSWLRS/
SSRN: http://www.ssrn.com/link/UNSW-LEG.html

DISTRIBUTED LEDGER TECHNOLOGY AND DIGITAL ASSETS

POLICY AND REGULATORY CHALLENGES IN ASIA

JUNE 2019

ASIAN DEVELOPMENT BANK

ADB

DISTRIBUTED LEDGER TECHNOLOGY AND DIGITAL ASSETS

POLICY AND REGULATORY CHALLENGES IN ASIA

JUNE 2019

ASIAN DEVELOPMENT BANK

6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines
Tel +63 2 632 4444; Fax +63 2 636 2444
www.adb.org

ISBN 978-92-9261-646-5 (print), 978-92-9261-647-2 (electronic)
Publication Stock No. TCS190205-2
DOI: http://dx.doi.org/10.22617/TCS190205-2

Notes:
In this publication, "$" refers to United States dollars.
ADB recognizes "China" as the People's Republic of China; "Republic of Georgia" as Georgia; "Hong Kong" as Hong Kong, China; "Korea" as the Republic of Korea; and "Russia" as the Russian Federation.

Cover design by Mike Cortes.

Contents

Tables, Figures, and Box

Tables

Figures

Box

Foreword

Distributed ledger technology (DLT) and blockchain, and their headline-catching applications in cryptoassets and initial coin offerings (ICOs), have attracted extraordinary global attention. Alongside Bitcoin's spectacular rise and fall in the past few years, there has been an explosion of ICOs, a tokenization of assets, and fund-raising projects utilizing digital tokens issued and operated on blockchains.

Asia has taken a leading role in many aspects of these phenomena, from blockchain development and cryptoasset investment, mining and trading, to launching and participating in ICOs. At the same time, an increasing range of jurisdictions in the region have become concerned about risks, particularly from nonsovereign cryptoassets and ICOs.

Yet, widespread misunderstanding in scholarly literature and the media of many aspects of these technological developments raises a number of unanswered questions. For example, what are the differences and links between DLT, blockchain, cryptoassets, and ICOs, and what are the current regulatory practices and challenges related to these new technologies?

This report offers a new analytical framework to help policymakers review and assess opportunities and challenges associated with DLT and blockchain for the financial services industry. With this framework, the report explains and defines the related concepts of cryptoassets and ICOs and seeks to clearly delineate the differences between each and bring much needed clarity to how to regulate them. This report also aims to illuminate the trends, concerns, and potential opportunities of DLT, especially for Asian markets, arguing that a proportionate, functionally focused approach is necessary to balance potential benefits with new risks.

This report offers basic guidelines for FinTech regulatory development. I believe it will be a useful resource to support financial inclusion in Asia and the Pacific by enhancing understanding of the benefits and limitationss of potential policies and regulations.

Yasuyuki Sawada
Chief Economist and Director General
Economic Research and Regional Cooperation Department
Asian Development Bank

Acknowledgments

The report was prepared by the Regional Cooperation and Integration Division (ERCI) of the Economic Research and Regional Cooperation Department, Asian Development Bank (ADB), under the supervision of ERCI Director Cyn-Young Park. Bo Zhao, Economist, ERCI coordinated overall production, assisted by Paulo Rodelio Halili and Mara Claire Tayag, both Senior Economics Officers, ERCI. The main contributors are Douglas Arner, Ross Buckley, Anton Didenko, Cyn-Young Park, Emilija Pashoska, Dirk Zetzsche, and Bo Zhao.

The report benefited from valuable comments from Lotte Schou-Zibell and Thomas E. Abell. Ritchie Anne Rono provided input for the distributed ledger technology use case studies, and Mara Claire Tayag, Clemence Fatima Cruz, and Chengcheng Liu provided excellent research support.

The report was edited by Eric Van Zant. Michael Cortes created the cover design and did the layout and typesetting. Support for publishing and printing was provided by the publishing team of the Department of Communications and by the Printing Services Unit of the Office of Administrative Services.

Abbreviations

ADB	Asian Development Bank
DLT	distributed ledger technology
EU	European Union
ICOs	initial coin offerings
IOSCO	International Organization of Securities Commissions
ISO	International Organization for Standardization
PRC	People's Republic of China

Executive Summary

Distributed ledger technology (DLT) creates new opportunities and challenges for the development of the financial sector in Asia. Indeed, the most prominent current applications of DLT—cryptoassets and initial coin offerings (ICOs)—have become very popular, their hype and volatility raising fundamental concerns among regulators. Over the medium to long term, nonetheless, DLT will likely find its way into an increasing range of contexts and, in some cases, fundamentally improve the financial systems involved.

This report offers an analytical framework that allows for more systematic assessments of DLT and its applications. As pointed out in section 1, the report looks at the evolution and typology of the emergent technology, its existing and projected applications, and the regulatory and policy issues that they entail.

Section 2 begins with an overview of distributed ledgers, the underlying technology for blockchain, followed by its applications such as cryptoassets, ICOs, or the automation of back-office clearing and settlement. DLT generally must be distinguished from blockchain, which is commonly run on distributed ledgers. The ledgers should also be distinguished from various end uses of these technologies, particularly cryptoassets and ICOs (a conjunction of crowdfunding and blockchain). Section 2 further discusses the potential of DLT beyond blockchain and its implications.

Section 3 zeroes in on cryptoassets, which can exhibit certain features of money, such as acting as a medium of exchange. But as alternative currencies, these cryptoassets have proven to be too speculative and have largely failed to function as a store of monetary value. While the rise of cryptoassets has yet to pose systemic concerns, monitoring is nonetheless in order as cryptoassets develop, particularly given rising market integrity and consumer protection concerns. In addition, a number of countries are examining the feasibility of introducing a sovereign cryptoasset (generally central bank-issued) as an alternative settlement currency, medium of exchange, and/or store of value. However, the implementation of such a sovereign alternative is fraught with technological, legal, macroeconomic, and other policy issues, many of which remain untested nationally and unresolved as a result.

Section 4 discusses ICOs, which raise funds by combining aspects of crowdfunding and cryptography. In an ICO digital tokens (coins) representing various rights are issued and managed on a blockchain that operates on a distributed ledger. ICO tokens can confer an entitlement to a share in profits or capital gain (in which case they will typically fall under regulation as securities or possibly as a collective investment scheme). They can also confer an entitlement to cryptoassets (which may subject them to regulation as derivatives) or an entitlement to use the product or join a community to be developed with the funds raised (which will typically not fall within the purview of financial regulation and merely be subject to general consumer and commercial laws).

Section 5 identifies the key limitations relevant for all applications of DLT and outlines the corresponding policy implications. The rapid spread of DLT applications has triggered regulatory actions across the region, mainly as warnings of the associated investment risks

(largely in relation to ICOs). While the economic potential of DLT and its applications is widely recognized, regulators are also mindful of the potential risks that would give rise to the need for protections for consumers and investors. Their actions have therefore gradually shifted toward regulation of DLT-based products and services, either by extending existing law to cover them or by issuing new regulations or guidance. However, distributed ledgers vary widely and some specific features—particularly relating to governance, such as consensus mechanisms—can influence the risks to be taken into account in deciding whether or to what extent to regulate DLT applications.

The report suggests in its final section a functional and proportional approach to these issues that balances the evident risks arising—such as in relation to transparency, cybersecurity, and immutability—with the significant opportunities for innovation. As such, regulators must carefully consider the uses and functions of DLT against its core strengths and features.

In summary, the following approach is recommended:

- From a regulatory and policy perspective, DLT should be treated as a platform technology which can be used across a wide variety of functional areas, from identity to property registration to financial infrastructure, payment, and fund-raising.
- National and international regulators should consider a system of categorization and certification [generally on an industry basis, e.g., through the International Organization for Standardization (ISO)] combined with the general legal system.
- Regulatory approaches should be flexible depending on the context, with the initial focus on regulating the applications of DLT in cryptoassets and, in particular, cryptoasset exchanges and ICOs.
- Consumer protection is an important consideration for regulatory frameworks, as both public interactions with DLT systems, and the role of intermediaries, are exposed (with a large range of market integrity, consumer protection, and financial stability risks).
- Finally, policymakers and regulators should strive to better understand individual use cases of DLT and underlying systems, balancing the opportunities to build better financial infrastructure that could bring massive long-term benefits with the management of the many risks that will arise along the way.

1. Introduction

Distributed ledger technology (DLT) and blockchain have attracted massive investment interest in recent years,[1] with asset values, projects, and investment hitting records in 2017. This is particularly so since alternative currencies, such as Bitcoin, a cryptoasset, have risen to global attention.

This investment interest reflects the very real transformative potential of DLT, especially in the financial sector. Many financial institutions are investing heavily in proof-of-concept demonstrations and the rollout of pilot applications of DLT, in addition to a range of high-profile consortium projects and an ever increasing range of startups.

Proponents hold out a long list of the potential promise of DLT—from capital raising and trading, to deposits and lending, to property and casualty claims processing (InsurTech), to digital identity management and authentication, to regulatory technology such as anti-money laundering and client-suitability checks. This report finds it likely that over time, DLT will become a useful tool in several contexts.

It is also true, however, that these developments warrant close attention to DLT by regulators as they aim to strike a balance between the potential benefits and the pitfalls. An increasing number of jurisdictions in Asia have become concerned about risks, particularly with nonsovereign cryptoassets and initial coin offerings (ICOs). This report therefore aims to clarify the most prominent issues.

It is now clear that Bitcoin and a number of other cryptoassets—regardless of their eventual long-term performance—were the focus of one of the biggest speculative bubbles in history, with a large volume of mining and trading taking place in Asia. The Bitcoin Bubble of 2017 and 2018 has now joined the Tulip Mania of 1637, the South Sea Bubble of 1720, the Dot.com Bubble of 2000, and many others.[2] During 2017, the price of Bitcoin and other cryptoassets increased dramatically, before falling steeply in 2018 (Figure 1).

Over the past 24 months, the "tokenization" of assets and creation of using ICOs, has also exploded.[3] ICOs typically use blockchain technology to offer tokens that confer various rights in return, most often for cryptoassets. These offerings can be seen as a conjunction of crowdfunding and blockchain.

Although ICOs have indeed displayed the hallmarks of a classic speculative bubble, it must be noted that the tulip hysteria notwithstanding, such investment crazes are *often* not without foundation. The joint stock company, the internet, and other advances of the past clearly

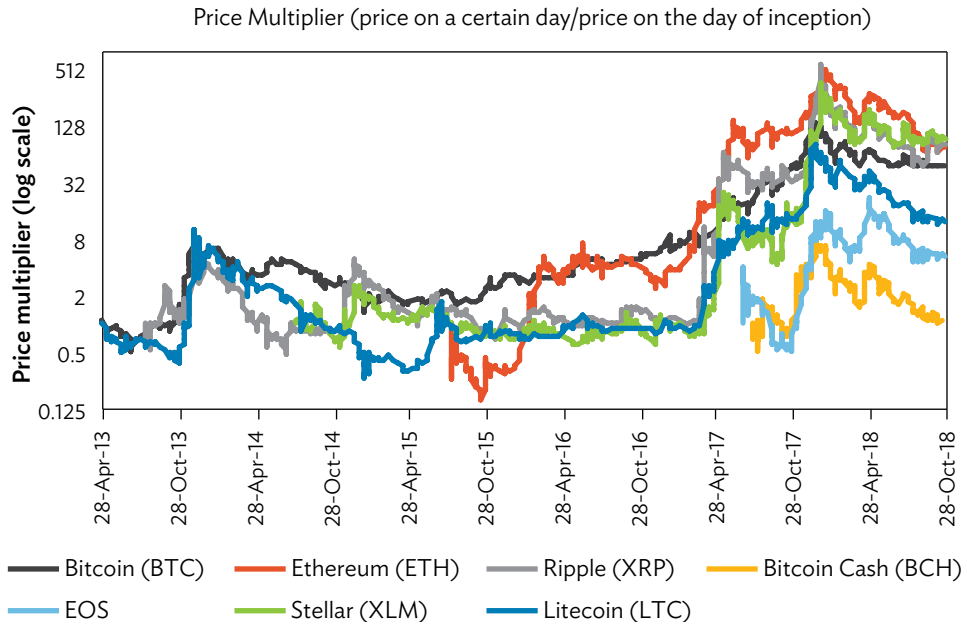
---

[1] The paper focuses on blockchains built on distributed ledgers and for this reason treats blockchain as a subset of DLT. Although broader application of blockchain cannot be excluded, instances of such broader application remain outside the scope of this paper.

[2] For the classic treatment, see Kindleberger 1978. *Manias, Panics, and Crashes.* New York: Wiley

[3] Tokenization is the process of converting an asset into a token that can be moved, recorded, or stored on a blockchain system.

Figure 1: Major Cryptoasset Price Changes, 2013–2018



Notes: The price multiplier shows the price change of each cryptoasset since its inception. A value above 1 (below 1) indicates the price has increased (decreased) by the factor. Period: 28 April 2013 to 31 October 2018.
Source: Coinmarketcap. https://coinmarketcap.com/(accessed 15 November 2018).

demonstrate this fact. Afterall, at the height of the dot.com bubble in the late 1990s and early 2000s, no one would have ever expected Amazon and Google to become as significant as they have. This is the core of Amara's law:

> "We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run." (Amara 2006).

While the law may be dull and the technology exciting, the impact of sovereigns and their institutions—in particular, central banks, regulatory agencies, and legal systems—cannot be simply wished away. Risk will remain from both a legal and technological standpoint. (Zetzsche, Buckley, and Arner 2018, 1407). Policymakers and regulators seeking to support appropriate approaches to 21st century financial infrastructure must focus on these potential consequences.

A disparate range of policy and regulatory responses across Asia has accompanied the surge in DLT activity, with substantial differences between approaches to the specific contexts of cryptoassets and ICOs, as compared to DLT and blockchain more generally.[4] While there are common features in the regulatory responses, such as the issuance of cautions in most jurisdictions in relation to the investment risks associated with ICOs and a slow shift toward regulation of these applications, policy approaches seem diverse across jurisdictions.

Both the People's Republic of China (PRC) and the Republic of Korea, for example, announced in 2013 that cryptoassets were to be treated as "virtual commodities" and not currencies. This restrictive approach has continued to date with the banning of ICOs. However, the Republic of

[4] Appendix 2 summarizes the various policy approaches taken in Asia toward cryptoassets, blockchain, and ICOs while Appendix 3 summarizes major policy and regulatory events in Asia regarding cryptoassets and ICOs.

Korea recently announced plans to allow ICOs in the near future. Singapore and Japan have both taken permissive approaches and early steps toward the regulation of these technologies. In 2014, Japan began developing cryptoasset regulations, and in 2016 recognized virtual currency as a legal means of payment subject to anti-money-laundering and know-your-customer requirements. In Singapore, cryptoassets have been regulated since 2014, and the jurisdiction has since engaged in a number of blockchain development projects. Thailand similarly issued its own regulatory approach to ICOs in 2017.

Other jurisdictions in Asia have taken less active approaches to the regulation of these technologies, and have instead issued cautions or similar alerts about associated risks. For example, in 2017, Malaysia issued cautions about the risks of virtual currencies while Macau, China issued cautions about the risks of ICOs.

Taking all this into account, this report aims to expand knowledge of the applications of the new technologies. As the report illuminates the trends in Asia for DLT and related concerns, risks and its very real potential, the report focuses on policy options and approaches to balancing risks and supporting useful innovation in the region.

2. Distributed Ledger Technology, Blockchain, and Applications

As is often the case with new technologies and other innovations, confusion frequently surrounds terminology arising out of emergent applications and the different perspectives of those involved. The best way to understand the field of DLT, blockchain, and related applications is to begin with the relevant underlying technology. A "distributed ledger" is a digital database that is shared, independently updated, and synchronized by consensus among the network participants. It is the underlying technology for blockchain which is, in fact, a form of distributed ledger with each block of transaction records linked by cryptographic signatures.

Section 2.1 provides typologies of DLT. The first sets forth the differences between centralized and distributed ledgers, and offers an explanation for the benefits of DLT over centralized ledgers that are currently the most common data storage system. Second is the difference between "permissioned" (such as Corda)[5] versus "permissionless" structures (such as Bitcoin) within those distributed ledgers. Section 2.2 zooms in on blockchain, which refers to how data are stored as a "block" on a distributed ledger and "smart contracts" as one aspect of this. It also reviews a range of applications, including cryptoassets and ICOs. Section 2.3 discusses the potential of DLT beyond blockchain and its implications.

2.1 About Distributed Ledger Technology

Centralized and Distributed Ledgers

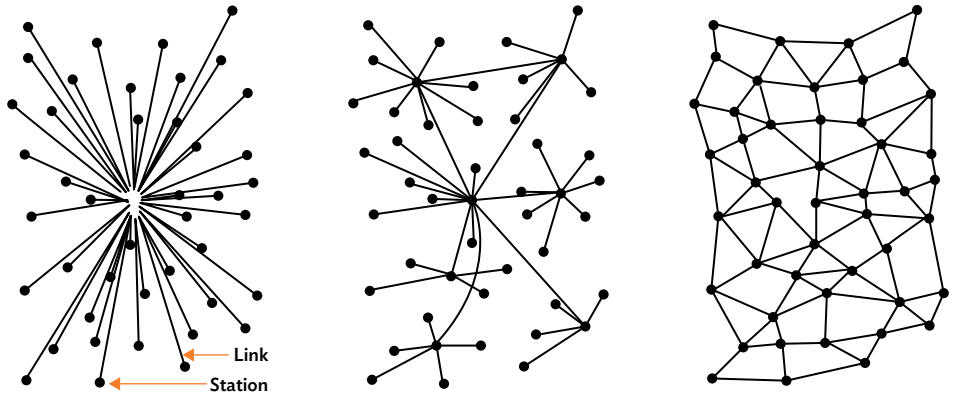
Distributed ledgers are perhaps best understood diagrammatically and in contrast to their counterpart, the centralized ledger (Figure 2).

Centralized ledgers are the most common data storage device in finance today. A trusted administrator maintains the stored data, recording transfers of assets and the like upon receipt of appropriately verified notifications. Examples of their use by the financial sector include most securities clearing and settlement systems and central counterparties as well as large value payment systems, including real time gross settlement in many jurisdictions across Asia. Others include traditional property registries whether digital or not. Centralized structures are typically secure because the single controlling entity can focus on this security aspect as well as speed of execution.

Centralized structures face risks, however. A ledger stored on a network server can be destroyed or, more likely, hacked or otherwise compromised, so that the original data are held for ransom or manipulated and replaced with new (inaccurate) data. Mathematical approaches can be used to determine how much effort is necessary to manipulate any given server. Every single server *can* be manipulated with sufficient computing power.

[5] Corda is an open source blockchain platform, introduced in 2016 by a consortium led by R3 LLC (R3). R3 is a DLT company which led a consortium of more than 200 firms to develop DLT applications for the financial system and other businesses. Corda was created especially for the financial companies to help them handle more complex transactions but restrict access to transaction data.

Figure 2: Distributed Communication Networks: Definition of Redundancy Level



Sources: Mougayar 2015. Baran, P. 1962. On Distributed Communication Networks. Rand Corporation. Paper. Quoted in Mougayar 2015. Understanding the Blockchain. O'Reilly. 16 January.

Centralized structures thus concentrate risk and use that concentration to focus security and management. Perhaps the best example of this comes in central counterparty clearing, which has been a major focus of post-2008 global financial regulatory reforms. For instance, central counterparty clearing in over-the-counter derivatives or securities exchanges provides a trusted central counterparty for transactions, reducing counterparty risk and interconnections with potential systemic implications in the financial system. At the same time, however, central counterparty clearing centralizes and concentrates risk and thus arguably creates a new form of systemic risk, highlighted in a range of processes from the Financial Stability Board, the Bank for International Settlements Committee on Payment and Market Infrastructure, and the International Organization of Securities Commissions (IOSCO) to develop regulatory approaches to systemically important financial market infrastructure, such as central counterparties and major payment systems, among others.

Distributed ledgers[6] address these problems by raising the barriers for manipulation of stored data. In distributed ledgers, many data storage points (nodes) are connected with each other and store all data simultaneously, and together constitute the common ledger. DLT requires consensus of those nodes. However, the technical details of how to achieve consensus vary—multiple concepts have been developed, such as proof-of-work, proof-of-stake, proof-of-authority, and many others.[7]

To illustrate, assume that in distributed communication networks, there are N nodes (rather than one centralized ledger) and E describes the effort necessary to break into any single server. Given that all other conditions such as the security of each server are equal, it is expected that

[6] For technical references in this area, see D. Zetzsche, R. P. Buckley, and D. W. Arner. 2018. The Distributed Liability of Distributed Ledgers: Legal Risks of Blockchain. University of Illinois Law Review. 2018 (4), 1370-1372.

[7] In a proof-of-work system, multiple servers (nodes) all try to solve one (generally complex and resource-intensive) mathematical problem. The first node to solve the problem is compensated for the "work" it has performed, while all others use the solution provided by the first node to verify that the problem has been correctly solved; the solution to the mathematical problem thereby assumes the function of a unique, one-time-use code. In proof-of-stake system, the cryptographic calculations are simpler for computers to solve: one only needs to prove he owns a certain percentage of all coins available in a given currency. Proof-of-authority system is a reputation-based consensus algorithm that leverages the value of identities and relies on a limited number of block validators.

the efforts necessary to manipulate all servers linked in the ledger would be N x E rather than 1 x E. The number of servers that will need to be manipulated to alter the outcome will depend on the number of servers necessary for consensus (C). If C>1, the distributed ledger is more secure than the centralized one. As already noted, this calculation is rather simplistic, since it assumes equal security of each server. In real-life applications, the security of the central node on a centralized ledger is likely to be far superior to that of each of the distributed nodes. This calculation also assumes that the manipulation of existing nodes is necessary to alter the overall consensus, whereas, in reality, consensus can be steered by other factors (such as control of the majority of processing power in a proof-of-work system). Furthermore, the calculation will be noticeably more difficult in an open, "permissionless" distributed database where new nodes can be easily added to the ledger (in which case one could simply create a sufficient number of new nodes to achieve C).

DLT systems thus offer the potential for greater security without the risks of concentration of centralized ledger systems. At the same time, however, they typically suffer in speed of execution when compared to centralized systems.

Permissioned and Permissionless Systems

DLT can also take various forms. In particular, DLT systems can be permissioned or permissionless. Permissioned systems are essentially private networks with a predefined governance structure where data authorization depends upon the agreement of multiple predefined servers. The leading example in the financial sector is Corda, under the governance of R3, a global consortium of financial institutions and related organizations.

In contrast, permissionless DLT systems, such as Bitcoin, operate on public domain software and allow anyone who downloads and runs the software to participate. In some cases, even the code is further developed in the public domain. The participants in those distributed ledgers may not know who else is running a server functioning as a node at any given time. There is an additional security element in this "unknown" inherent in this structure: if the number of overall nodes is known, a cyberattack may be planned with greater certainty, given that the maximum number of nodes is certain.[8] Permissionless (or public) systems include Ethereum (which is a decentralized platform on which a range of other applications can be built).

Permissionless systems arguably present the greatest opportunity to create alternative trust solutions, in that they are open to all and often designed to be self-perpetuating (e.g., Bitcoin and Ethereum). However, they raise risks in administration and control of data, with permissioned systems being far more common, particularly in the financial sector context.

2.2 Blockchain Technology and Applications

Blockchain refers to how data are stored on the ledger. Rather than being stored individually, data are stored in a block bundled with other data. A single block contains multiple data points, and all blocks are stored in a specific order (the chain). Each block includes a timestamp and a link to the previous block. In a cyberattack, rather than manipulating one data point alone, the bundling of multiple datasets in one block would require the manipulation of the *whole* block of data and—due to the timestamp and link—the blocks linked to the attacked block

[8] Information technology experts refer to this strategy as "security through obscurity".

(depending on the method used to connect the blocks into the chain). The level of resilience provided by the linking process may vary depending on the design of the blockchain. In a Bitcoin blockchain, the link is generated by "hashing" the data in the preceding block,[9] which means that the attacker needs to manipulate not only the block containing the desired data, but also every single block after it—while outpacing the entire network of Bitcoin miners (due to the proof-of-work consensus algorithm).

Blockchain's key benefit is tamper-evidence: in a hash-based blockchain database, any modification of data in any block will generate a different hash and any change will become evident from comparison with the hash recorded in the subsequent block. As a result, blockchain may be particularly useful in products and services that benefit from robust recordkeeping, such as cryptoassets and smart contracts. And so, blockchain may be used as a technology to generate, store, and distribute a cryptoasset (such as Bitcoin). Or it could involve one or more cryptoassets in some fashion, although this is by no means necessary. Blockchain may also involve smart contracts.

Bitcoin, for example, is a blockchain-based cryptoasset. Ethereum is a blockchain-based system which includes a cryptoasset (called the Ether, in relation to Ethereum transactions) as well as an open permissionless blockchain platform which can be used as the basis upon which to design a range of applications (smart contracts). Corda is a DLT system, although purists differ on whether it is a blockchain. It does not involve a native cryptoasset, although it will support the use of a range of digital currencies. Hyperledger is generally agreed to be a blockchain, but does not involve its own cryptoasset.

Smart contracts, meanwhile, refer to self-executing software protocols that reflect the terms of an agreement between two parties.[10] The conditions of the agreement are directly written into lines of code and typically operate on DLT.

These smart contracts permit transactions to be carried out among disparate parties without the need for an external enforcement mechanism (such as a supervisory authority or central clearing facility). As long as the code does not provide for a reversing procedure,[11] they render transactions traceable, transparent, and irreversible from a technological, if not a legal, standpoint.

The key impact of smart contracts is to disintermediate in both an institutional and a personal sense. Human intervention can delay administrative processes if the latter exclusively depend on "if–then" binary conditions. In contrast, a computer that detects that an "if–then" condition is met can automatically execute the protocol. For instance, if settlement exclusively depends on payment or margin coverage, a computer if adequately programmed could check more quickly and with greater accuracy than human beings whether the conditions are met. There are multiple uses in the collective investment scheme context, for instance, as well as across a range of networked market structures such as syndicated loans, trade finance, securities settlement, corporate actions, and so on.

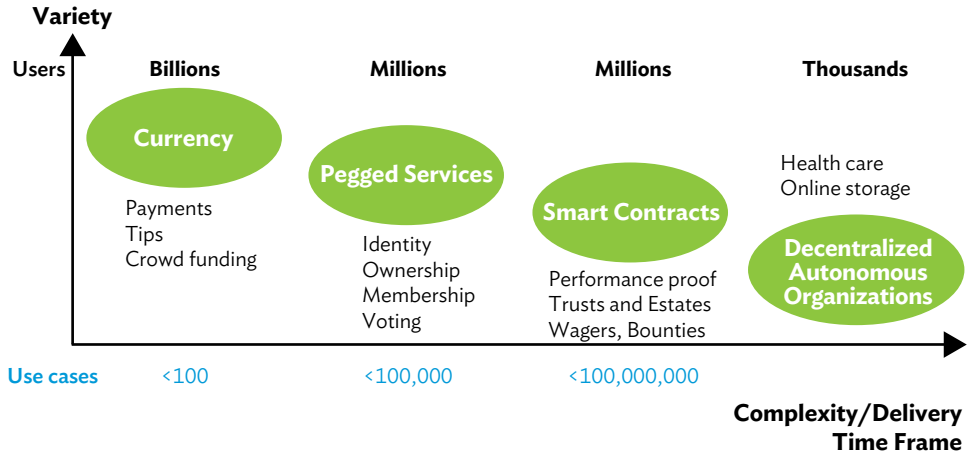
Figure 3 illustrates the four emerging segments for blockchain applications based on two dimensions: number of users and creation complexity and delivery time frame. These are currency, pegged services, smart contracts, and decentralized autonomous organizations. The currency-related segment targets money transfers, payments, tips, or crowdfunding

[9] Hashing is a form of cryptography that converts data into a unique string of text.

[10] On smart contracts, see the pioneering work by Szabo (1997, 2002); Casey and Niblett (2017, 26–32); Fairfield (2014, 36–41); Kõlvart, Poola, and Rull (2016, 133–149); Koulu (2016); Levy (2017); Lim, Shaw, and Sargeant (2016); Werbach and Cornell (2017); and Wright and De Filippi (2015).

[11] Adding such a procedure would remove most of the benefits of a smart contract to both parties.

Figure 3: Blockchain Applications: End-User View



Source: Mougayar, W. 2015. Understanding the Blockchain. *O'Reilly*. 16 January.

applications with billions of end users. It becomes more complicated and takes a longer time to develop pegged services, smart contracts and decentralized autonomous organizations with less and less end users (Mougayar 2015).

2.3 Technology Potential and Implications

Distributed Ledger Technology as a Technology-Based Trust Solution

The DLT provides trust solutions involving enhanced security, transparency, and permanence, and these characteristics make them suitable for a wide range of potential applications. These include, among other things, asset finance, back office clearing and settlement, trade processing and settlement, insurance claims tracking, cross-border remittances, internet of things, smart contracts, and digital identity instruments. Bitcoin and ICOs, among the best known uses, are of particular interest to financial market regulators, as are many of the other uses being developed in various forms of financial infrastructure, from trade finance to securities settlement and beyond.

At the heart of many arguments in favor of DLT is this idea of an independent, nonsovereign, technology-based trust solution, this technology can provide an alternative underlying platform for many core functions in modern economies and societies, from money (such as cryptoassets) to identity (a permanent public storage system independent of state control) to ownership (ownership and transaction registries for land, companies, intellectual property, etc.). These arguments usually depend in their extreme form on public permissionless DLT solutions—as these are argued to best realize the ideal of technological independence.

Proponents of such views argue that DLT offers an alternative to existing mechanisms for the institutional underpinnings of economies and societies. From the standpoint of the long-term impact, DLT certainly does have the potential to support or redesign many systems and to offer an alternative platform—superior in some cases—for the design of institutional frameworks and markets. However, it is generally becoming clear that this is not universally true—because the key attributes of DLT (security, transparency, and permanence) are certainly not absolute

and are not necessarily as strong as suggested and because these attributes are not appropriate for every context—a topic to be discussed in more detail in Sections 5 and 6.

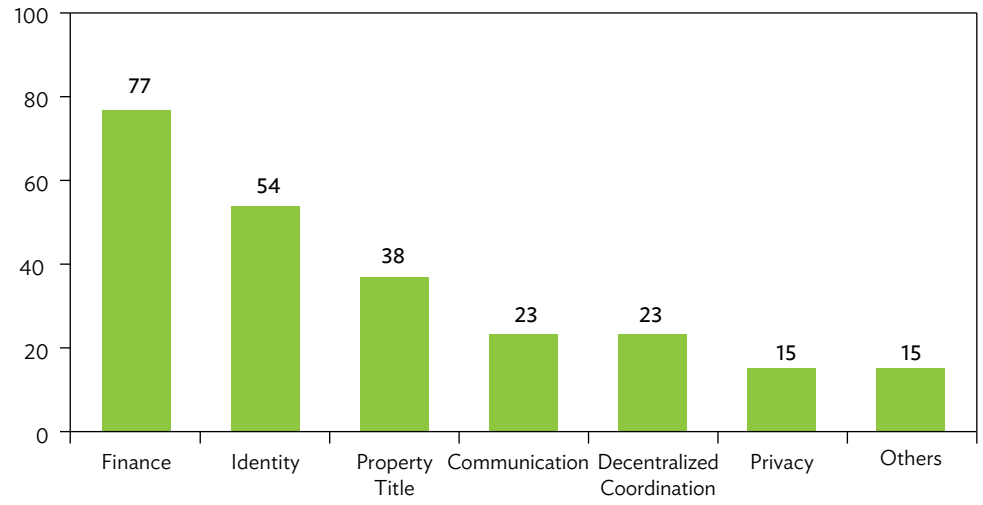
Distributed Ledger Technology Use Cases and Investment Trends

DLT use cases have clearly moved beyond just cryptoassets. Their application in a range of forms is now being explored across the financial system. Capital raising, trading, clearing and settlement, global payments, deposits and lending, property and casualty claims processing (InsurTech), digital identity management and authentication, and RegTech solutions (such as automated compliance, administration and risk management, and anti-money-laundering and client-suitability checks) have all been identified as significant potential DLT use cases.

Figure 4 shows the areas where DLT was believed to have the greatest potential impact, according to a 2016 survey of Bitcoin and DLT thought leaders. At that time, 77% of respondents believed DLT would have the greatest impact in finance.

The key benefit of DLT, as noted, lies in its ability to address the storage trust issue. Again, DLT ensures the validity of datasets by spreading data over many nodes which have to agree, through the previously determined consensus mechanism, to confirm that data are correct. DLT (in particular, blockchain built on a distributed ledger) can ensure better than other technologies that data are not manipulated while stored. DLT can also ensure that the party making a transfer has title on the ledger to the asset being transferred, and is not able to transfer it twice to separate buyers. Box 1 looks at blockchain applications in land registry systems.

Figure 4: Leading Global Sectors Expected to Be Impacted by Blockchain Technology Globally, 2016 Survey



Source: Statista. Which Areas Do You Think Blockchain Technology Will Have the Greatest Impact In? (as of 2016). https://www.statista.com/statistics/647728/worldwide-blockchain-technology-impact-survey-by-sector/ (accessed 27 November 2018).

Box: Blockchain Application in Land Registry Systems

The use of blockchain technology in land registry systems can provide a secure data system, thereby ensuring transparency and accountability. A blockchain-based registry substantially reduces the cost and time required to register and transfer property and provides government and individuals the ability to audit transactions quickly. Below is a summary of how blockchain can uniquely enhance the land sector.

Blockchain Feature	Description
Smart Contracts	Programmable contracts that self-execute when certain conditions are met. They also enable transactions to be completed more quickly through a blockchain registry.
Secure	All land records are individually encrypted. Each property could be given a unique code and a link to a smart key which will be held only by the owner.
Irreversible	Any validated records are irreversible and cannot be changed.
Time-stamped	In a blockchain registry, it is possible to securely keep track of the creation and modification time of a transaction.
Consensus	All network participants agree to the validity of each of the land records.

The following are three examples of how blockchain has been used to facilitate land transactions in three countries: Georgia, Sweden, and Fiji. Other countries considering or developing blockchain technology for land registry include Estonia, India, Japan, the Netherlands, the United Arab Emirates, and the United Kingdom.

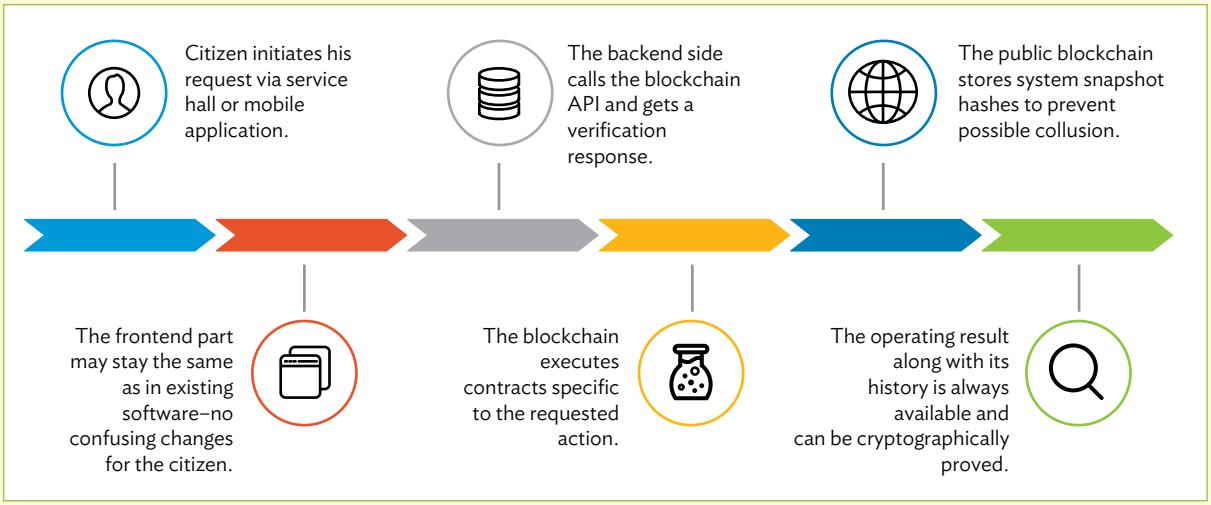
Georgia

Due to its well-functioning digital infrastructure and highly efficient public registry systems, Georgia is the first to register and store land titles using a blockchain-powered DLT. The Ministry of Justice traditionally made relevant public information accessible online as part of their post-Soviet reforms and open government drive. Georgia has long maintained its position among the world's top 10 economies in the World Bank Ease of Doing Business global rankings.

Nearly 1.3 million land registry documents are managed by National Agency for Public Registry of Georgia. In 2016, the agency partnered with a tech company, BitFury, to upload the complete land records of Georgia onto a public blockchain network. The agency emphasizes that this type of DLT helps achieve their institutional objective of making Georgia's land registry records even more secure by harnessing the core blockchain feature of decentralizing records into multiple nodes. This means that no single party can delete, alter, rewrite, or illegally manipulate data.

continued on next page

Blockchain Land Registry of Georgia[1]



Sweden

Sweden is an early adopter and considers blockchain technology a trusted machine that can provide a better foundation for investments and mortgage markets, thus boosting economic growth. Historically, the government has emphasized building a high level of trust in many aspects of its lands and real estate business processes. It stands to further revolutionize its property transactions through blockchain-enabled smart contracts. Lantmäteriet (the Swedish mapping, cadastre and land registration authority) partnered with ChromaWay, a local technology company centered on blockchain, to enable quick, transparent and secure transactions that can instantaneously produce legally binding contracts. Sweden is currently piloting smart contracts for property transfers, with blockchain as the underpinning technology, for immediate process approvals, real-time lease transactions, and fast payments.

Fiji

Most of the lands in Fiji are customary lands which are leased to investors. Fiji is modernizing its land management systems under an Asian Development Bank (ADB) initiative that features proof-of-concept for a blockchain-based system developed jointly with the iTaukei Land Trust Board. This blockchain testbed project is the output of ADB technical assistance that sought to improve the investment climate for lands in Fiji and:

- secure customary land records from paper to digital format to avoid complete data loss due to climate risks and streamline land lease transaction steps to reduce the risk for fraud and corruption;
- achieve consensus of involved parties on the validity of each step in the transaction, especially the dereservation process for customary lands, which reduces the need for document validation and multiple approvals; and
- ensure transparency whereby all parties (lessors, lessee, and the government) can have online access to the leasing process and an internal system for audit where every change is traceable.

The ADB Urban Sector Group, in partnership with KPMG Digital Village, will support the iTaukei Land Trust Board and the Government of Fiji to explore the advantages of blockchain technology for more effective and secure management of leasing customary lands by deploying a minimum viable product for a blockchain-based land-leasing platform to be completed in 2019. The following illustration depicts a hypothetical example of an investor's journey in the land market of Fiji through blockchain technology. The process is simple, fast and secure and vastly improves the user experience.

continued on next page

Box 1 continued

A Visual Depiction of Blockchain Technology for a Land Registry in Fiji[2]

New lease applicant **Roy**

Nationality: Fijian
Occupation: Property developer
Lease type: Residential
Land type: Unsurveyed, reserved and vacant land

Roy works for a property developer firm, and is looking to build rental apartments on leasehold land.

He is hoping for a **quick** and **convenient** way to invest in iTaukei land that does not require him to travel down to iTaukei Land Trust Board (TLTB) offices on multiple occasions, collect landowners' signatures manually and can assure his investment.

Roy is pleased with TLTB's new platform for its **simple** and **fast** leasing process.

With his lease record now **secured on blockchain**, he is more assured about his investment and will recommend TLTB's new platform to his colleagues.

STEP 1

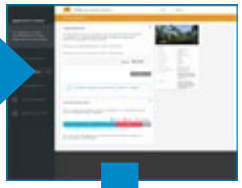
When Roy learns about the new web portal, he immediately goes online and browses through a variety of lease objects. He specifies his search based on different criteria (e.g., lease type, location, rental price).

Upon selecting his desired lease object, he views the important details and decides to apply for a lease.

STEP 2

Once Roy clicks on the apply for a lease button, he is requested to fill up the online application, upload necessary documents (e.g., birth certificate, bank statements) and also settle the lease application fee.

As Roy's lease object requires the landowners' consent, Roy pays a fixed fee for dereservation. Roy is able to easily view the voting progress as landowners vote online instantly.

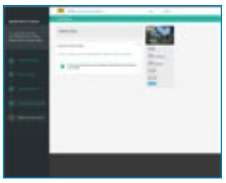


As Roy's lease object requires surveying, the platform provides Roy with a consolidated list of approved surveyors quotations based on price and the time required for surveying. Roy simply selects his surveyor of choice.

Roy receives the lease offer including the total payment breakdown. He confirms the lease offer and settles the final payment.

STEP 3

Once all steps are approved, Roy is informed about the successful lease transfer. His documents are available for download. Roy's lease ownership is secured in a tamper proof archive and all platform transactions are recorded on blockchain.



From here onwards, no further actions are required from Roy. He is instantly notified when the Department of Town and Country Planning, Ministry of Lands and Mineral Resources, Fiji Revenue and Customs Service, and the Office of the Registrar of Titles provide approval and he can follow-up with relevant parties directly in case of any delays.

Sources:

1 Bitfury Group and Government of Republic of Georgia Expand Historic Blockchain Land-Titling Project. 7 February 2016. https://bitfury.com/content/downloads/the_bitfury_group_republic_of_georgia_expand_blockchain_pilot_2_7_16.pdf
2 ADB and KPMG Digital Village. 2018. TA 9170: REG: Promoting Smart Systems in ADB's Future Cities Program. Manila.

3. Cryptoassets

Section 3 looks specifically at various aspects of cryptoassets. Cryptoassets can fall into various categories subject to an evolving typology of virtual and digital currencies,[12] including:

(i) alternative currencies which are alternatives to sovereign issued currencies,
(ii) digital currencies which are digitized forms of sovereign or alternative currencies,
(iii) cryptoassets which are generally based on blockchain and rely upon cryptography, and
(iv) ICOs which may or may not involve cryptoassets, alternative currencies, or digital currencies/e-money, but which typically involve the offering of rights on a blockchain.

Clearly, real-life use cases, as well as the regulatory and policy implications of these currency types, vary dramatically. This report therefore narrowly interprets "cryptoassets" by reference to those alternative currencies that are (i) digital, (ii) cryptographically protected, (iii) based on DLT, and (iv) convertible by design into fiat currency (and vice versa).

Section 3.1 examines the potential of cryptoassets as alternatives to existing currencies and payment systems. Section 3.2 details the rise of Bitcoin and other types of cryptoassets. Section 3.3 discusses recent developments in the use of cryptoassets as sovereign digital currencies either as central bank person-to-person or intermediated payment systems or as central bank-issued digital currencies. Section 3.4 reviews the benefits and risks of sovereign digital currencies. Section 3.5 considers the legal and regulatory implications.

3.1 Cryptoassets as Alternative Currencies

Cryptoassets are a subset of the larger category of alternative currencies. The latter operates outside the regulated space and creates what may be called "alternative payment systems" that coexist with the payment systems recognized by national and/or supranational laws. Alternative currencies come in a variety of forms. They can be physical (like seashells still used by some Pacific nations), or digital (like Bitcoin), or both (like the Bristol Pound, which has a paper and a digital version circulating at the same time) (Didenko and Buckley 2019, 1074–1075). They can enjoy varying levels of convertibility into fiat currency and can be either centralized (i.e., with a single center of issuance and administration), or decentralized (without such a center) (Didenko and Buckley 2019, 1075–1079). Overall, the number of alternative currency options is significant, limited only by human ingenuity.

The term "cryptoassets" can be confusing, since cryptographic protection is utilized in a variety of alternative currencies, from Bitcoin to digital community currencies (like the Bristol Pound) or even "gold" in computer games (Didenko and Buckley 2019, 1080–1082).

[12] For a comprehensive currency taxonomy, see Didenko and Buckley (2019).

At the same time, however, governments and central banks find alternative currencies less than appealing and often reacted cautiously, particularly given concerns regarding consumer protection, financial crimes, and economic usefulness. Thus, a wide range of jurisdictions have developed regulatory approaches to cryptoassets, ranging from facilitative frameworks (such as in Japan) to outright bans, such as in the People's Republic of China (PRC).

Much discussion centers around whether cryptoassets are in fact money or currency, functionally and/or legally. From a functional standpoint, money plays three major roles: as a unit of account, as a store of value, and as a means of exchange. Functionally, cryptoassets do in some cases fulfill these functions, but the volatility in their value erodes all three functions, meaning that cryptoassets certainly in 2017–2018 have been more speculative than monetary in nature.

From a legal standpoint, whether something is money or currency is determined by the laws of an individual jurisdiction, with many jurisdictions providing a monopoly to the national currency under the aforementioned functional roles of money (e.g., the PRC). In such jurisdictions, absent a change in law, cryptoassets will not be legal forms of money. Other jurisdictions, however, have been more facilitative (e.g., Hong Kong, China; Japan; Singapore) in allowing alternatives to the national currency including, in some cases, cryptoassets (e.g., Japan, Singapore).

Overall, this question of whether to allow the use of cryptoassets for payment and settlement appears to largely be a domestic policy question. To date, Bitcoin has been most popular in economies with very volatile currencies, often issued by governments with financial challenges. It therefore seems that the question of whether Bitcoin or other cryptoassets can challenge sovereign alternatives has been answered: good money will drive out bad—regardless of the source, per Gresham's Law.

In jurisdictions which do not regulate cryptoassets as money, other potential approaches apply beyond prohibition (which is often of limited effectiveness outside of effective national internet surveillance) or the development of a specific legal framework (as has been done in Japan). The most common issue in such jurisdictions is whether cryptoassets can be recognized as a part of the formal payment system, which in most jurisdictions draw regulatory scrutiny, typically from the central bank under international standards from the Committee on Payments and Market Infrastructures of the Bank for International Settlements. "Payment system" is a broader concept than just currency (and includes rules, participants, etc.). Cryptoassets do form payment systems, but these are alternative payment systems.

The question of whether a given cryptoasset will be recognized as part of the formal payment system will largely depend on how it is meant to be used in a given jurisdiction: Bitcoin and Ether often fall outside, while Ripple and XRP often fall within the system. This is because formal payment systems are generally closed-loop systems. If some cryptoassets can be integrated into the formal payment system, they can then be used as a settlement vehicle—not as a medium of exchange. Other jurisdictions may classify cryptoassets as commodities (such as the United States does) or simply apply consumer protection laws.

3.2 Bitcoin and Other Cryptoassets

Cryptoassets are often presented as decentralized alternatives to the existing currency types in the financial system: this is the fundamental premise of Bitcoin. Bitcoin was designed as a disruptive alternative to existing sovereign currency arrangements, it was intended to be a technology-based alternative which operated independently of any government.

In many ways, Bitcoin is somewhat unusual in the broader DLT landscape. From a typological standpoint, it combines blockchain and cryptography in a distributed ledger. It is a permissionless system, open to anyone who downloads the open-source software, with the transaction record publicly available. It is a decentralized system, in that there is no single or group of controllers, but rather all participants are involved in the development and use of the system. It is designed to provide a nonsovereign, permissionless, decentralized trust solution in the form of an alternative currency, with security provided through the blockchain structure and other forms of cryptography (such as public key encryption). Bitcoin uses the proof-of-work concept to achieve consensus among the nodes, with transaction confirmation through independent users who solve cryptographic problems in order to generate new blocks that record transactions and are in turn paid in newly created Bitcoin as well as applicable commissions, i.e., "mining".

Bitcoin had a strong appeal to many people in the aftermath of the 2008 global financial crisis, and the timing of Bitcoin's launch was thus very fortuitous and came during a period characterized by FinTech seeking to develop better alternatives to traditional financial institutions, markets, and approaches.

The launch of Bitcoin[13] in 2009 gave rise to the subsequent development of a whole range of cryptoassets. There has been an explosion of other cryptoassets, some, such as Ether on the Ethereum network, combine cryptoassets and smart contracts (e.g., systems allowing the building of a range of applications which operate on the underlying blockchain and which may use the systems' cryptoasset for transactions, recordkeeping, and so on).

In 2015 the overall number of cryptoassets reached 500 (ECB 2015, 4), and at the time of writing, it had more than tripled, reaching over 2,000.[14] These are dominated, however, by a small number of "major" cryptoassets. Table 1 highlights the top cryptoassets by founder location.

It would be extremely naive to expect governments and national regulators to act as idle observers of the proliferation of cryptoassets, which have the potential to challenge the existing value exchange process based on fiat currency (even though at the time of writing such a possibility remains largely theoretical). Since direct regulation of cryptoassets built on top of a permissionless blockchain can be impractical, if not impossible (at least in the absence of a coordinated *international* response), a number of countries are now rethinking their approach to cryptoassets.

Instead of attempting to regulate something as elusive as Bitcoin (which has no issuer and center of operation and, consequently, no situs and no "home country"), what governments can do is to observe the early stages of a paradigm shift and determine whether to offer end users new or redesigned government-issued or government-backed digital currencies that—if designed accordingly—could be more convenient, resilient, and ultimately more useful than (formally unrecognized and unregulated) cryptoassets." These cryptoassets may even come with significant added benefits for regulators (such as automated taxation or better information about the flow of value within the economy).

---

13 Bitcoin was the first cryptoasset and the first decentralized, convertible virtual currency. See Financial Action Task Force. 2014. *Virtual Currencies: Key Definitions and Potential AML/CFT Risks*. FAFT Report. FAFT/ OECD. Paris.; ECB. 2012. *Virtual Currency Schemes*. October; Task Force 2014, pp. 5–6); and Nakamoto, S. 2008. *Bitcoin: A Peer-to-Peer Electronic Cash System*. 31 October.

14 Coinmarketcap. https://coinmarketcap.com/ (accessed 4 October 2018).

Table 1: Top 20 Cryptoassets by Company Location (as of October 2018)

No.	Name	Location	Market Capitalization ($)
1	Bitcoin	Not specified	113,923,794,526
2	Ethereum	Switzerland	23,043,040,037
3	Ripple	United States	21,507,352,542
4	Bitcoin Cash	Not specified	9,139,198,331
5	EOS	Cayman Islands	5,148,876,432
6	Stellar	United States	4,632,485,681
7	Litecoin	Not specified	3,452,238,359
8	Tether	Hong Kong, China	2,798,061,303
9	Cardano	Switzerland	2,135,494,787
10	Monero	Not specified	1,891,106,160
11	IOTA	Germany	1,555,435,741
12	Dash	Canada	1,513,558,032
13	TRON	PRC	1,443,110,342
14	Binance Coin	PRC	1,214,870,601
15	NEO	PRC	1,184,528,771
16	Ethereum Classic	Switzerland	1,173,913,323
17	NEM	Singapore	959,534,752
18	Tezos	United States	805,787,507
19	VeChain	Singapore	715,268,205
20	Dogecoin	United States	667,038,134

PRC = People's Republic of China.
Source: Coinmarketcap. https://coinmarketcap.com/ (accessed 4 October 2018).

3.3 Sovereign Digital Currencies

Two alternative approaches are envisaged: (i) central bank accounts with general access or intermediated access, and (ii) new digital forms of official (fiat) currency.[15]

Central Bank Person-to-Person or Intermediated Payment Systems

The idea of providing alternative and safer options for storing value in the form of official currency is not new, but these options have generally not been technologically feasible. However, over the past 30 years, technology has advanced to the point where this is no longer necessarily the case. As a result, increasing numbers of proposals, pilots, and launches of payment systems allow the general public and nonfinancial institutions broader access to central bank accounts. Such access can be provided to end users *directly* or through *intermediaries* (such as through private operators guaranteed by central banks) (Didenko and Buckley 2019, 1087–1088).

Such discussions raise a major policy question: even if the technology is now available to replace traditional interbank, large-value payment systems with alternative payment systems (particularly based on the provision of individual accounts through a centralized system), should it be done? At present, the major central banks which have faced this question (such as the Bank of England and the Bank of Canada) have understandably decided they do not yet want to take this leap into the unknown. From a policy standpoint, the arguments in terms of efficiency and macroeconomic and macroprudential monitoring capability for the central bank are compelling, as are the possibilities of removing the traditional public good of providing payments from the banking system. However, the

[15] For a more detailed discussion of available approaches, see Didenko and Buckley (2019, 1087–1090).

existing system, which largely evolved in the 19th century and which has been digitized and improved since the early 1970s, particularly in large value real time gross settlement systems, is familiar. In addition, as a result of the long period of attention, it is also arguably robust: payment systems in major markets functioned without issue throughout the 2008 global financial crisis. At the same time, there is real concern about the impact on the banking system—which still plays an important role in financial intermediation and savings in addition to payment.

Sovereign (Central Bank) Cryptoassets

The declared intent and ongoing work of some states to develop digital currencies linked to central banks has attracted a lot of attention to the prospects of an "official" cryptoasset.[16] For example, Venezuela issued the newest national digital currency Petro in 2018, although its functionality as a currency remains questionable.[17] Since then, an increasing range of countries is studying or considering such projects, including in Asia and across both developed and developing countries. Table 2 summaries the existing and announced projects on central bank cryptoassets.

Table 2: Summary of Central Bank Cryptoassets: Existing and Announced Projects (as of December 2018)

Economy	Currency/Project	Description	Source
Brazil		Brazil is researching how a digital fiat currency would function and related architecture.	Burgos & Batavia 2018
Canada		Central bank (Bank of Canada) is studying key design questions relating to a central bank digital currency.	Lane 2018
People's Republic of China		Central bank (People's Bank of China) is developing a digital currency.	Library of Congress - PRC
Organization of Eastern Caribbean States	Digital East Caribbean dollar	Considering issuing a digital currency by the East Caribbean Central Bank, a cooperation of eight national central banks.	Hales 2018
Ecuador	Dinero electronico (decommissioned)	Legislation was passed in Sep 2014 with Dinero becoming spendable in February 2015. In Dec 2017, legislation was passed to decommission Dinero.	White 2018
Estonia		The central bank decided against issuing a digital currency (Estcoin).	Ummelas 2018
Hong Kong, China		Central bank (Hong Kong Monetary Authority) has no plan to issue a digital currency.	Government of Hong Kong, LCQ5 2018
India		The central bank (Reserve Bank of India) is investigating issuing a digital currency.	Reserve Bank of India 2018
Indonesia	Digital Rupiah	The central bank (Bank Indonesia) is considering issuing a digital rupiah.	Gorbiano 2018
Israel		A team working for the central bank does not recommend issuing a digital currency (E-Shekel).	Bank of Israel 2018
Japan		No plan to issue a digital currency that can be used for payment or settlement purposes.	Reuters 2018b

continued on the next page

[16] Barrdear, J. and M. Kumhof. 2016. The Macroeconomics of Central Bank Issued Digital Currencies. Bank of England. *Staff Working Paper* No. 605; Bech, M. L. and R. Garratt. 2017. Central Bank Cryptocurrencies. BIS *Quarterly Review*. September; Danezis, G. and S. Meiklejohn. 2016. Centrally Banked Cryptocurrencies. February. Unpublished; Engert, W. and B. Fung. 2017. Central Bank Digital Currency: Motivations and Implications. *Bank of Canada Staff Discussion Paper* 2017-16; Koning, J. 2016. Fedcoin: A Central Bank-issued Cryptocurrency. *R3 Reports*. 15 November; and Wandhöfer, R. 2017. *The Future of Digital Retail Payments in Europe: A Role for Central Bank Issued Crypto Cash?* Paper prepared for ECB and Bank of Italy "Digital transformation of the retail payments ecosystem conference". Rome. 30 November and 1 December.

[17] Government of Venezuela. 2018. *Petro: Towards the Economic Digital Revolution*. White Paper.

Table 2 continued

Economy	Currency/Project	Description	Source
Kazakhstan	CryptoTenge	Kazakhstan created sovereign cryptocurrency tied to fiat.	Priess 2018
Kyrgyz Republic		Kyrgyz Republic created gold-backed digital currency.	Lou 2017
Marshall Islands	SOV	Sovereign digital currency based on blockchain technology and issued by the Minister of Finance was given legislative backing on 26 February 2018.	Parliament of the Republic of the Marshall Islands 2018
Netherlands		The central bank (De Nederlandsche Bank [DNB]) is critical of central bank digital currencies.	De Nederlandsche Bank 2017
Papua New Guinea		Blockchain technology is supported. The Bank of Papua New Guinea (PNG) states blockchain could lead to central bank digital currency issuance.	Bank of Papua New Guinea 2016 and 2017
Republic of Korea		The central bank (Bank of Korea) has a taskforce investigating the possibility of a digital currency.	James 2018[j]
Russian Federation	Cryptoruble	Government is considering issuing a CryptoRuble .	Popper 2018
Senegal	eCFA	Supported by Senegalese Central Bank and issued by the regional bank, Banque Régionale de Marchés (BRM), the eCFA is a West African Economic and Monetary Union (cross-border) digital currency based on the franc.	Banque Regionale de Marches 2016
Singapore		The Central bank (Monetary Authority of Singapore) is hesitant to issue a digital currency, but remains open for future consideration.	Lee 2018
South Africa		In August 2017, the central bank stated that it was too risky to issue a central bank digital currency.	Higgins 2017[l]
Sweden	E-krona	The central bank is seriously considering issuing a digital currency.	Sveriges Riksbank 2018
Thailand	Project Inthanon	The central bank (Bank of Thailand), with a number of banks, is developing a wholesale central bank digital currency to facilitate interbank settlements by the first quarter of 2019.	Bank of Thailand 2018
Tunisia	e-Dinar	Tunisia adopted a blockchain-backed electronic national currency (the e-Dinar plus) in 2015, through a partnership between La Poste Tunisienne (Tunisia's national postal service), Swiss tech firm Monetas, and the Tunisian startup DigitUS.	Yerkes and Polcari 2017
United Kingdom		Bank of England is not considering issuing a digital currency	Bank of England
Uruguay		The central bank (Central Bank of Uruguay) conducted a pilot of a digitalized Uruguayan peso.	Central Bank of Uruguay 2017
United States		The U.S. Federal Reserve states there is no compelling reason for a Fed-issued digital currency.	Brainard 2018
Venezuela	Petro	The government launched a sovereign digital currency supported by a basket of commodities in February 2018.	Government of Venezuela 2018

The concept of an "official" cryptoasset issued by a central bank is an attempt to marry the benefits of certain alternative currencies and central bank money. Its status as central bank money ensures its universal acceptance within the formal (regulated) payment system. Nonetheless, in contrast to various proposals envisaging intermediated access to central bank money through authorized private or public parties, this "official" cryptoasset concept allows the complete elimination of middlemen. The key disadvantage of existing forms of digital

central bank money is thus eliminated as they become directly accessible for the majority of end users (Hampl 2017, 2).

DLT (especially if implemented in the form of blockchain) offers various advantages to the circulation of central bank money, such as the ability, as noted earlier, to have at all times a tamper-evident record of each transaction and the elimination of various intermediaries and the corresponding risks.[18] In terms of issuance control, the system is likely to be centralized. Existing concepts of central bank-issued cryptoassets suggest different approaches.

3.4 Benefits and Risks of Sovereign Digital Currencies

Outlined below are some of the more prominent aspects of the benefits and opportunities as well as risks and challenges of sovereign digital currencies.

Benefits and Opportunities

First, sovereign digital currencies may reduce the risks of circulation of fiat money in digital form, which is routinely through commercial bank accounts. Direct access to central bank money generally remains a privilege for a very limited number of entities, such as the largest banks, foreign central banks, or governments. Sovereign digital currencies may change this status quo by offering much broader access to central bank money. It is expected that, within new sovereign digital currency schemes, central banks are likely to act as the ultimate trusted intermediary that is immune to insolvency, replacing commercial banks. A truly disintermediated sovereign digital currency is conceivable in theory, but seems unlikely in practice, since this would require regulators to relinquish control over transaction confirmation and recordkeeping for operations in the new digital currency—a giant leap of faith that requires absolute trust in the technology that is still in its infancy.

Second, the integration of blockchain into sovereign digital currency offers enhanced recordkeeping functionality. Bitcoin's implementation of blockchain technology demonstrates the ultimate level of transaction tracing, that is, every single unit of currency can be tracked back to its source. A similar level of tracing functionality could be integrated into a sovereign digital currency to enhance the quality of data on the national economy compiled by central banks. Ironically, this seemingly enticing benefit for regulators may be seen as unnecessarily intrusive and privacy-defying by end users and could, conversely, promote the use of "real" cash instead of its new "digital" counterpart.

Third, sovereign digital currencies could be used as a vehicle for critical national expenditure (public procurement, military expenses, payments of salaries, and government subsidies) to bypass commercial banks completely. This could substantially reduce the systemic risks associated with commercial banks, lower the impact of collapse of any given financial institution and, consequently, diminish incentives to bail out failed banks.

Fourth, central banks could seize the opportunity to modernize their aging wholesale payment systems, many of which are already at the end of their technological life cycle. Furthermore, governments could use sovereign digital currency platforms as a foundation to further develop their payment systems into one that is capable of supporting smart contracts and other advanced functionalities.

[18] This is particularly relevant for jurisdictions with large numbers of commercial banks, many of which are risky deposit holders. For example, the Russian Federation has over 800 registered banks, but just over 500 have the right to carry out banking operations as a result of various restrictions imposed by the central bank.

Fifth, digital currencies have the potential to provide financial services to underserved populations and regions and dramatically improve financial inclusion, provided that the necessary infrastructure is in place. In developing countries, various forms of "electronic money", often used on mobile phones, have provided digital alternatives to cash (e.g., M-Pesa which was launched in Kenya in 2007). Most of these digital currencies are privately issued but governments and central banks may soon consider developing new digital forms of official currency to take advantage of the technology. Further advantages for regulators may include enhanced control over benefits distribution and easier collection of data on the spending patterns of the most vulnerable demographic groups.

Risks and Challenges

Regulatory risks and challenges relating to sovereign digital currencies are also many and can be grouped into three broad categories.

The first one covers all kinds of technical issues involved in setting up a sovereign digital currency, particularly in the absence of accepted international standards on DLT and blockchain. As a result, regulators are faced with a multitude of possible design choices, yet also have inadequate resources, insufficient knowledge, or limited access to computer engineering, cybersecurity, and other needed expertise.

The second set of challenges concerns the impact of a sovereign digital currency on the payment system, financial markets, and economy as a whole. Regulators should consider performing a comprehensive preliminary analysis of the corresponding financial system, while identifying entities that may end up in direct competition with the state once it implements an "official" cryptoasset—such entities may include commercial banks, electronic money issuers, international payment card platforms, and other payment services providers, as well as issuers of nonsovereign cryptoassets.

The third category refers to legal challenges and reflects the need to introduce the concept of a sovereign digital currency into the national regulatory system. This may, in turn, alter the existing approach to the regulation of nonsovereign cryptoassets in jurisdictions that already have dedicated rules, or lead to a change of regulatory stance in relation to nonsovereign cryptoassets in countries that have opted for a wait-and-see approach instead.

3.5 Legal and Regulatory Implications

Overall, the key for any jurisdiction is to consider the potential range of risks and develop a balanced and proportional approach to the risks which arise. Particular attention needs to be paid to the areas of monetary and financial stability, as well as consumer protection.

First, regulators need to answer many technical questions prior to setting up a sovereign digital currency:

- Should the system utilize distributed ledger technology and, if so, what consensus algorithm should be implemented?[19]
- Will the database constitute a blockchain and, if so, how will the blocks be linked together?
- What cybersecurity protections should be put in place?
- Can each unit of sovereign digital currency be traced back to its source at any point of time

[19] Although the starting question should arguably be different: does the use of DLT and blockchain provide sufficient benefits compared to a centralized database in the first place?

and, if so, how would such system scale over time, as the number of transactions increases?
- Can transactions on a sovereign digital currency blockchain be reversed and how can mistakes/erroneous payments be rectified?
- What algorithm or which regulator/authority/group of entities controls the issuance of sovereign digital currency?
- What information about users of sovereign digital currency and their transactions are public and what kinds of data are only available to the regulator?
- How do end users access their sovereign digital currency balances: through biometric/multifactor identification or otherwise?

Second, authorities need to pay attention to potential risks to financial stability. Although the value and volatility of cryptoassets is high, so far there appears to be little linkage to the credit system, the formal payment system, or the traditional financial system, thus minimizing potential sources of systemic risk. The Financial Stability Board has also concluded that "crypto-assets do not pose a material risk to global financial stability".[20] However, monitoring is in order.

In particular, excessive competition from alternative payment systems and financial service providers may erode the profits of the traditional banking systems. Some of these businesses may be forced to rethink their business model, relocate to another jurisdiction, or cease operations altogether. Uncontrolled implementation of sovereign digital currencies may also lead to commercial bank runs and upset the duality of central bank and commercial bank money, which forms the basis of most payment systems today.

Regulators might consider collaboration, as opposed to direct competition, with other participants of the payment system. On one hand, sovereign digital currencies could utilize the existing infrastructure of commercial banks upon agreement with the latter. On the other hand, regulators may implement a range of measures to create a level playing field with private parties, or even artificially make sovereign digital currencies less attractive (at least initially, to allow the market to adjust). These measures could include establishing upper limits, or negative interest rates, on sovereign digital currency balances, as well as lifting deposit insurance limits (at least up to the maximum permitted sovereign digital currency balance, if the latter is restricted). While the partnership with private entities most likely reduces the time to develop and implement new currency systems, the impact of involving private entities and their incentive structure and activity on financial markets must be carefully considered particularly if they acquire proprietary information.

Third, regulators also need to account for any implications on the money supply and consider whether the new currency will be issued through an ICO or other form of initial distribution, in exchange for other forms of sovereign money such as cash or central bank account balances for eligible entities, commercial bank money, or both, and design corresponding conversion mechanisms.

From the standpoint of monetary policy, the main question would be whether or not alternative currencies pose risks to the ability of central banks or monetary authorities to manage the economy and maintain the integrity of the national monetary system. Appropriate macroeconomic policy together with stable inflation and prudent fiscal position should reinforce trust in the domestic currency, removing the need for nonsovereign alternatives.

Issues related to market integrity and consumer protection will be discussed in Section 6.

[20] Financial Stability Board. 2008. Crypto-Asset Markets: Potential Channels for Future Financial Stability Implications. 20 October. http://ww.fsb.org/wp-content/uploads/P101018.pdf. A crypto-asset is defined as "a type of private asset that depends primarily on cryptography and distributed ledger or similar technology as part of their perceived or inherent value."

4. Initial Coin Offerings and Tokenization

ICOs are one application of DLT typically representing a combination of distributed ledgers and crowdfunding.[21] They are one form of tokenization: with a digital token evidencing, or at least purporting to, some sort of right or interest.[22] ICOs take a number of forms—like crowdfunding—depending on what sort of token is being offered. In keeping with the crowdfunding typology, these range from donations to rewards to investment ICOs, as well as pure cryptoasset ICOs.[23]

These are discussed directly below. This section then presents data on ICOs in Asia and elsewhere, and the regulation of ICOs in Asia.

4.1 Typology

Donation ICOs are tokens offered in exchange for donations in support of some activity or product, mirroring donation-based crowdfunding, such as through GoFundMe.com.

Rewards ICOs are based on the tokenization of some sort of advance purchase or other type of entitlement to the outcomes of the project funded by the ICO, mirroring reward-based crowdfunding, such as through Kickstarter.com. These are frequently labelled "usage" or "utility" tokens. But this label is often misleadingly applied; frequently it is used to try to avoid characterization as a financial product and the related legal and regulatory requirements. The key to a rewards ICO is that it entitles the holder of the token to use something, typically the software to be developed with the proceeds of the ICO or to be a member of some community with certain rights. One can think of it as paying in advance for a software license or community membership.

Investment ICOs involve the issuance of tokens for a wide range of investment opportunities generating financial return, typically involving potential profits through the appreciation of the value of the token. This is in contrast to rewards ICOs, in which the return on funding is provided in kind. Investment ICOs raise the same sorts of issues as any other form of financial product and generally raise the same sorts of potential risks and concerns, albeit with the addition of issues raised by the application of DLT. The Securities and Exchange Commission of the United States typically characterizes investment ICOs as securities and subjects them to securities laws. This is also increasingly the case in other jurisdictions, as highlighted by the wide range of related statements collected from individual securities regulators around the world by the International Organization of Securities Commissions (IOSCO).[24]

---

[21] Crowdfunding is financing by soliciting contributions from many funders, commonly through the internet or mobile phone.

[22] The legal effects of tokenization, the nature of connection between a token and the underlying asset or right, as well as enforceability of tokens, is ultimately a matter of applicable law.

[23] For a detailed analysis, see Zetzsche, D., R. P. Buckley, D. W. Arner, and L. Föehr. 2019. The ICO Gold Rush: It's a Scam, It's a Bubble, It's a Super Challenge for Regulators. *Harvard International Law Journal.* 32 (2).

[24] For a list and archive of jurisdictions in which regulators which have issued statements on ICOs, see the IOSCO at https://www.iosco.org/publications/?subsection=ico-statements.

In addition to this traditional crowdfunding typology, there are also specifically "cryptoasset ICOs". In their pure form, these are a means to raise funds to develop, or ensure the wide distribution of created, new cryptoassets. However, these are often also combined with some aspect of blockchain platform technology, tokenization and/or smart contracts, as with Ethereum. As such, they are often in reality investment ICOs, with pure cryptoasset ICOs uncommon. For pure cryptoasset ICOs, the typical regulatory treatment is under currency, payment, or commodity rules in most jurisdictions, typically resulting in a lower regulatory burden than that which would be applied to investment ICOs. Cryptoasset ICOs that confer upon the holder of the token the right to an amount of cryptoasset could also be classified as derivatives, as the value of the ICO derives from the value of the underlying cryptoasset if the definition of derivatives in that jurisdiction includes references to cryptoassets, or fiat currency if the cryptoasset relates to that.

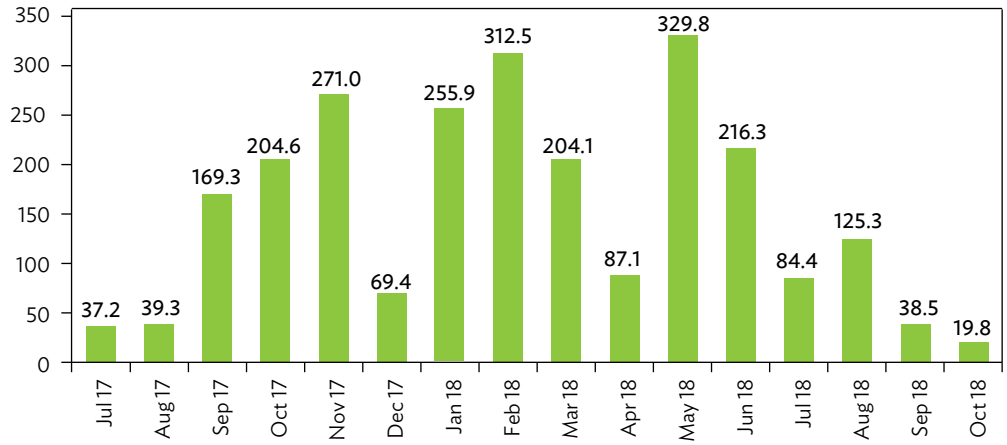
ICOs can also be asset-backed: digital tokens backed by specific assets. In a rewards structure, the token might take the form of a digital coupon which could be presented for an underlying asset (e.g., a pizza). In an investment structure, the token could represent an investment asset (such as a security or other ownership interest). In a cryptoasset ICO, the token could represent another cryptoasset. Such tokens highlight an important element of the broader potential of blockchain: the use of digital tokens to provide liquidity, transparency, and permanence for real assets which were previously largely illiquid (such as real estate in a blockchain-based property registry) or where ownership and/or providence concerns are high (e.g., diamonds or agricultural products).

From this typology of ICOs, an ICO can be seen as an application of blockchain or DLT in fund-raising. ICOs may or may not involve cryptoassets, but will typically involve the conferral of rights that are issued and managed on a blockchain.

4.2 Initial Coin Offerings in Asia and Worldwide

ICOs have raised very substantial amounts of funds, particularly in 2017 and 2018. Asia has been a substantial source of investment and of offerings (Figure 5 and Table 3).

Figure 5: Total Initial Coin Offerings Capital Raised in Asia, July 2017–October 2018
($ million)



ICO = initial coin offering.
Note: ICOs in which raised capital was not disclosed were excluded from the sample.
Source: TrackICO (web-scraped). https://www.trackico.io (accessed 28 November 2018); 419 observations, of which 184 with disclosed capital.

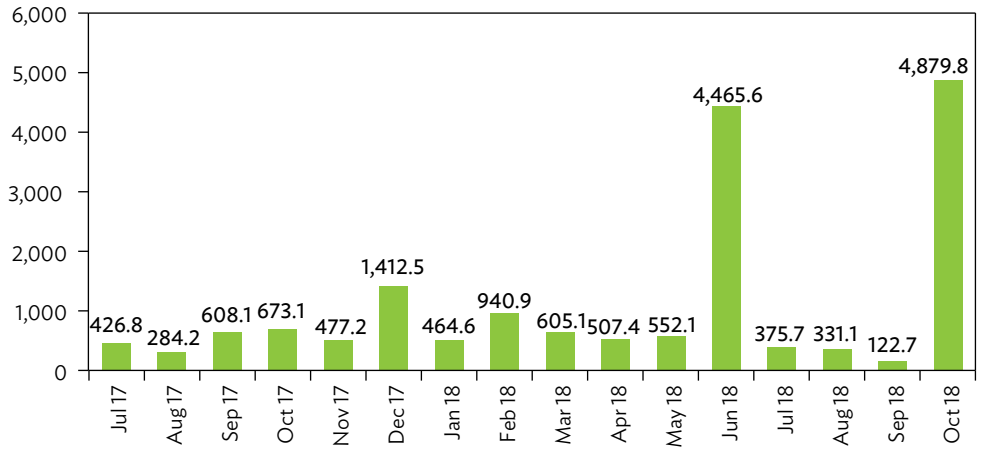
Table 3: Initial Coin Offering in Selected Asian Economies, July 2017–October 2018

Economy	Obs (Obs with disclosed $)	Average Amount Raised ($ million)
Cambodia	2(1)[a]	13.6
China, People's Republic of	14(8)	9.2
Georgia	10(8)	5.2
Hong Kong, China	72(33)	7.7
India	22(5)	10.0
Indonesia	7(1)[1]	35.0
Japan	15(8)	28.2
Kazakhstan	3(1)[1]	1.0
Korea, Republic of	12(8)	19.8
Lao People's Democratic Republic	1(0)	NA
Malaysia	3(2)	2.8
Pakistan	1(0)	NA
Philippines	4(2)	7.4
Singapore	229(104)	15.2
Taipei,China	11(2)	11.1
Thailand	11(1)[a]	0.1
Viet Nam	2(0)	NA

NA = not available, obs = observations.
[a] Information based on just one datapoint, since that much was disclosed by the parties.
Note: Data based on disclosures from TrackICO; Initial coin offerings in which raised capital was not disclosed were excluded from the sample.
Source: TrackICO (web-scraped); 419 observations (184 observations with disclosed capital).

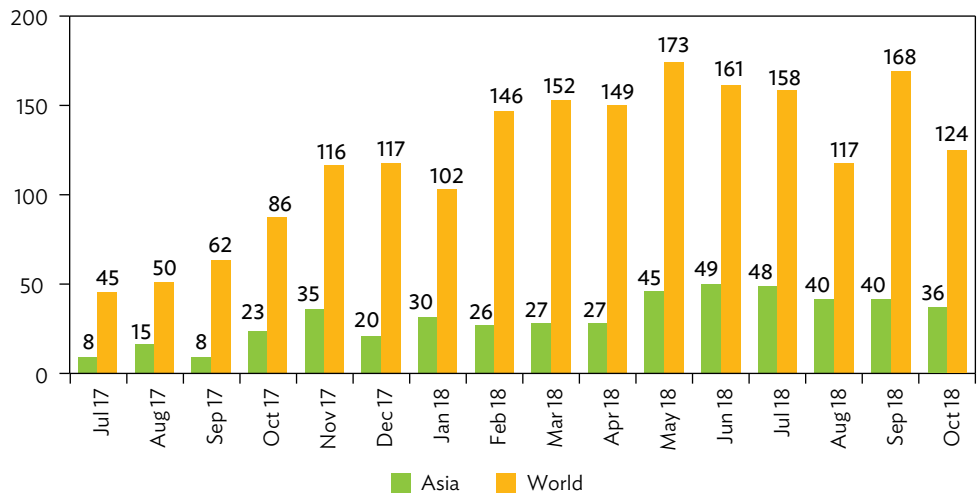
Just as the value of cryptoassets has fluctuated over time, most notably the rapid decline in the value of Bitcoin in December 2017, total capital raised in ICOs continues to fluctuate (Figure 6). However, these figures do not appear to have changed significantly in response to major regulatory changes in the industry. At the same time as the PRC and the Republic of Korea curtailed support for cryptoassets, however, jurisdictions like Japan and Taipei,China predominantly supported the potential of cryptoassets and ICOs.

Figure 6: Total Initial Coin Offering Capital Raised Worldwide, July 2017–October 2018 ($ million)



Note: The huge jumps in June and October 2018 data are due to outliers. In June 2018, EOS raised $4 billion; in October 2018 RedCab raised $4.7 billion. Without these outliers, a downward trend is noted starting in December 2017, in correlation to the first rapid decline of Bitcoin.
Source: TrackICO (web-scraped). https://www.trackico.io (accessed 28 November 2018); 704 full observations.

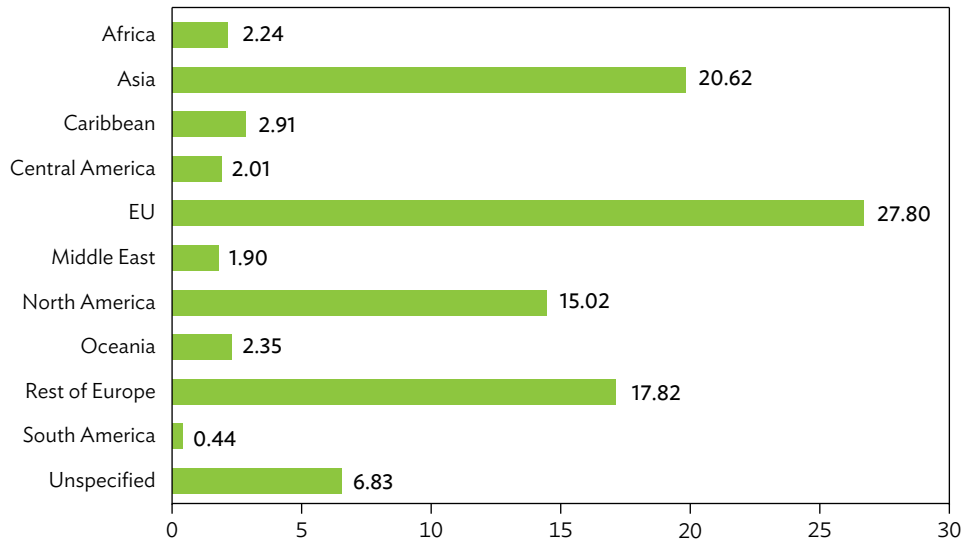
Figure 7: Issued Initial Coin Offering in Asia and Worldwide, July 2017–October 2018



ICO = initial coin offerings.
Source: TrackICO (web-scraped). https://www.trackico.io (accessed 28 November 2018); Asian sample includes 477 ICO issues, world sample counts 1,926 ICOs.

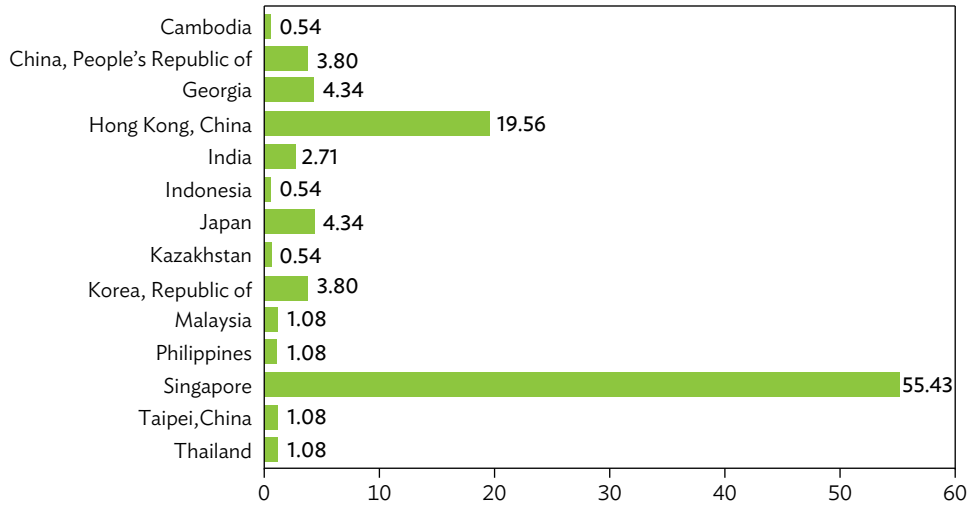
The number of ICOs originating in Asia and other parts of the world has generally increased to date and those originating in Asia have remained a significant amount of those worldwide (Figure 7). Figure 8 presents a geographical regional breakdown, highlighting the role of Asia, with ICOs in Asia peaking in June 2018 and in the world in May 2018. In Asia, Singapore, and Hong Kong, China are the top two economies based on the number of ICOs (Figure 9).

Figure 8: Initial Coin Offering Distribution by Region: Asia and Worldwide, July 2017–October 2018 *(%)*



EU = European Union.
Source: TrackICO (web-scraped). https://www.trackico.io (accessed 28 November 2018); sample of 892 initial coin offerings.

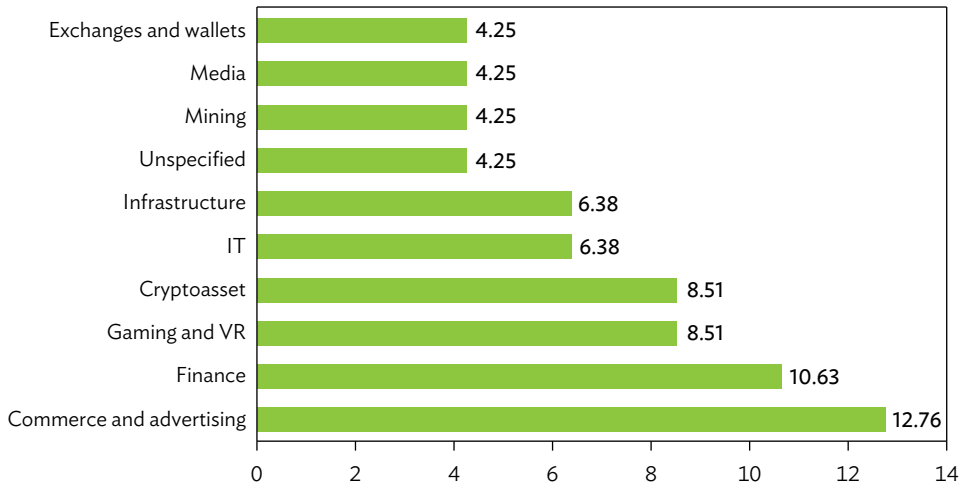
Figure 9: Distribution of Initial Coin Offerings by Economy in Asia, July 2017–October 2018 (%)



Source: TrackICO (web-scraped). https://www.trackico.io (accessed 28 November 2018); sample of 184 initial coin offerings.

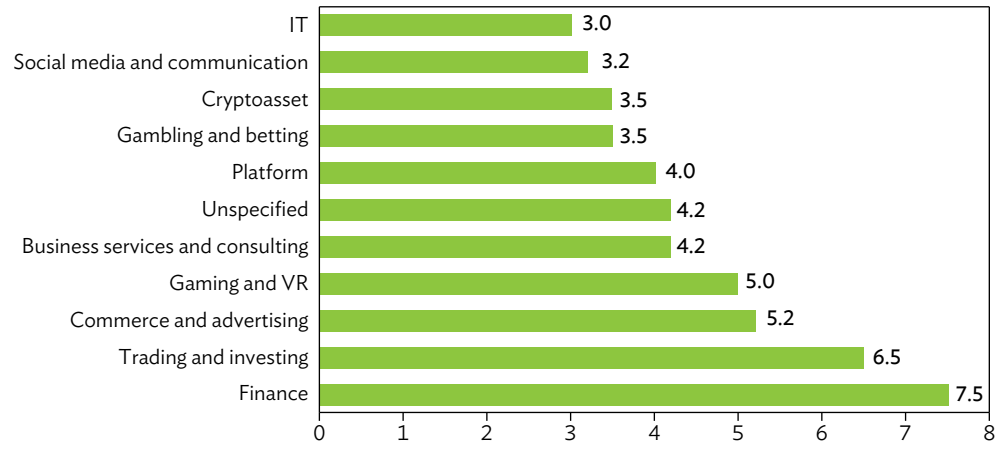
The results show that the European Union (EU) has the largest number of ICO issues and Asia is dominated by ICOs issued in Singapore. The ICO market in the EU has been dominated by Estonia, Malta, and the United Kingdom. Outside the EU but within Europe, Switzerland has established itself as a FinTech innovation hub and hosted some of the largest ICOs to date, such as Tezos. Singapore is particularly popular in Asia due to the clarity of the Monetary Authority of Singapore about when an ICO is treated as a security, closely followed by Hong Kong, China, which has similarly published its own "Best Practices for Token Sales". Figures 10 and 11 highlight the wide range of uses of ICOs in fund-raising.

Figure 10: Top 10 Industries Using Initial Coin Offerings in Asia, July 2017–October 2018 (%)



IT = information technology, VR = virtual reality.
Source: Dataset hand-compiled based on initial coin offering white papers by the Appui au Développement Autonome Chair for Financial Law (inclusive finance) at the University of Luxembourg; sample size 996 initial coin offerings.

Figure 11: Distribution of Initial Coin Offerings by Industry Worldwide
(%)



IT = information technology, VR = virtual reality.
Source: Dataset hand-compiled based on initial coin offering white papers by the Appui au Développement Autonome Chair for Financial Law (inclusive finance) at the University of Luxembourg; sample size 996 initial coin offerings.

In Asia, unlike the rest of the world, ICOs targeting financial industry projects are the second largest category, with commerce and advertising taking the largest share. However, a range of other categories, including trading and investment, and exchanges and wallets are often related to financial sector projects. Nonetheless, the range of projects for which fund-raising is occurring is significant, and this highlights some of the greatest potential benefits in the combination of blockchain and crowdfunding, although these must be carefully balanced against the risks, the subject of the next section.

ICOs thus are a form of raising finance built around the concept of tokenization of various assets that uses DLT.[25] Distributed ledgers are used to store and allocate tokens among ICO participants. The technology offers greater transparency of entitlements offered by the ICO originator that are shared across the entire ledger. Coupled with blockchain, it also allows better tracking of such entitlements, since each transfer of such entitlements will be recorded in sequential order (Zetzsche, Buckley, Arner, and Föehr 2018). DLT-based cryptoassets are often used as the consideration to be provided in exchange for ICO tokens, but this use of cryptoassets is circumstantial: consideration can generally take the form of "any type of valuable asset" (Zetzsche, Buckley, Arner, and Föehr 2018).

4.3 Regulation of Initial Coin Offerings in Asia

Regulators in Asia have adopted a range of responses to ICOs.

Outright Ban

In light of the US Securities and Exchange Commission's investigations into "pump-and-dump" ICO schemes in the United States (Roberts 2017), the PRC and the Republic of Korea issued outright bans on ICOs in September 2017. In the PRC, regulators published a joint statement

[25] For a detailed explanation of ICO mechanics, see Zetzsche, Buckley, Arner, and Föehr (2018,. 7–11).

labelling ICOs as "unauthorised illegal fund-raising activities" (Choudhury 2017). This far-reaching prohibition put an immediate stop to all existing ICOs, warned against any future fund-raising through an ICO and placed major incumbent ICO platforms under review (Zetzsche, Buckley, Arner, and Föehr 2018, 22–23). In a similar fashion, the Republic of Korea's Financial Services Commission announced its ban on all forms of ICOs (Ponciano 2017), though it has since backtracked to some extent.

Regulatory Warnings

Other regulators in Asia have not been as decisive and have adopted a more cautious approach, issuing warnings to various stakeholders stressing the risks of investment in ICOs. In a joint notice, the Commercial Affairs Department and the Monetary Authority of Singapore explained to consumers certain mechanics of an ICO and outlined the common risks, proposing the "ask–check–confirm" approach: (i) ask the seller as many questions as necessary to understand the investment opportunity, (ii) check whether the information provided is true and (iii) confirm the seller's credentials using a list of resources recommended by the regulators (Monetary Authority of Singapore 2017b).

Application of Existing Securities and Investment Product Laws

An increasing number of jurisdictions in Asia and around the world are taking the approach of clarifying that relevant financial regulatory frameworks apply to ICOs which are, in effect, investment products. For instance, the Hong Kong Securities and Futures Commission, in addition to a cautionary statement concerning ICOs, clarified the application of securities laws in the jurisdiction to different token types, which can be classified as shares, debentures, or interests in collective investment schemes, depending on the specific criteria established by the law (Securities and Futures Commission 2017; Polk 2018).

As several of the authors have argued elsewhere (Zetzsche, Buckley, Arner, and Föehr 2018, 7–8), the crowdfunding typology provides an appropriate approach, differentiated on the basis of the purpose of the ICO, as discussed in Section 6.

Is Distributed Ledger Technology the Problem?

Interestingly, the regulatory measures adopted thus far do not appear to be a direct response to the use of DLT in ICOs. If nothing else, greater access to data and transaction recording can simplify regulatory monitoring and oversight of financial markets. Regulatory concerns seem to be much more prosaic: inadequate disclosure and immaturity of the business or the entrepreneurs, risks of fraud, and other forms of deceptive business practices are the key issues so far. This is hardly surprising given the existing "cavalier disregard" of the need to provide adequate disclosure, coupled with the lack of appreciation of legal risks in many ICOs. Opportunistic expectations that ICOs can somehow exist outside any legal system are, of course, naive (Zetzsche, Buckley, Arner, and Föehr 2018, 11). Nevertheless, existing regulatory measures in the area of finance are not based on or triggered by the defining features of DLT. DLT is merely the technology underlying the operation of the ICO. It is not the technology used by the ICO, but what it promises, how it discloses the risks it poses, and how it is promoted to the market, that will determine its legal status in each jurisdiction.

5. Distributed Ledger Technology: Risks and Concerns

With so much interest and so many potential uses of DLT in Asia, many argue that DLT will transform the entire financial system, from money to infrastructure to fund-raising. A high level of industry penetration requires careful analysis of underlying risks. Some of the authors have provided a detailed account of such risks elsewhere (see Zetzsche, Buckley, and Arner 2018). This report furthers the DLT discussion by examining the various underlying challenges through the lens of the regional Asian financial market.

Despite the prospective benefits offered by DLT (see section 3.4), implementation of this technology in Asia has been fraught with difficulties that highlight its potential weaknesses. Notable examples include the loss of 750,000 customer Bitcoins and 100,000 Bitcoins owned by the Japanese Mt. Gox Bitcoin exchange, and the loss of 119,756 Bitcoins by Hong Kong, China-based Bitfinex.[26]

The starting point of the discussion that follows is that "risk does not vanish if financial services are provided via distributed ledgers" (Zetzsche, Buckley, and Arner 2018, 1369). Simply put, DLT and blockchain may enhance efficiency (e.g., by making it more difficult to tamper with the stored data), but the underlying risks do not disappear entirely: DLT does not necessarily make data tamper proof although blockchain can make data tamper-evident. At the same time, this is only one side of the coin. Specific features of DLT may multiply some of the existing risks and even give rise to new risks of a different nature.

This section identifies the key limitations relevant for all applications of DLT and outlines the corresponding implications in Asia. Three major types of risk are relevant for DLT: ledger transparency risks, cyber risks, and operational risks. This section also looks at blockchain-specific risks.

5.1 Transparency Risks

The key idea behind DLT—that the same data are distributed among all data nodes—promotes transparency as well as security. The data that end up being distributed across the entire ledger can be repackaged or encrypted, but remain accessible by every node operator.[27] This makes DLT systems potentially ideal for dealing with issues concerning money laundering. Thus contra to the often perceived problem of total secrecy, DLT—if its design implements blockchain—can provide complete transparency of identity and transactions, including over time in that the history is tamper-evident.

---

[26] For details and references, see Zetzsche, D., R. P. Buckley, and D. W. Arner. 2018. The Distributed Liability of Distributed Ledgers: Legal Risks of Blockchain. University of Illinois Law Review. 2018. (4).

[27] For instance, in Bitcoin, all the data is on the blockchain except the identity of the owners. To know that, one requires the private key. The private key is stored on the owner's wallet rather than the ledger. "However, anyone can see who owns each block, via its public header information, and can follow the links through the entire chain right back to the first block" Umeh, J. 2016. Blockchain Double Bubble or Double Trouble? ITNOW. 58 (1).

At the same time, this creates obvious complications for the use of DLT whenever shared data or parts of shared data are to remain confidential. Even where data on a DLT do not reveal the identity of a person (e.g., a Bitcoin wallet owner) because a private key is required for that function, there is a risk that the information from the user' profile can be used to reconstitute such identity. Re-personalization of pseudonymous data on distributed ledgers has already become a business, with companies offering data-tracking services.[28]

Increased transparency puts greater emphasis not only on the protection of data on a distributed ledger, but also on its structure and content. Distribution of personal data is restricted under data protection laws in Asia. Penalties for violations may be severe.

This also raises particular problems in the cross-border context, in that data protection legislation in Asia varies from jurisdiction to jurisdiction (unlike in the EU, with the new General Data Protection Regulation),[29] often with conflicting requirements. This raises the potential need for regional cooperation in addressing data issues—and for a range of possible technological solutions, including through DLT systems.

5.2 Cyber Risks

DLT does not immediately reduce cyber risks, and in some cases even enhances them.

First, a set of inaccurate data distributed across a distributed network will remain inaccurate, and its visibility within the entire network may increase the likelihood that others may act upon such data. The use of DLT certainly does not rectify inaccurate data.

Second, DLT offers increased safety of data compared to a centralized ledger only when the cybersecurity of the central node of the centralized ledger is lower than the resilience of such number of nodes that is sufficient to establish a consensus of the entire distributed ledger. In practice, this assumption is often inaccurate. On the one hand, centralized ledgers often boast robust security mechanisms that significantly outclass individual end-user nodes on a distributed ledger. On the other hand, not all nodes of a distributed ledger are equal, often as a result of the adopted consensus algorithm. For example, in a proof-of-work model, generation of new data on the ledger is often limited to a handful of nodes with the highest processing power. Ledgers that require a majority of nodes to vote for a consensus may be more easily manipulated if attacks are targeting nodes with the weakest level of cybersecurity (Zetzsche, Buckley, and Arner 2018, 1378). This concentration can be abused by potential attackers.

While the use of DLT is proliferating in Asia, there are to date no systems of certification of this technology. While the attractiveness of DLT is based on its central attributes of security, transparency, and permanence, the reality is that different applications of the same technology are not created equal.

[28] For example, Elliptic offers Bitcoin forensic services that draw on an "extensive number of both public and privately accessible sources of information in order to identify real-world identities on the bitcoin [*sic*] blockchain" (Elliptic. 2017. Introduction to Forensics Software. Fact Sheet for the Cyber Security Summit 2017, pp. 1).

[29] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L 119/1, 4.5.2016.

5.3 Operational Risks

Operational risks are another area where the strengths of DLTs may turn into weaknesses. Any errors in the code implemented on the ledger are replicated across the entire network. Outdated or otherwise insecure code can be abused by attackers in wide-scale attacks, as with Mt. Gox and the DAO (Zetzsche, Buckley, and Arner 2018, 1377). At the same time, the consensus mechanism used to reconcile data across all nodes may itself be inadequately coded and consequently exploited.

The distributed nature of a ledger does not reduce the end users' reliance on experts who understand how the system operates. As a result, mistakes made by such experts are likely to be repeated by others. When mistakes happen or the expectations associated with the increased efficiency of DLT are not met, questions as to who is responsible and their legal responsibilities will arise.

It is important to note in this context that simply because the Bitcoin has proven famously robust, not all applications of DLT will be. The same is true for the infrastructure created to support and provide end users with access to DLT-based products and services, as has been demonstrated by numerous successful hacks of wallets and exchanges storing and transacting in Bitcoins. Today, a blockchain can be built using online resources by a moderately talented technologist in a few hours. It will not in all likelihood, however, be very robust.

There is thus a clear need for some sort of certification system to differentiate the quality of DLT-based systems, for instance in the International Standards Organization (ISO) and its certification processes.

5.4 Blockchain-Specific Risks

Blockchain's key distinguishing feature is the sequential order of data that is split into portions (blocks). This structure is "append-only" and allows information to be added but not removed. Changes to a single block in the chain require alteration of the whole sequence of blocks that come after it. Depending on the type of consensus implemented by the blockchain on a distributed ledger, this feature may make reversal of records on a blockchain extremely difficult, thus creating a semblance of immutability.

The append-only nature feature of blockchain is at odds with the "right to be forgotten" granted in some jurisdictions (Zetzsche, Buckley, and Arner 2018, pp. 1376). It may also preclude effective implementation of certain remedies, in cases where actions recorded on a blockchain need to be reversed. For example, if an asset registry is transferred to a blockchain and a fraudulent transfer of title occurs as a result of a hacking attack, the title could be subsequently transferred back to the rightful owner by a reversing transaction, but the block recording the fraudster's transaction would remain on the chain. At the same time, consensus algorithms could be adjusted to provide for transaction reversal in required circumstances.

6. Policy Issues and Suggestions

Regulatory measures addressing technological innovation take time to develop. Governments often stay in "listening mode" while observing developing trends and assessing the risks underlying new technologies. While regulators are waiting, businesses come up with new business models and products implementing the new technologies. If successful, this implementation may delay or eliminate the need for new regulation. However, if new risks emerge—especially systemic ones—a regulatory response may be needed swiftly. Urgent measures generally target specific business models or products, rather than technologies as such. The recent ban on initial coin offerings in the Republic of Korea is a good example. In the meantime, other regulators in the region (e.g., in Singapore) have opted for a more facilitative approach. But in no case has the regulation imposed been on the technology (the distributed ledger technology) but rather on its applications, in this case, ICOs.

6.1 International Regulatory Context

The main regulatory challenge for the applications of DLT lies in its multifaceted nature. Variations of DLT can be applied across the entire financial system and, as a result, the regulatory response has been limited so far. Some legislatures are attempting to provide a firm legal basis for distributed ledgers by implementing the corresponding definitions by virtue of statute.[30] Others focus specifically on blockchain.[31] The majority, however, are silent on the matter of bespoke regulation of either component of DLT.

This does not mean, however, that DLT systems operate in a legal vacuum.[32] Both regulators and lawyers apply already existing legal constructs and principles, including but not limited to corporate, contract, tort, and property law. It remains to be seen whether this is a temporary solution. It is likely that jurisdictions will approach the matter in different ways in the absence of international rules.[33]

Early attempts to regulate DLT have been fraught with problems of terminology, especially in jurisdictions aiming to establish special rules for blockchain. The latter concept has proven particularly difficult to define with sufficient accuracy, culminating in new rules that are not only overly simplistic, but also confusing and even misleading. For example, the new blockchain

---

30 Russian federal Draft Law No. 419059-7, *On Digital Financial Assets 2018*, defines a "distributed ledger of digital transactions" as a "systematic database of digital transactions that are stored and simultaneously created and updated on all nodes of all ledger participants on the basis of pre-defined algorithms ensuring its sameness among all users of the ledger". Delaware's *An Act to Amend Title 8 of the Delaware Code Relating to the General Corporation Law 2017* (https://legis.delaware.gov/BillDetail/25730) established the legal basis for the maintenance of stock ledgers using "distributed electronic networks or databases."

31 Arizona has adopted a blockchain law. See Arizona, House Bill 2417, An Act Amending Section 44-7003, Arizona Revised Statutes; Amending Title 44, Chapter 26, Arizona Revised Statutes, By Adding Article 5; Relating To Electronic Transactions § 2 AZ HB2417 (2017).

32 For a comprehensive analysis of applicability of law to DLT generally, ssee Zetzsche, D., R. P. Buckley, and D. W. Arner. 2018. The Distributed Liability of Distributed Ledgers: Legal Risks of Blockchain. University of Illinois Law Review. 2018 (4). 1382–1402.

33 See also Didenko, A. 2018. Regulating FinTech: Lessons from Africa. *San Diego International Law Journal.* 19 (2).

law in Arizona claims that data stored on a blockchain is "*immutable* and auditable and provides an uncensored truth", thus creating a qualitative test that is extremely difficult if not completely impossible for any DLT application to fulfil, since absolute immutability is only achievable in theory and remains unrealistic in practice, at least at the current level of technology.[34]

It is recommended that regulators, for the time being at least, focus upon regulating the principal applications of DLT, which are cryptoassets and ICOs, and not devote substantial and scarce resources to trying to regulate the technology itself. The regulation of technology is hardly possible (given its rapid further development) and rarely necessary. Blockchain, for instance, can really be thought of as a particularly robust, resilient, and secure filing cabinet for sequenced information and no legislature has, evidently, ever found it necessary to pass a filing cabinet law. The attempted regulation of technology is, in general, fraught with difficulty. It may eventually prove necessary in this case, and some jurisdictions may wish to do so to highlight their receptiveness to the new technology, but for now the priorities lie elsewhere in the regulation of the technology's applications.

The apparent confusion of some lawmakers and hesitation of others can be explained, at least in part, by the lack of accepted international terminology and the absence of agreed standards to define DLT:

> "Whoever is right, one thing is quite clear: the terminology around the whole phenomenon is still heavily in flux. Caught in the middle of it all, it can be difficult to form a clear picture on blockchain technology and the phenomenon that surrounds it" (Mattila 2016, 3).

One of the latest attempts to fix the terminology barrier is the creation of a dedicated ISO Technical Committee ISO/TC 307 focusing on the development of a whole range of international standards, including ISO/CD 22739 "Blockchain and distributed ledger technologies—Terminology".

6.2 A Functional Proportional Approach Balancing Risks and Opportunities

At the most general level, the specific core attributes of DLT, (i.e., security, transparency, and relative permanence) make it highly attractive in applications which benefit from these characteristics. However, it is very clear that not every application does. The potential of DLT in any particular context varies with the needs and requirements of the individual use case. Thus, use cases need to be considered very carefully against the core strengths of the technology. DLT is not the solution to all problems, but depending on the specific context, it may constitute an appropriate—and in some cases even transformative—platform technology.

Over the medium to long term, it is likely that DLT will find its way into an increasing range of contexts and in some cases fundamentally improve the particular system involved. Examples are likely in certain areas of financial infrastructure that benefit from security, transparency, and permanence, in particular anything relating to registration or ownership of property and property rights as well as the execution of standard transactions (such as clearing and

[34] This matter has already attracted academic attention: a recent study challenges the simplistic approach to understanding blockchain technology, questioning the widespread (and allegedly wishful) association of blockchain with the "immutability" characteristic. See Walch, A. 2017. The Path of the Blockchain Lexicon (and the Law). *Review of Banking & Financial Law.* 36 (713). 735–745.

settlement systems). Other examples are likely in areas where a chain of custody or provenance are significant, as in the case of trade in goods, artworks, jewelry, diamonds, etc. In areas where speed, anonymity, and fungibility are central (such as securities trading as opposed to settlement), DLT solutions are far less likely to be suitable or beneficial.

Over time, perhaps the greatest impact of DLT may simply be that the hype around it encourages a wide range of people to reconsider the design of underlying systems and infrastructure and how new technologies might allow the redesign of these systems or the design of better systems. It is this incentive to consider aspects of underlying infrastructure (such as property registries) that may well offer the greatest long-term impact of DLT: regardless of whether or not DLT is eventually the chosen solution (as so far it has not been in high volume payments systems). This is the central idea of regulatory technology (RegTech): building better systems for finance regulation, and compliance.[35]

Nonetheless, as this report has made clear throughout, even if DLT is suitable, there are wide variations in the design and governance of systems, with permissionless public systems at one extreme and permissioned closed private systems at the other. In the former, network effects mean that—as in most platform technologies—there will be a trend toward consolidation and a small number of major systems will eventually dominate. In the latter—already by far the most numerous and greatest focus of investment—this will not necessarily be the case, although many of these will tend to use the major platforms as opposed to creating new systems.

In any of these systems, just because it is a DLT system does not necessarily mean that it actually has the key attributes except that its functions will be distributed, somehow, among several nodes: implementations of these technologies may vary greatly and there is real need for a system of certification, ideally through the ISO or similar processes.

Whether individual jurisdictions will need specific legislation to support DLT depends on the specific features of the legal system and the policy choices made by the relevant authorities. However, jurisdictions seeking to highlight their openness to innovation as well as those with judicial systems which are less than robust may find such an approach useful. Note that the often overstated distinction between civil and Anglo-Saxon legal families does not play a role here, since all advanced legal systems have legal instruments to deal with cooperation—which is the core of DLT. In all cases, jurisdictions will need to consider the robustness of consumer protection legislation and enforcement arrangements in order to deal with public interactions with DLT systems. In addition, data protection rules may impact the use of DLT, given that data are spread over and stored by many nodes simultaneously.

A field where legislation could provide additional certainty, however, is in conflicts of law where multiple nodes from multiple jurisdictions interact. While exclusivity stipulations in national law regarding the law applicable to torts rarely find acceptance in other jurisdictions, national legislation could clarify which law applies to DLT solutions that are legally characterized as multiparty contracts and partnerships or, more precisely, what type of connecting factor determines the applicable law.

Beyond the general framework of certification and standardization—combined with the general legal framework and systems of consumer protection and data protection which should apply across all the various functional applications—there will be a need to consider how specific applications fall into functional categories which draw additional regulatory attention. Among these are money, payment, fund-raising, credit provision, insurance, and

[35] See Arner, Barberis, and Buckley 2017.

so on. In each case, DLT systems should be treated according to the same general objectives and principles applicable (such as financial stability, prudential regulation, financial integrity and conduct, data protection, and competition considerations). A part of such a treatment is whether the technology itself furthers market concentration (which in turn prompts antitrust concerns).

Finally, exchanges and similar arrangements should be subject to specific attention, with differential treatment depending on the type of digital asset involved, with digital financial product exchanges a particular focus of attention.

6.3 Core Strategy and the Role of International Regulatory Cooperation

In summary, the following approach is recommended:

1. In general, policymakers and regulators should treat DLT as a platform technology which can be used across a wide variety of functional areas, from identity to property registration to financial infrastructure, payment, and fund-raising.

2. At the most general level, there should be a system of categorization and certification (generally on an industry basis, e.g., through the ISO) combined with the general legal system. This is because, as demonstrated elsewhere, the reality is that the legal system will apply everywhere there are users of the system. This system applies in particular to consumer protection, data protection, choice of law/courts, and competition frameworks.

3. Regulatory treatment should vary depending on the context. For now, however, the focus should be on regulating the applications of DLT: cryptoassets and, in particular, cryptoasset exchanges and ICOs. Regulators should focus on specific applications associated with the biggest risks. The recent examples of measures targeting ICOs are an illustration of this approach, where differential treatment is merited for those which are in fact financial products, as opposed to those which are not.

4. In addition to this functional approach, there is a clear need to focus on the public interactions with such systems and the role of intermediaries, as this is where the greatest risks have arisen and are likely to arise in future (with digital asset exchanges the most urgent focus of attention, so as to address the largest range of market integrity, consumer protection, and financial stability risks).

5. At the same time, policymakers and regulators should strive to better understand individual use cases and systems, balancing the opportunities presented to build better financial infrastructure with massive long-term benefits with management of the many risks which will arise along the way. This requires massive investment in technology and innovation expertise; a crucial precondition for this is the insight that new opportunities must be balanced with a prudent risk view on innovation.

Appendix 1: Glossary of Terms

Term	Definition
Blockchain	A blockchain is essentially a shared database with entries that are confirmed and encrypted. It typically uses distributed ledger technology; that is, a blockchain is just one type of distributed ledger. The word "blockchain" refers to the "blocks" that get added to the chain of transaction records.
Cryptoassets	Cryptoassets are digital assets that utilize cryptography and distributed ledger to regulate the generation of new units, verify the transactions, and secure the transactions without the intervention of any middleman.
Distributed ledger technology (DLT)	A distributed ledger is a database that exists across several locations or among multiple participants. Most companies, in contrast, still use a centralized database in a fixed location. A centralized database essentially has a single point of failure. Because a distributed ledger is decentralized it eliminates the need for a central authority or intermediary to process, validate, or authenticate transactions. This is among its primary features that has generated the most excitement about its potential uses.
Cryptoasset mining	Cryptoasset mining is a process in which transactions for various forms of cryptoasset are verified and added to the blockchain digital ledger.
Initial Coin Offering (ICO)	An initial coin offering, also commonly referred to as an ICO, is a fund-raising mechanism in which new projects sell their underlying crypto tokens in exchange for funding. It is somewhat similar to an initial public offering in which investors purchase shares of a company.
Permissioned systems	Permissioned systems are essentially private networks with a predefined governance structure where data authorization depends upon the agreement of multiple predefined servers.
Permissionless systems	Permissionless systems operate on public domain software and allow anyone who downloads and runs the software to participate.
Smart contracts	Smart contracts refer to self-executing software protocols that reflect the terms of an agreement between two parties.
Tokenization	Tokenization is the conversion of an asset into a token that can be moved, recorded, or stored on a blockchain system.

Appendix 2: Policy Approaches to Cryptoassets, Blockchain, and ICOs in Select Asian Economies

	Cryptoasset		Blockchain		Initial Coin Offerings
	Sovereign	Non-Sovereign	Public	Permissioned	For consideration
China, People's Republic of (PRC)	Permissive. People's Bank of China is developing its own digital currency.[a]	Permissive for Chinese investors only. Investors are free to hold cryptoassets including Bitcoin. PRC has prohibited the use of cryptoasset exchanges and financial institutions from providing cryptoasset services.[a]	Permissive. In 2017 more than half blockchain-related patent applications were from PRC; 12 out of 26 listed banks have adopted blockchain applications.[b]	Permissive. PBOC favoring centralized blockchain solutions for a sovereign digital currency and possibly trade finance.[c]	Banned. PRC has banned domestic ICOs and strengthened rules to block online trading in offshore ICOs.[d]
Hong Kong, China	Permissive. HKMA has no plan to issue a central bank digital currency as at 30 May 2018.[e]	Permissive. Cryptoassets are considered virtual commodities.[f]	Permissive. Public and private sector. For Example, a DLT or blockchain-based cross-border trade and trade finance platform is being developed by the HKMA and MAS.[g]	Permissive.	Permissive. The SFC regulates ICOs involving "securities" and wrote to seven exchanges. Most confirmed compliance with the SFC regulatory regime and the others ceased offering tokens to Hong Kong, China investors (Feb 2018).[h]
India	Permissive. Reserve Bank of India investigating launching a digital currency (Aug 2018).[i]	Currently permissive but regulations are being devised to ban private cryptoassets. Crypto exchanges are legal but because banks are prohibited from dealing with crypto exchanges the business model is becoming increasingly unviable.[j]	Permissive. The government has stated that it will use blockchain proactively for ushering in digital economy (1 Feb 2018).[k]	Permissive.	Permissive. ICOs are not regulated but the ban on banks engaging in cryptoasset activities limits the market. This has resulted in one of the largest exchanges closing in Sep 2018.[l]
Indonesia	Permissive. The Bank Indonesia is considering issuing a cryptoasset or digital rupiah. A study is to be completed by 2020.[m]	Banned for payments only and is not legal currency. Financial institutions banned from trading. Otherwise cryptoassets are permissive and may be considered a commodity.[n]	Permissive. Five banks are considering implementing blockchain into their systems. An Indonesian Blockchain Association and Hub have been established.[o]	Permissive. The Bank Indonesia is considering using a centralized system for the digital rupiah.[p]	Permissive. Regulations being considered for crypto exchanges.[q]

continued on the next page

continued

Japan	Permissive. Bank of Japan Deputy Governor states that there are no plans to issue a cryptoasset as at 20 Oct 2018.[r]	Permissive. From April 2017 the Payment Services Act defines cryptoassets as property values stored electronically are not currency. Crypto exchanges must be registered.[s]	Permissive. Blockchain widely used beyond the financial services industry. The government supports the use of DLT in its Future Strategy 2017.[t]	Permissive.	Permissive. Regulations are currently being developed. Selling tokens requires a licence.[u]
Korea, Republic of	Permissive. The Bank of Korea has a taskforce investigating the possibility of issuing a central bank digital currency (May 2018).[v]	Permissive. The use of anonymous bank accounts for virtual coin trading was banned from 30 Jan 2018 to stop cryptoassets being used in money laundering and other crimes.[w]	Permissive. The Ministry of Economy and Finance has allocated 1.6 trillion won towards "Growth through Innovation" investment plan focusing on big data, AI and blockchain (Aug 2018).[x]	Permissive.	Currently banned. ICOs were banned from 29 September 2017. The government is considering ending the ban and issuing guidelines.[y]
Singapore	Permissive. MAS is hesitant to issue a digital currency but open for future consideration.[z]	Permissive. The current scale of trading does not pose risks.[aa]	Permissive. Public and private. For example, Project Ubin has tested DLT for the clearing and settlement of payments and securities.[bb]	Permissive.	Permissive. MAS states that an offer of digital tokens or coins may constitute products regulated under the Securities and Futures Act.[cc]

AI = artificial intelligence, DLT = distributed ledger technology, HKMA = Hong Kong Monetary Authority, ICO = initial coin offering, MAS = Monetary Authority of Singapore, PBOC = People's Bank of China, PRC = People's Republic of China, SFC = Securities and Futures Commission of Hong Kong, China.
Note: As of 31 October 2018.
Sources:

[a] Wenhao and Kim 2018; and Library of Congress, PRC.
[b] James 2018; and Zhao 2018a.
[c] Wenhao and Kim 2018; Malwa 2018; and Zhao 2018b.
[d] Library of Congress, People's Republic of China; and Wenhao and Kim 2018.
[e] Government of Hong Kong, China 2018.
[f] Government of Hong Kong, China 2014a.
[g] Hong Kong Monetary Authority 2017.
[h] Securities and Futures Commission 2018.
[i] Reserve Bank of India 2018c.
[j] Government of India, Ministry of Finance 2018; Reserve Bank of India 2018b; and Ghoshal 2018.
[k] Jaitley 2018.
[l] Reserve Bank of India 2018b; and Ghoshal 2018.
[m] Gorbiano 2018; and Fintechnews 2018.
[n] Ministry of Finance (Indonesia) 2018; Tempo.co 2018; and The Jakarta Post 2018.
[o] OJK (Indonesia) 2017; Ariffin 2018; and Fintechnews Singapore 2018.
[p] Ariffin 2018; and Fintechnews 2018.
[q] The Jakarta Post 2018.
[r] Reuters 2018b.
[s] Library of Congress, Japan.
[t] Government of Japan.
[u] Mori Hamada & Matsumoto 2018, p. 21.
[v] Kim 2018b.
[w] Financial Services Commission (Republic of Korea) 2018.
[x] Ministry of Economy and Finance (Republic of Korea) 2018.
[y] Financial Services Commission (Republic of Korea) 2018; and Yoon 2018a.
[z] Lee 2018.
[aa] Monetary Authority of Singapore 2018.
[bb] Monetary Authority of Singapore 2018; and SGX 2018.
[cc] Monetary Authority of Singapore 2017a.

Appendix 3: Major Policy and Regulatory Events Concerning Cryptoassets and Initial Coin Offerings in Selected Asian Economies, end of October 2018

	Date	Event
China, People's Republic of (PRC)	5 Dec 2013	The People's Bank of China (PBOC) announces a ban on financial institutions transacting in Bitcoin. From Apr 2014.[a] Bitcoin is defined as a virtual commodity that is not a currency. Banks are requested to extend their money-laundering supervision to institutions providing cryptoasset services.[b] Citizens can trade in Bitcoin online but are warned of the risks.[a]
	7 May 2014	The PBOC warns banks to tighten monitoring of virtual currency trades, notably Bitcoin.[c]
	21 Jan 2016	The PBOC plans to issue a sovereign digital currency following studies beginning in 2014.[a]
	11 Jan 2017	The PBOC announces that Bitcoin exchanges will be inspected for regulatory compliance breaches.[d]
	4 Sep 2017	PRC bans all domestic initial coin offerings (ICOs) following a PBOC report which states 90% are fraudulent.[e] ICO rules prohibit financial institutions and nonbank payment institutions from directly or indirectly providing cryptoasset services.[a]
	15 Sep 2017	PRC officially bans all domestic virtual currency exchanges. The PBOC issues a joint statement that cryptoassets do not have the legal status of money.[b]
	20 Nov 2017	PRC says people are free to participate in the Bitcoin market.
	17 Jan 2018	The PBOC orders financial institutions to shut down payment services which trade virtual currencies.[f]
	5 Feb 2018	The PBOC states that regulations will be tightened to ban domestic investors transacting in overseas ICOs and virtual currencies. Measures are strengthened to block online platforms (domestic and offshore) engaged in virtual currency trading and ICOs.[g]
Hong Kong, China	16 Nov 2013	The Hong Kong Monetary Authority (HKMA) states that Bitcoin is a virtual commodity, not a currency.[h]
	8 Jan 2014	The Hong Kong, China government states that Bitcoin and other virtual currencies are virtual commodities.[i]
	9 Jan 2014	The HKMA issues a circular on virtual commodity (i.e., Bitcoin) risks.[j]
	16 Jan 2014	The Securities and Futures Commission (SFC) issues a circular on the money laundering and terrorist financing risks associated with virtual commodities.[k]
	29 Jan 2014	Insurance Authority issues a letter to authorized insurers on the money laundering and terrorist financing risks associated with virtual commodities.[l]
	14 Mar 2014	Hong Kong, China government warns the public of the risks associated with virtual commodities such as Bitcoin.[i]
	21 Mar 2014	SFC issues another circular on the money laundering and terrorist financing risks associated with virtual commodities.[k]
	21 Mar 2014	Insurance Authority issues another letter on virtual commodity money laundering and terrorist financing risks.[l]
	30 Apr 2014	HKMA issues a letter to all authorized institutions warning of virtual commodity risks.[j]
	11 Feb 2015	HKMA warns of the risks associated with Bitcoin.[j]
	25 Mar 2016	Hong Kong, China government indicates no need to regulate or ban trading in Bitcoin or other virtual commodities.[a]

continued on the next page

Continued

Hong Kong, China	5 Sep 2017	SFC states that digital tokens offered in an ICO may be "securities" and therefore part of a regulated activity subject to the Securities and Futures Ordinance.[k]
	8 Nov 2017	Hong Kong, China government says digital tokens should be considered virtual commodities rather than currencies.[i]
	11 Dec 2017	SFC issues reminder on cryptoasset-related products and derivatives.[k]
	9 Feb 2018	SFC warns of cryptoasset exchange and ICO risks.[k]
	1 Jun 2018	SFC issues a circular to cryptoasset intermediaries on compliance with notice requirements.[k]
India	24 Dec 2013	The Reserve Bank of India (RBI) cautions users, holders, and traders of virtual currencies, including Bitcoins, about potential financial, operational, legal, and customer protection and security-related risks.[m]
	1 Feb 2017	The RBI again cautions against virtual currency risks.[m] The RBI states that it has not issued any licenses or authorized any entity or company to operate schemes or deal in Bitcoin or virtual currencies. (However, it is not illegal to do so).[m]
	12 Apr 2017	The Ministry of Finance constitutes an Inter-Disciplinary Committee chaired by Special Secretary (Economic Affairs) to examine the existing virtual currency regulatory and legal framework and suggest measures for dealing with virtual currencies including consumer protection and money-laundering issues.[n]
	29 Dec 2017	The Ministry of Finance cautions the public against the risks of investing in virtual currencies.[o]
	1 Feb 2018	The minister of finance states in the budget speech that the government does not consider cryptoassets as legal tender and will take all measures to eliminate the use in financing illegitimate activities or being part of the payment system.[p]
	5 Apr 2018	The RBI states that its Inter-Disciplinary Committee will study and provide guidance on the feasibility and desirability of issuing a central bank digital currency.[m] The RBI states that regulated entities (i.e., banks) shall not deal in virtual currencies from 6 Jul.[m]
	6 Apr 2018	The RBI again cautions against virtual currency risks.[m] The RBI again states that regulated entities shall not deal in virtual currencies.[m]
	30 Oct 2018	The Financial Stability and Development Council was briefed by Ministry of Finance's Inter-Disciplinary Committee to devise an appropriate legal framework to ban the use of private cryptoassets while encouraging the use of DLT.[n]
Indonesia	6 Feb 2014	Bank Indonesia states that Bitcoin and other virtual currencies are not currencies or legal payment instruments.[q]
	9 Nov 2016	Bank Indonesia issues regulations prohibiting payment system operators from processing virtual currencies for payment system activities.[e]
	19 Dec 2017	Bank Indonesia issues regulations prohibiting financial technology operators from processing payments using virtual currencies.[e]
	13 Jan 2018	Bank Indonesia issues a warning to the public concerning the risks of buying, selling, and trading virtual currencies.[q] Bank Indonesia reiterates that virtual currencies including Bitcoin and not allowed to be used for payments in Indonesia.[q]
	23 Jan 2018	Minister of finance warns that virtual currencies are high-risk and speculative investments that cannot be legally used for transactions.[r]
	25 Jan 2018	The Financial Services Authority states that the financial industry is barred from trading cryptoassets and Bitcoin, especially if it acts as a commodity.[s]
	4 Jun 2018	A senior officer of the Commodity Futures Trading Supervisory Agency states that cryptoassets will be treated as futures trading subjects or commodities.[t] The official also stated that regulations were being developed to govern the operation of crypto exchanges and for anti-money laundering countering the financing of terrorism.[t]

continued on the next page

Continued

Japan	19 Jun 2014	The Financial Services Agency (FSA) starts to develop cryptoasset regulations following the failure of Mt. Gox—a Bitcoin exchange.[u]
	4 Mar 2016	Virtual currencies are recognized as a legal means of payment (not a currency) from 1 Apr 2016.[v] Bitcoin exchanges will be legally subject to anti-money-laundering/ know-your-customer rules.[b] Banks are prohibited from dealing in Bitcoins or acquiring a virtual exchange company. Banks are not prohibited from investments in financial products which incorporate Bitcoin.[v]
	25 May 2016	Japan amends the Payment Services Act to define cryptoassets and require virtual exchange operators to be subject to financial conditions, such as separating customer assets and undergo external auditing.[a]
	1 Apr 2017	Amendments to the Payment Services Act take effect.[w] Cryptoassets are defined as property stored electronically that excludes currency and currency-denominated assets.[e] Virtual currency (or cryptoasset) exchange service providers are permitted subject to licensing requirements.[e]
	30 Sep 2017	The FSA grants the first cryptoasset exchange licenses.[a]
	27 Oct 2017	The FSA issues user and business operator warnings about the risks of ICOs.[v]
	30 Jan 2018	The FSA requests all cryptosset exchanges to review system-risk management plans and report the results.[x]
	8 Mar 2018	The FSA creates a research group to investigate virtual currency exchanges.[e]
	5 Apr 2018	The government issues a report which proposes guidelines for ICOs to facilitate stronger consumer protections.[w] More stringent registered exchange operator standards proposed—regulating pursuant to the Financial Instruments and Exchange Act as opposed to the Payment Services Act to oblige the separation of customer funds and to introduce insider trading rules.[x]
	6 Aug 2018	The Virtual Currency Exchange Association, a self-regulatory body, which represents all 16 approved crypto exchanges successfully, applies for FSA certification.[x]
Korea, Republic of	10 Dec 2013	The Bank of Korea, Financial Supervisory Service, Ministry of Strategy and Finance, and the Financial Services Commission (FSC) state that Bitcoin and other virtual currencies are not real legal currency.[y]
	18 Nov 2016	The FSC launches a task force and convenes a meeting of supervisors to discuss the regulation of digital currencies and crypto exchange licensing rules.[a]
	3 Jul 2017	The government introduces a bill to amend the Electronic Financial Transactions Act that requires traders, brokers, or other businesses involved in cryptoasset transactions to obtain regulatory approval from the FSC.[z]
	29 Sep 2017	The FSC bans all forms of cryptoasset-based money raising activities (including ICOs) over concerns of fraud and speculation.[b]
	6 Dec 2017	The FSC issues a directive banning securities firms from intermediating in Bitcoin futures transactions.[aa]
	11 Jan 2018	The justice minister states that regulators are preparing legislation to halt cryptoasset trading—this never eventuates.[bb]
	18 Jan 2018	The FSC states that the government is considering a ban on all virtual currency exchanges—this never eventuates.[bb]
	30 Jan 2018	The Korea Financial Intelligence Unit issues Virtual Currency Anti-Money Laundering Guidelines.[e]
		Cryptoasset trading must occur through real-name bank accounts linked to crypto exchanges (i.e., anonymous trading is banned).[e]
	31 Jan 2018	The finance minister states that government's immediate task is to regulate exchanges.[cc]
	20 Feb 2018	The Financial Supervisory Service states the government supports "normal" cryptoasset trading and encourages financial institutions to facilitate transactions with cryptoasset exchanges.[e]
	28 May 2018	The government officially plans to allow ICOs by suggesting a legislative and policy proposal with consumer protections.[aa]
	8 Jun 2018	The Korean Policy Advisory Council meets to develop a regulatory framework for cryptoasset exchanges.[dd]

continued on the next page

Continued

Korea, Republic of	15 Jun 2018	The Bank of Korea releases the "Payment and Settlement Systems Report 2017" which outlines research on cryptoassets and blockchain.[a]
	27 Jun 2018	The FSC announces a revision to the Virtual Currency Anti-Money Laundering Guidelines, effective 10 Jul 2018.[ee]
	17 Jul 2018	The FSC announces the creation of the Financial Innovation Bureau (a temporary body with a 2-year life span), which will be tasked with policy initiatives and respond to developments and challenges in cryptoassets.[ee]
	11 Oct 2018	The government states that it is likely to announce its position on ICOs in Nov 2018.[ff]
Macau, China	27 Sep 2017	Macau, China issues alert to risks of virtual commodities and tokens.[e]
Malaysia	7 Sep 2017	Malaysia issues a caution to investors on the risks of ICOs.[gg]
	19 Jan 2018	Malaysia issues a cautionary statement that ICO issuers may be subject to securities and banking laws.[gg]
Singapore	8 Jan 2014	Singapore states that Bitcoin is not a currency for taxation purposes.[d]
	13 Mar 2014	The Monetary Authority of Singapore (MAS) states that virtual currency intermediaries will be regulated to address potential money laundering and terrorist financing risks.[hh]
	25 Aug 2016	MAS proposes a new regulatory framework for digital payments to capture virtual currency intermediaries.[hh]
	16 Nov 2016	Singapore announces the development of a blockchain proof-of-concept pilot project ("Ubin") for interbank payments.[a]
	1 Aug 2017	MAS announces that it plans to regulate ICOs which are deemed "securities" under the Securities and Futures Act.[hh]
	10 Aug 2017	Singapore issues consumer advice on investment schemes involving digital tokens including virtual currencies.[hh]
	14 Nov 2017	MAS issues a Guide to Digital Token Offerings.
	21 Nov 2017	Singapore releases a proposed Payment Services Bill and consultation paper to regulate payment activities including virtual currency services.[a]
	19 Dec 2017	MAS cautions against investments in cryptoassets.[gg]
	24 May 2018	MAS warns ICO issuers trading in digital tokens that are deemed securities that they need MAS authorization.[gg]
	24 Aug 2018	MAS and SGX partner with Anquan, Deloitte, and Nasdaq to harness blockchain for the settlement of tokenized assets.[hh]
Thailand	27 Oct 2017	Thailand issues regulatory approach to ICOs.[gg]

DLT = distributed ledger technology, FSA = Financial Services Agency of Japan, FSC = Financial Services Commission of the Republic of Korea, HKMA = Hong Kong Monetary Authority, ICO = initial coin offering, MAS = Monetary Authority of Singapore, PBOC = People's Bank of China, PRC = People's Republic of China, RBI = Reserve Bank of India, SFC = Securities and Futures Commission of Hong Kong, China.

Sources:

[a] Perkins Coie, LLP 2018, China, Singapore, Republic of Korea, Japan and Hong Kong.
[b] Holman and Stettner. 2018, pp. 30–31.
[c] Wall Street Journal 2014.
[d] Coindesk 2014; and 2017.
[e] Library of Congress, People's Republic of China, Republic of Korea, and Japan.
[f] Yu 2018.
[g] Xinhuanet 2018.
[h] Coinnewsasia, Hong Kong.
[i] Government of Hong Kong 2014a; 2014b; 2015; and 2017.
[j] Hong Kong MonetaryAuthority 2014a; 2014b; and 2015.
[k] Securities and Futures Commission (Hong Kong) 2014a; 2014b; 2017a; 2017b; 2018a; and 2018b.
[l] Office of the Commissioner of Insurance (Hong Kong) 2014a; and 2014b.
[m] Reserve Bank of India 2013; 2017; 2018a; and 2018b.
[n] Government of India, Ministry of Finance 2017; and 2018.
[o] Government of India, Press Information Bureau 2017.
[p] Jaitley (Minister of Finance, India) 2018, p. 20 [112].
[q] Bank Indonesia 2014; and 2018.
[r] Ministry of Finance (Indonesia) 2018.
[s] Tempo.co 2018.
[t] The Jakarta Post 2018.
[u] Steele and Morishita Forthcoming.
[v] Mori Hamada & Matsumoto 2018, p. 3.
[w] Charltons Quantum 2017; and 2018.
[x] Financial Services Agency (Japan) 2018.
[y] Park 2016.
[z] Korea Herald 2018.
[aa] Yoon 2017; and 2018.
[bb] Kim and Kim 2018; and Kim and Yang 2018.
[cc] Wenhao and Kim 2018, Republic of Korea.
[dd] Coingeek 2018.
[ee] Financial Servcies Commission (Korea) 2018a; and 2018b.
[ff] The Investor 2018.
[gg] IOSCO. Regulators' Statements on Initial Coin Offerings.
[hh] Monetary Authority of Singapore 2016, 2017a; 2017b; and 2018a.

References

Amara, R. 2006. *The Age.* Quoted in S. Ratcliffe. 2016. *Oxford Essential Quotations.* 4th ed. Oxford: Oxford University Press. http://www.oxfordreference.com/view/10.1093/acref/9780191826719.001.0001/q-oro-ed4-00018679

Ariffin, E. 2018. Indonesia Embraces Blockchain. *The ASEAN Post.* 23 August. https://theaseanpost.com/article/indonesia-embraces-blockchain

Arner, D. W., J. Barberis, and R. P. Buckley. 2017. FinTech, RegTech, and the Reconceptualization of Financial Regulation. *Northern Journal of International Law & Business*. 37 (3).

Bank for International Settlements. 2018. "Thai Economy: The Current State and Way Forward." Keynote Address by the Governor of the Bank of Thailand at the Nomura Investment Forum Asia 2018. Singapore. 5 June. https://www.bis.org/review/r180606g.pdf

Bank of England. Digital Currencies. https://www.bankofengland.co.uk/research/digital-currencies (accessed 29 November 2018).

Bank Indonesia. 2014. Statement of Bank Indonesia Related to Bitcoin and Virtual Currency Offers. Jakarta. 6 February. https://www.bi.go.id/id/ruang-media/siaran-pers/Pages/sp_160614.aspx

_____. 2018. The Bank of Indonesia Warns not to Sell, Buy or Trade Virtual Currencies. Jakarta. 18 January. https://www.bi.go.id/id/ruang-media/siaran-pers/Pages/sp_200418.aspx

Bank of Israel. 2018. The Bank of Israel Published a Summary of the Work of the Team to Examine Central Bank Digital Currency (CBDC). 6 November. https://www.boi.org.il/en/NewsAndPublications/PressReleases/Pages/6-11-18.aspx

Bank of Thailand. 2018. Announcement of Project Inthanon Collaborative Partnership. Press release No. 54/2018. 21 August. https://www.bot.or.th/Thai/PressandSpeeches/Press/News2561/n5461e.pdf

Bank of Papua New Guinea. 2017. Speech by Governor Loi Bakani, CMG at the Blockchain Seminar at PNG Institute of Banking & Business Management (IBBM) Auditorium. 18 August. https://www.bankpng.gov.pg/announcement/governor-loi-m-bakani-cmg-speech-at-blockchain-seminar-at-png-institute-of-banking-business-management/

_____. Blockchain. https://www.bankpng.gov.pg/blockchain/#

Banque Régionale de Marchés (BRM). 2016 . Press release (English Translation of BRM). November. https://www.ecurrency.net/static/news/201611/press_release_BRM_translated.pdf

Baran, P. 1962. On Distributed Communication Networks. Rand Corporation. Paper. https://www.rand.org/content/dam/rand/pubs/papers/2005/P2626.pdf. Quoted in W. Mougayar. 2015. Understanding the Blockchain. *O'Reilly*. 16 January. https://www.oreilly.com/ideas/understanding-the-blockchain

Barrdear, J. and M. Kumhof. 2016. *The Macroeconomics of Central Bank Issued Digital Currencies*. Bank of England. *Staff Working Paper* No. 605.

Bech, M. L. and R. Garratt. 2017. Central Bank Cryptocurrencies. *BIS Quarterly Review*. September. https://www.bis.org/publ/qtrpdf/r_qt1709f.pdf

Brainard, L. 2018. Cryptocurrencies, Digital Currencies, and Distributed Ledger Technologies: What Are We Learning? Board of Governors of the Federal Reserve System speech. 15 May. https://www.federalreserve.gov/newsevents/speech/brainard20180515a.htm

Burgos, A. and B. Batavia. 2018. Currency in the Digital Era. Central Bank of Brazil. Working Paper. July. https://www.bcb.gov.br/htms/public/inovtec/Currency-in-the-Digital-Era.pdf

Casey, A. and A. Niblett. 2017. Self-Driving Contracts. *Journal of Corporation Law*. 43 (1). 26–32.

Central Bank of Uruguay. 2017. The BCU Presented A Pilot Plan for the Issuance of Digital Tickets (in Spanish). 3 November. https://www.bcu.gub.uy/Comunicaciones/Paginas/Billete_Digital_Piloto.aspx

Charltons Quantum. 2018. Regulation of Cryptocurrencies and Initial Coin Offers (ICOs) in Japan. August. https://charltonsquantum.com/regulation-cryptocurrency-initial-coin-offerings-ico-japan/

Charltons Quantum. 2017. Hong Kong Regulation of Cryptocurrencies and Initial Coin Offers (ICOs). September. https://charltonsquantum.com/fintech-icos-and-cryptocurrencies/regulation-of-cryptocurrencies-and-icos/

Choudhury, S. R. 2017. China Bans Companies from Raising Money through ICOs, Asks Local Regulators to Inspect 60 Major Platforms. *CNBC*. 4 September. https://www.cnbc.com/2017/09/04/chinese-icos-china-bans-fundraising-through-initial-coin-offerings-report-says.html

Coindesk . 2018. Blockchain Venture Capital. https://www.coindesk.com/bitcoin-venture-capital (accessed 29 November 2018).

Coinmarketcap. All Cryptocurrencies. https://coinmarketcap.com/all/views/all/ (accessed 28 November 2018).

Coinnewsasia. Legality by Country (Asia). http://www.coinnewsasia.com/legality-by-country-asia/ (accessed 29 November 2018).

Danezis, G. and S. Meiklejohn. 2016. Centrally Banked Cryptocurrencies. February. Unpublished. https://eprint.iacr.org/2015/502.pdf

Davis Polk. 2018. SEC Debuts Roadmap for Resolving Illegal ICOs. Client Memorandum. New York. 20 November. https://www.davispolk.com/files/2018-11-20_sec_debuts_roadmap_resolving_illegal_icos.pdf

De Nederlandsche Bank. 2018. *DNB Annual Report 2017*. Amsterdam.

Didenko, A. 2018. Regulating FinTech: Lessons from Africa. *San Diego International Law Journal*. 19 (2).

Didenko, A. and R. Buckley. 2019. The Evolution of Currency: Cash to Cryptos to Sovereign Digital Currencies. *Fordham International Law Journal*. 42 (4). 1041–1094.

Elliptic. 2017. Introduction to Forensics Software. Fact Sheet for the Cyber Security Summit 2017. https://cybersecuritysummit.co.uk/wp-content/uploads/sites/29/2017/10/Elliptic_Forensic_1Sheet_PRINT.pdf

Engert, W. and B. Fung. 2017. Central Bank Digital Currency: Motivations and Implications. *Bank of Canada Staff Discussion Paper* 2017-16. https://www.bankofcanada.ca/wp-content/uploads/2017/11/sdp2017-16.pdf

European Central Bank (ECB). 2012. *Virtual Currency Schemes*. October. https://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemes201210en.pdf

_____. 2015. *Virtual Currency Schemes—A Further Analysis*. February. https://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemesen.pdf (accessed 27 November 2018).

Fairfield, J. A. T. 2014. Smart Contracts, Bitcoin Bots, and Consumer Protection. *Washington and Lee Law Review Online*. 71 (2). 36–41.

Financial Action Task Force. 2014. Virtual Currencies: Key Definitions and Potential AML/CFT Risks. FAFT Report. FAFT/OECD. Paris. http://www.fatf-gafi.org/media/fatf/documents/reports/Virtual-currency-key-definitions-and-potential-aml-cft-risks.pdf

Financial Services Agency (Japan). 2018. Establishment of "Study Group on Virtual Currency Exchange Industry etc" (In Japanese). 8 March. https://www.fsa.go.jp/news/30/singi/20180308.html

Financial Services Commission (Korea). 2018a. Revision to Virtual Currency Anti-Money Laundering Guidelines. Press release. 27 June. https://www.fsc.go.kr/eng/new_press/releases.jsp?menu=01&bbsid=BBS0048

_____. 2018b. FSC Reshuffles Organizational Structure. Press Release. 17 July. https://www.fsc.go.kr/downManager?bbsid=BBS0048&no=127904

Financial Stability Board. 2018. Crypto-Asset Markets: Potential Channels for Future Financial Stability Implications. 10 October. http://www.fsb.org/wp-content/uploads/P101018.pdf

Fintechnews. 2018. Bank Indonesia Studies Use of Blockchain. 17 May. https://www.fintechnews.org/bank-indonesia-studies-use-blockchain

Fintechnews Singapore. 2018. How is Indonesia Implementing Blockchain Technology? 10 April. http://www.fintechnews.sg/18744/indonesia/blockchain-use-case-indonesia/.

Ghoshal, D. 2018. One of India's Biggest Cryptocurrency Exchanges Is Shutting Down. *QuartzIndia*. 28 September. https://qz.com/india/1405918/zebpay-a-major-indian-bitcoin-exchange-is-closing/

Gibbs, E. 2018. Coingeek. 13 June.

Government of Hong Kong. 2014a. LCQ 1: Monitoring the Use of Bitcoins. 8 January. https://www.info.gov.hk/gia/general/201401/08/P201401080357.htm

_____. 2014b. Hong Kong Government Warns Public of the Risks Associated with Virtual Commodities. 14 March. https://www.info.gov.hk/gia/general/201403/14/P201403140751.htm

_____. 2015. LCQ4: Regulation of Trading Activities of Bitcoin. 25 March. https://www.info.gov.hk/gia/general/201503/25/P201503250463.htm

_____. 2017. LCQ15: Regulation of Offering and Trading of Digital Tokens. 8 November. http://www.info.gov.hk/gia/general/201711/08/P2017110800405.htm

_____. 2018. *LCQ5: Issuance of cryptocurrency*. 30 May. https://www.info.gov.hk/gia/general/201805/30/P2018053000387.htm.

Government of Venezuela. 2018. *Petro: Towards the Economic Digital Revolution* (In Spanish). White Paper. h ttps://www.petro.gob.ve/descargas/Petro_whitepaper.pdf

Gorbiano, M. I. 2018. Digital Rupiah Study to be Completed in 2020: BI. *The Jakarta* Post. 1 February 2018. http://www.thejakartapost.com/news/2018/02/01/digital-rupiah-study-to-be-completed-in-2020-bi.html

Government of India, Ministry of Finance. 2017. Government Constitutes an Inter-Disciplinary Committee Chaired by Special Secretary (Economic Affairs) to Examine the Existing Framework with Regard to Virtual Currencies. Print release. 12 April. http://www.pib.nic.in/newsite/PrintRelease.aspx?relid=160923

_____. 2018. 19th Meeting of the Financial Stability and Development Council (FSDC) Held under the Chairmanship of the Union Finance Minister, Shri Arun Jaitley reviewed the current global and domestic economic situation and financial sector performance; The Council decided that the Regulators and the Government would keep a close watch on the developing situation and take all necessary measures. 30 October. http://www.pib.nic.in/newsite/PrintRelease.aspx?relid=184478

Government of India, Press Information Bureau. 2017. Government Cautions People Against Risks in Investing in Virtual 'Currencies'; Says VCs are like Ponzi Schemes. Delhi. 29 December. http://www.pib.nic.in/PressReleseDetail.aspx?PRID=1514568

Government of Japan. Drive Innovation and Trade. https://www.japan.go.jp/abenomics/innovation/index.html

Hale, K. 2018. Cryptocurrencies Filling The Caribbean Banking Void. *Forbes*. 29 May. https://www.forbes.com/sites/korihale/2018/05/29/cryptocurrencies-filling-the-caribbean-banking-void/#521dda9f5efa

Hampl, M. 2017. *Central Banks, Digital Currencies and Monetary Policy in Times of Elastic Money*. Speech at the Official Monetary and Financial Institutions Forum (OMFIF) Roundtable. London. 11 July. https://www.bis.org/review/r170720b.htm

Holman, D. and B. Stettner. 2018. Anti-Money Laundering Regulation of Cryptocurrency: U.S. and Global Approaches. *Allen and Overy, LLP* (ICGL TO: Anti-Money Laundering 2018). http://www.allenovery.com/publications/en-gb/Documents/AML18_AllenOvery.pdf

Hong Kong Monetary Authority. 2014a. Risks Associated with Virtual Commodities. 9 January.

_____. 2014b. Risks Associated with Virtual Commodities. 30 April.
_____. 2015. The HKMA Reminds the Public to be Aware of the Risks Associated with Bitcoin. 11 February.
_____. 2017. Hong Kong and Singapore Launch a Joint Project on Cross-Border Trade and Trade Finance Platform. 15 November.
International Organization for Standardization. ISO/TC 307a: About. Blockchain and Distributed Ledger Technologies. https://www.iso.org/committee/6266604.html
_____. ISO/TC 307b: Standards Catalogue. Blockchain and Distributed Ledger Technologies. https://www.iso.org/committee/6266604/x/catalogue/p/0/u/1/w/0/d/0
The Investor. 2018. Gov't Likely to Announce ICO Stance in Nov. 11 October. http://www.theinvestor.co.kr/view.php?ud=20181011000606
IOSCO. Regulators' Statements on Initial Coin Offerings. https://www.iosco.org/publications/?subsection=ico-statements
_____. 2017. *IOSCO Research Report on Financial Technologies (Fintech)*. February. https://www.iosco.org/library/pubdocs/pdf/IOSCOPD554.pdf.
Jaitley, A. (Minister of Finance, India). 2018. Budget 2018–2019, Speech. 1 February. https://www.indiabudget.gov.in/ub2018-19/bs/bs.pdf
The Jakarta Post. 2018. Cryptocurrencies Decided as Future Trading Commodity. 4 June. http://www.thejakartapost.com/news/2018/06/04/cryptocurrencies-decided-as-future-trading-commodity.html
James, A. 2018. China Leads World in Blockchain Patent Applications. *Bitcoinist*. 30 March. http://bitcoinist.com/china-leads-world-in-blockchain-patent-applications/
Kim, Y. 2018. BOK Eyeing Digital Currencies. *The Korea Times*. 2 May. http://www.koreatimes.co.kr/www/news/biz/2018/05/602_248317.html
Kim, D. and C. Kim. 2018. Reuters. 18 January.
Kim, C. and H. Yang. 2018. Reuters. 12 January.
Kindleberger, C. 1978. *Manias, Panics, and Crashes*. New York: Wiley.
Kõlvart, M., M. Poola and A. Rull. 2016. Smart Contracts. In T. Kerikmäe and A.Rull, eds. *The Future of Law and eTechnologies*. Cham: Springer.
Koning, J. 2016. Fedcoin: A Central Bank-issued Cryptocurrency. *R3 Reports*. 15 November. https://www.r3.com/wp-content/uploads/2017/06/fedcoin_central-bank_R3.pdf
Koulu, R. 2016. Blockchains and Online Dispute Resolutions: Smart Contracts as an Alternative to Enforcement. *Scripted*. 13 (1).
Lane, T. 2018. Decrypting "Crypto". Calgary. 1 October. https://www.bankofcanada.ca/2018/10/decrypting-crypto/.
La Poste Tunisienne (Tunisian Post Office). Dinar Electronique. http://e-dinar.poste.tn (accessed 23 November 2018).
Lee, J. 2018. Singapore Wary of Issuing Digital Currencies to Public: MAS Chief Ravi Menon. *The Straits Times*. 15 January. https://www.straitstimes.com/business/companies-markets/singapore-wary-of-issuing-digital-currencies-to-public-mas-chief
Levy, K. E. C. 2017. Book-Smart, Not Street-Smart: Blockchain-Based Smart Contracts and The Social Workings of Law. *Engaging Science, Technology, and Society*. 3.
Library of Congress. Regulation of Cryptocurrency Around the World. https://www.loc.gov/law/help/cryptocurrency/ (accessed 27 November 2018).
Lim, C., T.J. Shaw, and C. Sargeant. 2016. Smart Contracts: Bridging the Gap Between Expectation and Reality. University of Oxford Business Law Blog. 11 July. https://www.law.ox.ac.uk/business-law-blog/blog/2016/07/smart-contracts-bridging-gap-between-expectation-and-reality
Luu, L. 2017. A State-Issued Coin Could Unleash Untapped Potential for Cryptocurrencies. *Forbes*. 17 December. https://www.forbes.com/sites/luuloi/2017/12/17/a-state-issued-coin-could-unleash-untapped-potential-for-cryptocurrencies/#4874f9203c2f

Malwa, S. 2018. People's Bank of China to Build Blockchain and Crypto Research Center to Test Digital Currencies. *Cyrptoslate*. 6 September. https://cryptoslate.com/peoples-bank-of-china-to-build-blockchain-and-crypto-research-center-to-test-digital-currencies/

Mattila, J. 2016. The Blockchain Phenomenon: The Disruptive Potential of Distributed Consensus Architectures. *BRIE Working Paper*. 2016-1. https://brie.berkeley.edu/sites/default/files/juri-mattila-.pdf

Ministry of Economy and Finance (Korea). 2018. 'Growth through Innovation' Investment Plan. 13 August. http://englich.moef.go.kr/pc/selectTbPressCenterDtl.do?boardCd=N0001&seq=4532

Ministry of Finance (Indonesia). 2018. Minister of Finance: Bitcoin is Not in Line with Law. Jakarta. 25 January. https://www.kemenkeu.go.id/en/publications/news/minister-of-finance-bitcoin-is-not-in-line-with-law/

Monetary Authority of Singapore. 2016. MAS Proposes New Regulatory Framework and Governance Model for Payments. 25 August. https://www.mas.gov.sg/News-andPublications/Media-Releases/2016/MAS-Proposes-New-Regulatory-Framework-and-Governance-Model-for-Payments.aspx

_____.2017a. MAS Clarifies Regulatory Position on the Offer of Digital Tokens in Singapore. 1 August. http://www.mas.gov.sg/News-and-Publications/Media-Releases/2017/MAS-clarifies-regulatory-position-on-the-offer-of-digital-tokens-in-Singapore

_____. 2017b. Consumer Advisory on Investment Schemes Involving Digital Tokens (Including Virtual Currencies). 10 August. http://www.mas.gov.sg/News-and-Publications/Media-Releases/2017/Consumer-Advisory-on-Investment-Schemes-Involving-Digital-Tokens.aspx

_____. 2018a. MAS and SGX partner Anquan, Deloitte and Nasdaq to harness blockchain technology for settlement and tokenised assets. 24 August. https://www.mas.gov.sg/News-and-Publications/Media-Releases/2018/MAS-and-SGX-partner-Anquan-Deloitte-and-Nasdaq-to-harness-blockchain-technology.aspx

_____. 2018b. Reply to Parliamentary Question on Banning the Trading of Bitcoin Currency or Cryptocurrency. 5 February. http://www.mas.gov.sg/News-and-Publications/Parliamentary-Replies/2018/Reply-to-Parliamentary-Question-on-banning-the-trading-of-bitcoin-currency-or-cryptocurrency.aspx

Mori Hamada & Matsumoto. 2018. Japan's Virtual Currency Regulation and its Recent Developments. April. https://events.eventact.com/ki2/crypto/Masakazu%20Masujima%20(Mori%20Hamada%20&%20Matsumoto)-Japans%20Virtual%20Currency%20Regulation%20and%20its%20Recent%20Developments.pdf

Mougayar, W. 2015. Understanding the Blockchain. *O'Reilly*. 16 January. https://www.oreilly.com/ideas/understanding-the-blockchain

Nakamoto, S. 2008. Bitcoin: A Peer-to-Peer Electronic Cash System. 31 October. https://bitcoin.org/bitcoin.pdf

Office of the Commissioner of Insurance (Hong Kong). 2014a. Money Laundering and Terrorist Financing Risks Associated with Virtual Currencies. 29 January. https://www.ia.org.hk/en/legislative_framework/circulars/antimoney_laundering/files/cir_aml_20140129.pdf

_____. 2014b. Money Laundering and Terrorist Financing Risks Associated with Virtual Currencies. 21 March. https://www.ia.org.hk/en/legislative_framework/circulars/antimoney_laundering/files/cir_aml_20140321b.pdf

OJK (Indonesia). 2017. Press Release: OJK Issues Regulation on IT-Based Lending Services. 10 January. https://www.ojk.go.id/en/berita-dan-kegiatan/siaran-pers/Pages/Press-Release-OJK-Issues-Regulation-on-It-Based-Lending-Supervision.aspx

Park, E. 2016. Government to Introduce Regulations for Bitcoin. *Korea Joongang Daily*. 18 November. http:// koreajoongangdaily.joins.com/news/article/Article.aspx?aid=3026364

Perkins Coie, LLP. 2018. Digital Currencies: International Actions and Regulations. June. https://www.perkinscoie.com/en/news-insights/digital-currencies-international-actions-and-regulations.html.

Ponciano, J. 2017. Forbes. 29 September.
Popper, N. 2018. Russia and Venezuela's Plan to Sidestep Sanctions: Virtual Currencies. *New York Times*. 3 January. https://www.nytimes.com/2018/01/03/technology/russia-venezuela-virtual-currencies.html
Priess, R. M. 2018. National Government Digital Currencies Versus Globally Distributed Cryptocurrencies: in Depth. *CoinTelegraph*. 21 May. https://cointelegraph.com/national-government-digital-currencies-versus-globally-distributed-cryptocurrencies-in-depth
Reserve Bank of India. 2013. RBI Cautions Users of Virtual Currencies against Risks. Press release. 24 December. https://rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx?prid=30247
_____. 2017. RBI Cautions Users of Virtual Currencies. 1 February. Press release. https://rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx?prid=39435.
_____. 2018a. Statement on Development of Regulatory Policies. Press release. 5 April. https://rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx?prid=43574
_____. 2018b. Prohibition on Dealing in Virtual Currencies (VCs). 6 April. https://rbi.org.in/Scripts/NotificationUser.aspx?Id=11243.
_____. 2018c. Annual Report. 29 August. https://rbi.org.in/scripts/AnnualReportPublications.aspx?Id=1229.
Reuters. 2018. BOJ Deputy Governor Doubts Digital Currency Will Enhance Monetary Policy. 20 October. https://www.reuters.com/article/us-japan-economy-boj-cryptocurrency/boj-deputy-governor-doubts-digital-currency-will-enhance-monetary-policy-idUSKCN1MU07X
Rizzo, P. 2017. China's Central Bank Issues Warnings to Major Bitcoin Exchanges. *Coindesk*. 6 January. https://www.coindesk.com/china-central-bank-issues-warnings-major-bitcoin-exchanges
Roberts, J. J. 2017. SEC Warns Scammers Are Using ICOs to Pump and Dump. *Fortune*. 29 August. http://fortune.com/2017/08/29/sec-blockchain-ico-scam/.
Securities and Futures Commission (Hong Kong). 2014a. Circular to Licensed Corporations and Associated Entities – Anti-Money Laundering / Counter-Terrorist Financing Money Laundering and Terrorist Financing Risks Associated with Virtual Currencies. 16 January. https://www.sfc.hk/edistributionWeb/gateway/EN/circular/anti-money-laundering/doc?refNo=14EC2
_____. 2014b. Circular to Licensed Corporations and Associated Entities – Anti-Money Laundering / Counter-Terrorist Financing Money Laundering and Terrorist Financing Risks Associated with Virtual Currencies. 21 March. https://www.sfc.hk/edistributionWeb/gateway/EN/circular/anti-money-laundering/doc?refNo=14EC14
_____. 2017a. Statement on initial coin offerings. 5 September. https://www.sfc.hk/web/EN/news-and-announcements/policy-statements-and-announcements/statement-on-initial-coin-offerings.html
_____. 2017b. SFC issues a reminder on cryptocurrency-related products and derivatives. 11 December. https://www.sfc.hk/edistributionWeb/gateway/EN/news-and-announcements/news/doc?refN0=17PR147
_____. 2018a. SFC Warns of Cryptocurrency Risks. 9 February. https://www.hk/distributionWeb/gateway/EN/news-and-announcements/news/doc?refNo=18PR13
_____. 2018b. Circular to intermediaries on compliance with notification requirements. 1 June. https://www.sfc.hk/edistributionWeb/gateway/EN/circular/openFile?refNo=18EC38
SGX. 2018. MAS and SGX Partner Anquan, Deloitte and Nasdaq to Harness Blockchain Technology for Settlement of Tokenised Assets. 24 August. https://www.sgx.com/wps/wcm/connect/sgx_en/home/highlights/news_releases/MAS_and_SGX_partner_Anquan_Deloitte_and_Nasdaq_to_harness_blockchain_technology_for_settlement_of_tokenised_assets

Son, J. 2017. Bills move to give bitcoin legal grounds. *Korea Herald*. 3 July. http://www.koreaherald.com/view.php?ud=20170703000867

Southurst, J. 2014. Singapore Government: This is How We Intend to Tax Bitcoin. *Coindesk*. 9 January. https://www.coindesk.com/singapore-government-how-we-intend-tax-bitcoin

Statista. Which Areas Do You Think Blockchain Technology Will Have the Greatest Impact In? (as of 2016). https://www.statista.com/statistics/647728/worldwide-blockchain-technology-impact-survey-by-sector/ (accessed 27 November 2018).

Steele, S. and T. Morishita. Forthcoming. Lessons from Mt. Gox: Practical Considerations for a Virtual Currency Insolvency.

Strate. 2017. You Can Now Watch Videos from the 2017 Strate GIBS Fintech Innovation Conference Online. From the Strate GIBS Fintech Innovation Conference 2017. Johannesburg. 12 September. https://www.strate.co.za/blog/2017/09/you-can-watch-videos-from-the-2017-strate-gibs-fintech-innovation-conference-online/.

Sveriges Riksbank. 2018. E-Krona Project, Report 2. 26 October. https://www.riksbank.se/en-gb/payments --cash/e-krona/e-krona-reports/e-krona-project-report-2/

Szabo, N. 1997. The Idea of Smart Contracts. Keynote speech at the IEEE International Workshop on Electronic Contracting. San Diego. 6 July 2004. http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/contractlanguage.html

_____. 2002. A Formal Language for Analyzing Contracts. http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/contractlanguage.html.

Tempo.co. 2018. OJK: Indonesia Bans Bitcoin, Other Virtual Currencies. 25 January. http:/en.tempo.co/read/news/2018/01/25/056915174/OJK-Indoensia-Bans-Bitcoin-Other-Virtual-Currencies

TrackICO. https://www.trackico.io (accessed 28 November 2018).

Umeh, J. 2016. Blockchain Double Bubble or Double Trouble? *ITNOW*. 58 (1).

Ummelas, O. 2018. Estonia Scales Down Plan to Create National Cryptocurrency. *Bloomberg*. 1 June. https://www.bloomberg.com/news/articles/2018-06-01/estonia-curbs-cryptocurreny-plan-that-drew-rebuke-from-draghi

Walch, A. 2017. The Path of the Blockchain Lexicon (and the Law). *Review of Banking & Financial Law*. 36 (713).

Wall Street Journal. 2014. China Central Bank Warns Banks on Bitcoin. 7 May. https://www.wsj.com/articles/china-central-bank-warns-banks-on-bitcoin-1399454876

Wandhöfer, R. 2017. *The Future of Digital Retail Payments in Europe: A Role for Central Bank Issued Crypto Cash?* Paper prepared for ECB and Bank of Italy "Digital transformation of the retail payments ecosystem conference. Rome. 30 November and 1 December. http://www.ecb.europa.eu/pub/conferences/shared/pdf/20171130_ECB_BdI_conference/payments_conference_2017_academic_paper_wandhoefer.pdf

Wenhao, S. and M. Kim. 2018. Cryptocurrency Laws and Regulations in Asia. *Asia Business Law Journal*. 16 July. https://www.vantageasia.com/cryptocurrency-law-asia/.

Werbach, K. and N. Cornell. 2017. Contracts Ex Machina. *Duke Law Journal*. 67 (313).

White, L. 2018. The World's First Central Bank Electronic Money Has Come – And Gone: Ecuador, 2014-2018. *Cato Institute*. 2 April. https://www.cato.org/blog/worlds-first-central-bank-electronic-money-has-come-gone-ecuador-2014-2018

Wright, A. and P. De Filippi. 2015. Decentralized Blockchain Technology and the Rise of Lex Cryptographia. Unpublished. https://ssrn.com/abstract=2580664

Xinhuanet. 2018. China to rein in overseas virtual currency trading. 2 May. http://www.xinhuanet.com/english/2018-02/05/c_136951244.htm

Yerkes, S. and J. Polcari. 2017. An Unexplored Opportunity. *Diwan* (Carnegie Middle East Centre). 20 December. https://carnegie-mec.org/diwan/75071

Yoon, Y. 2017. S. Korean Financial Authorities Ban Bitcoin Futures Trading. *BusinessKorea*. 7 December. http://www.businesskorea.co.kr/news/articleView.html?idxno=20022

_____. 2018. National Assembly Calls for Measures to Allow ICOs. *BusinessKorea*. 29 May. http://www.businesskorea.co.kr/news/articleView.html?idxno=22613

Yu, X. 2018. China Orders Banks to Stop Financing Cryptocurrencies As Noose Tightens Around Disrupter. 6 February. https://www.scmp.com/business/banking-finance/article/2129645/pboc-orders-banks-halt-banking-services-cryptocurrency

Zetzsche, D., R. P. Buckley, and D. W. Arner. 2018. The Distributed Liability of Distributed Ledgers: Legal Risks of Blockchain. *University of Illinois Law Review*. 2018 (4).

Zetzsche, D., R. P. Buckley, D. W. Arner, and L. Föehr. 2019. The ICO Gold Rush: It's a Scam, It's a Bubble, It's a Super Challenge for Regulators. *Harvard International Law Journal.* 32 (2).

Zhao, W. 2018a. 12 Chinese Banks Say They Deployed Blockchain in 2017. *Coindesk*. 4 May. https://www.coindesk.com/12-chinese-banks-adopted-blockchain-apps-in-2017-filings-show/

_____. 2018b. PBoC-Backed Blockchain Trade Finance Platform Enters Test Phase. Coindesk. 4 September. https://www.coindesk.com/pboc-backed-blockchain-trade-finance-platform-enters-test-phase/

Distributed Ledger Technology and Digital Assets

Policy and Regulatory Challenges in Asia

This report offers an analytical framework to help policymakers assess the challenges and opportunities of distributed ledger technology (DLT), which underpins blockchain and applications such as cryptoassets and initial coin offerings. The report examines the evolution and different types of the emergent technology, its existing and projected applications, and the regulatory and policy issues entailed. It highlights the risks and potential benefits of using DLT, especially for Asian markets, and sets out a functional and proportional approach to these issues.

About the Asian Development Bank

ADB is committed to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific, while sustaining its efforts to eradicate extreme poverty. Established in 1966, it is owned by 68 members—49 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

ADB

ASIAN DEVELOPMENT BANK
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org