J.P. MORGAN CENTER
FOR COMMODITIES
UNIVERSITY OF COLORADO
DENVER BUSINESS SCHOOL

GLOBAL COMMODITIES
APPLIED RESEARCH DIGEST

SPECIAL FEATURE:
Cutting-Edge Innovation in the Cryptosphere

Supported by a
generous grant from
CME GROUP
FOUNDATION

Business School
UNIVERSITY OF COLORADO DENVER

Blockchain and Financial Market Innovation

Rebecca Lewis
Former Analyst, Federal Reserve Bank of Chicago.

John McPartland
Senior Policy Advisor, Federal Reserve Bank of Chicago

Rajeev Ranjan
Senior Vice President, Citi and
Former Policy Advisor, Federal Reserve Bank of Chicago

Introduction and Summary

Blockchain technology is likely to be a key source of future financial market innovation. It allows for the creation of immutable records of transactions accessible by all participants in a network. A blockchain database is made up of a number of blocks "chained" together through a reference in each block to the previous block. Each block records one or more transactions, which are essentially changes in the listed owner of assets. New blocks are added to the existing chain through a consensus mechanism in which members of the blockchain network confirm transactions as valid. The technology allows the creation of a network that is "fully peer to peer, with no trusted third party," such as a government agency or financial institution (*Economist*, 2015).

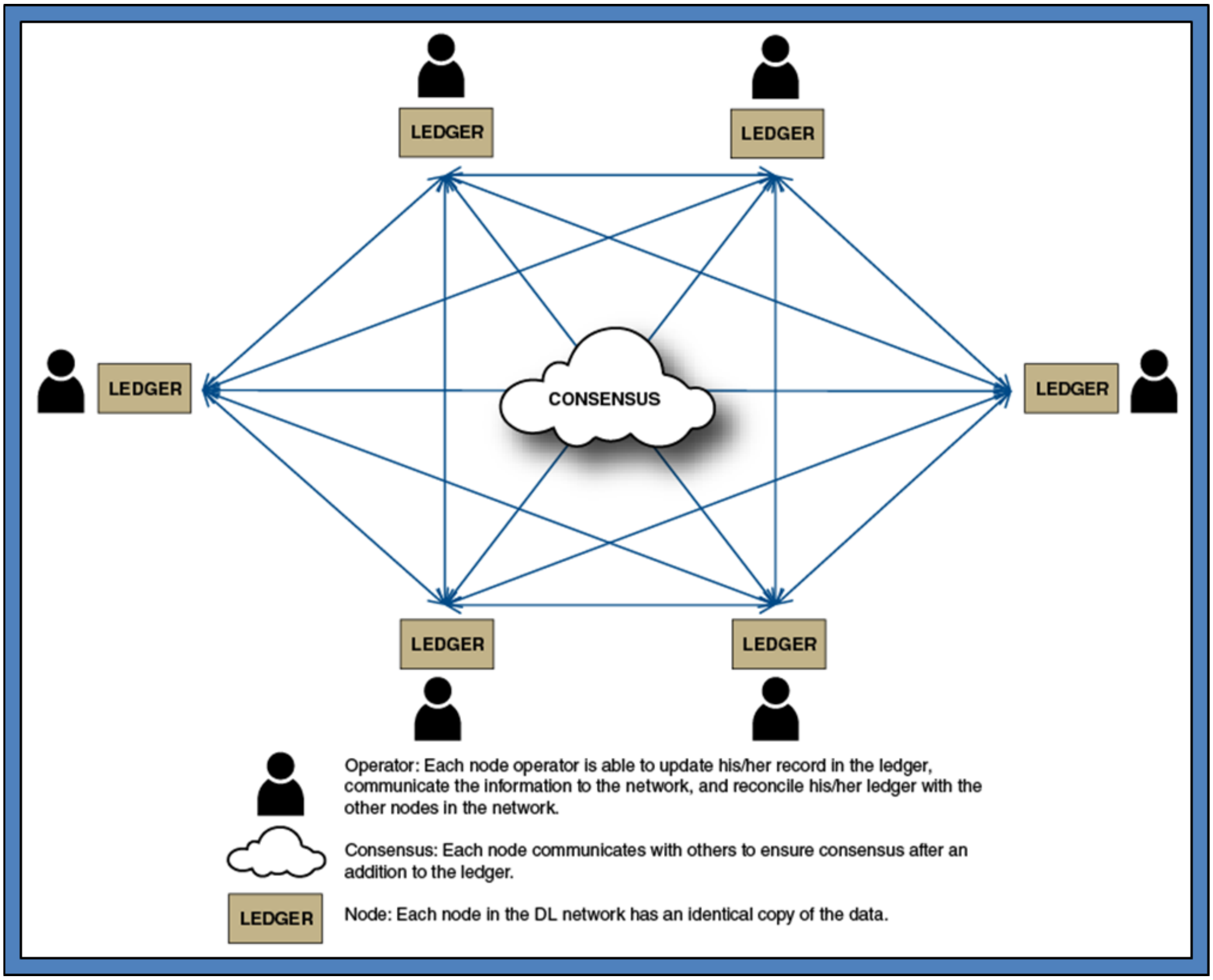
While all are in the early stages of development, there are many promising applications of blockchain technology in financial markets. The bitcoin ecosystem represents the largest implementation of blockchain technology to date (Church, 2017). Interest in the technology continues to grow in the financial technology and broader financial services communities. In this article, we provide a brief overview of what blockchain technology is, how it works, and some potential applications and challenges.

What is a Blockchain Database?

A blockchain database has a network of users, each of which stores its own copy of the data, giving rise to another term for blockchain technology: distributed ledger technology (DLT). Basic elements of a DLT network are a digital ledger, a consensus mechanism used to confirm transactions, and a network of node operators; see Figure 1 on the next page for the network setup. Generally speaking, the terms DLT and blockchain are used interchangeably in position papers and popular media though DLT is considered by some to be a more general term.

____
The articles in this Special Feature do not necessarily represent the views of the JPMCC, its sponsors, or donors. The articles are for educational purposes only.

Figure 1
Distributed Ledger (DL) – Setup



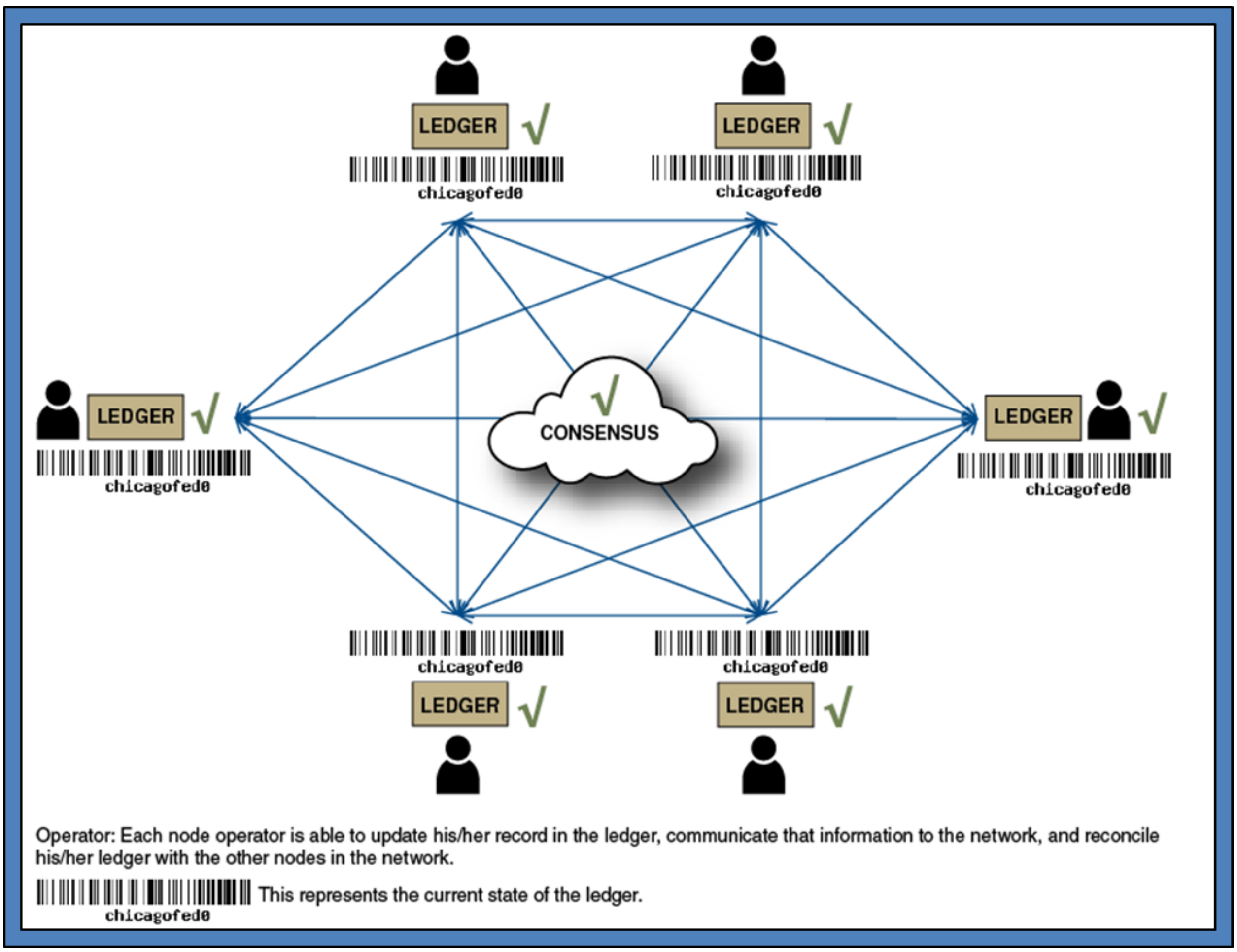
Source: Financial Markets Group, Federal Reserve Bank of Chicago.

As one industry participant involved in developing blockchain technology described it, blockchain technology is essentially a new approach to database architecture. "Fundamentally, [it is] an improvement over the way that, traditionally, databases have been designed and used in the past," noted Morgan Stanley (2016). A traditional database is a large collection of data organized for rapid search and retrieval. While there are various ways of organizing data, traditionally, the vast majority of databases have been relational, storing data in tables that users can update and search (Meunier, 2016). Relational databases are centralized, with a master copy controlled by a central authority. Users sharing a database must trust the central authority to keep the records accurate and maintain the technological infrastructure necessary to prevent data loss from equipment failure or cyberattacks. This central authority represents a single point of failure; if the central authority fails, the database is lost. Users who do not trust one another must maintain separate databases that they periodically reconcile.

How Does Blockchain Technology Work?

The key elements of a blockchain-based ledger, those that will enable future efficiency gains, are the distributed nature of the ledger, its immutable character, and the existence of an agreed-upon consensus mechanism. These make it possible to automate transactions, providing for close to real-time settlement, while maintaining strong controls against fraud. These benefits do not depend on the exact technical implementation of any given blockchain—implementations will continue to be worked out in the coming years. However, a high-level overview of how a blockchain works helps to inform discussions about potential applications of blockchain and challenges that may arise.

Figure 2
Distributed Ledger (DL) Network – All Records are Updated



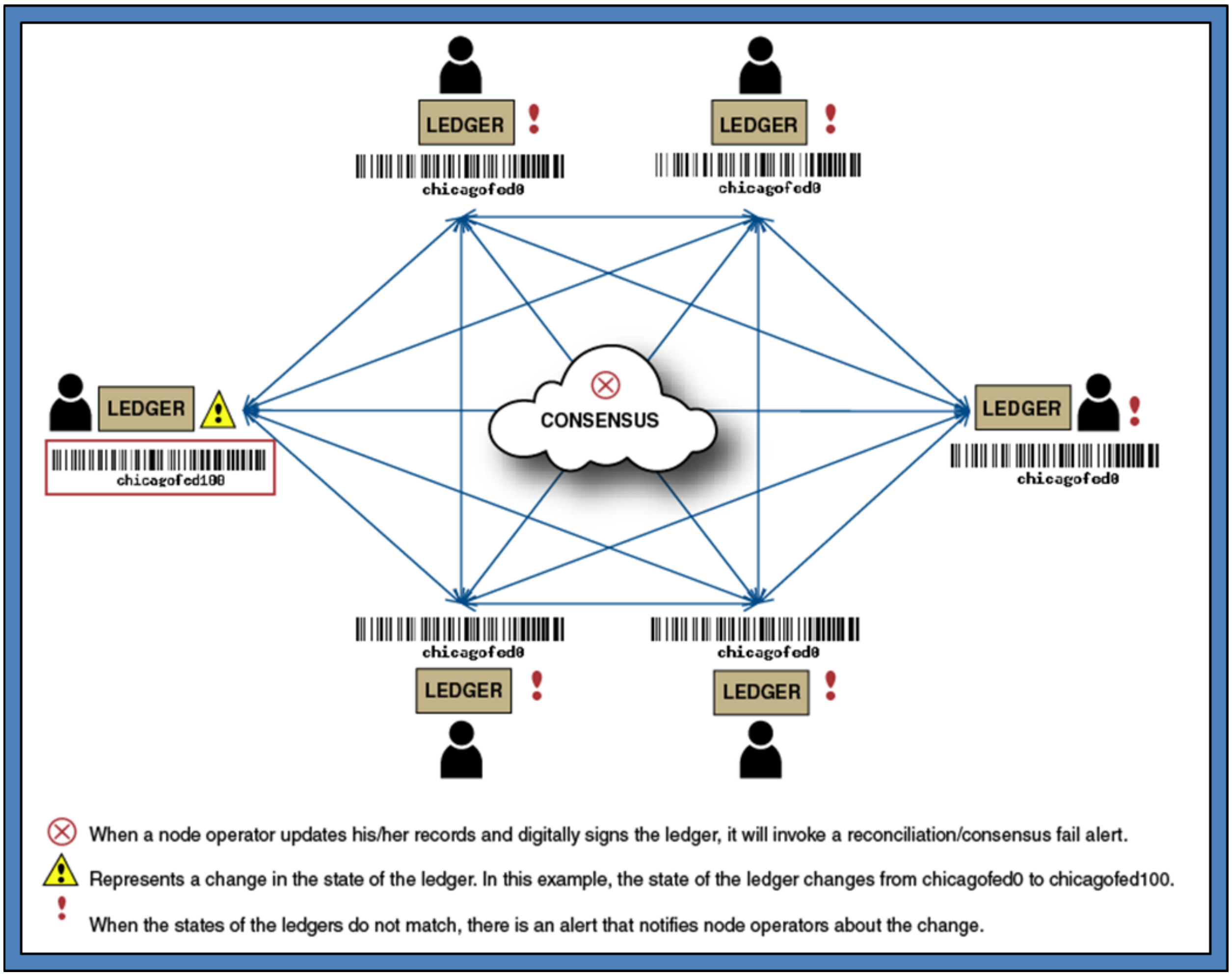
Source: Financial Markets Group, Federal Reserve Bank of Chicago.

A Simple Distributed Ledger

In its simplest form, each user can read from and write to the database, and each user's copy is updated to reflect the new state of the ledger after a transaction is confirmed through a previously agreed-upon consensus mechanism; see Figure 2 above. Once a transaction is added, it cannot be updated or deleted. In the example in Figure 2, all the node operators have the same version of the ledger ("chicagofed0"). Since all the versions of the ledgers are the same, consensus is achieved and the records are final.

When a member of a blockchain network engages in a transaction, they submit the transaction to the network; see Figure 3 below.

Figure 3
Distributed Ledger (DL) Network – New Record Added and State Changes



Source: Financial Markets Group, Federal Reserve Bank of Chicago.

The submission of the new transaction changes the state of the ledger (here to "chicagofed100"), which is now in conflict with the state of other copies of the ledger. Once the new transaction is discovered by the network, the consensus breaks, forcing other operators to either validate and update their records with the latest change or reject the new addition to the ledger.

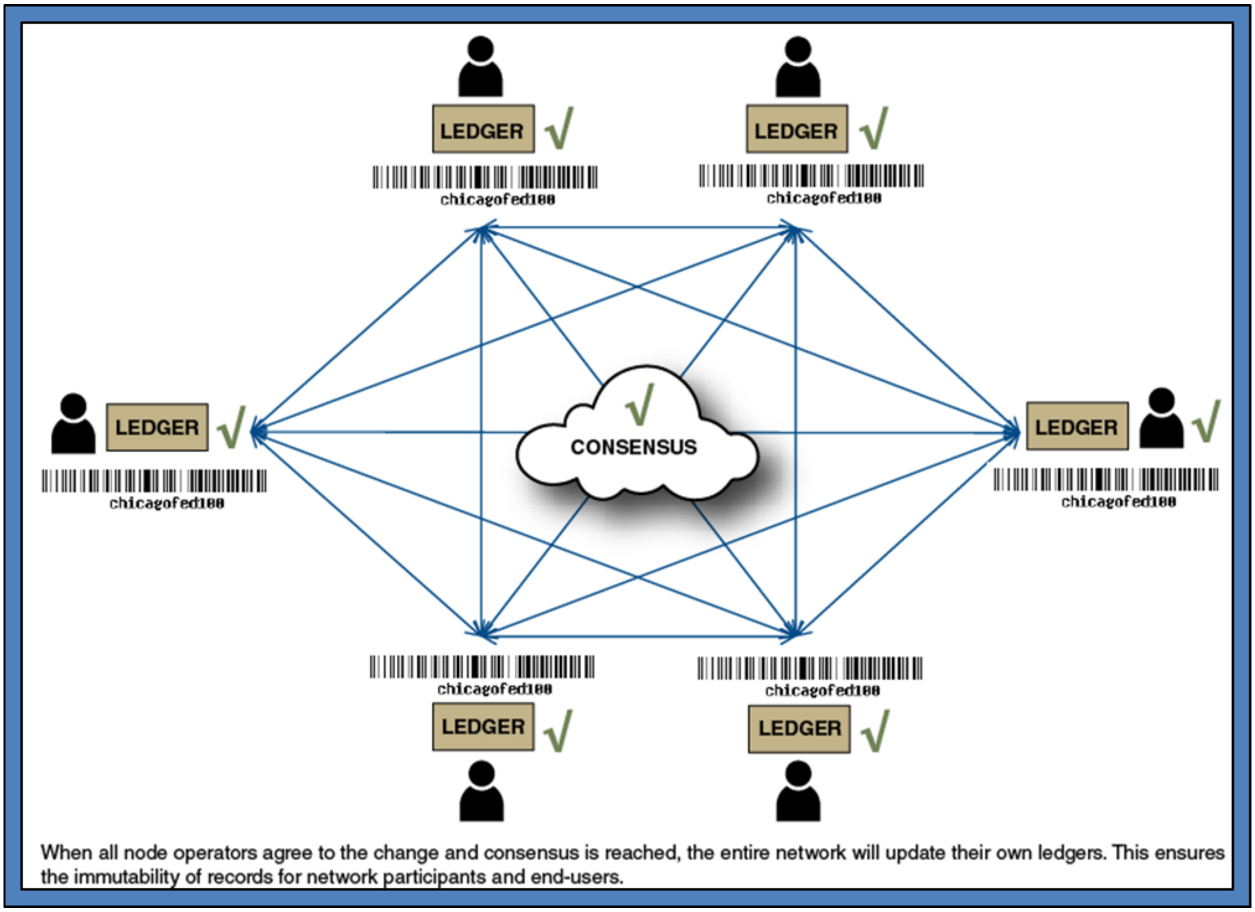
A consensus mechanism then confirms the submitted transaction as valid. There are various methods of achieving consensus on a blockchain, as we discuss below. At this point, it is simply important to understand that a blockchain database must have a mechanism through which participants agree to a change in the state of the ledger. Once consensus is achieved, all ledgers are updated to reflect the new state; see Figure 4 on the next page.

How are Transactions Added to a Blockchain?

At its most basic level, a transaction on a blockchain is simply a change in the registered owner of an asset. The process through which transactions are created and added to the blockchain is illustrated in Figure 5 on page SF7.

For person A to transfer an asset to person B, it is first necessary to determine if A is the rightful owner of that asset. This can be done by referencing past transactions in the blockchain and finding that, at some point, A received the asset and has not yet sold it. Once this is done, A and B can agree to the transaction (step 1). A block is created with the details of the new contract (step 2), and then A and B agree to the contract by adding their unique digital signatures (steps 3 and 4). Once both parties have signed the transaction, a cryptographic hash is calculated that will be used to link this new transaction to the chain of previous transactions (step 5). The cryptographic hash is a string of characters associated with a given block that is difficult to calculate but easy to verify. This makes it simple to verify a legitimate block, but difficult to engineer and insert into the chain a block recording illegitimate transactions.

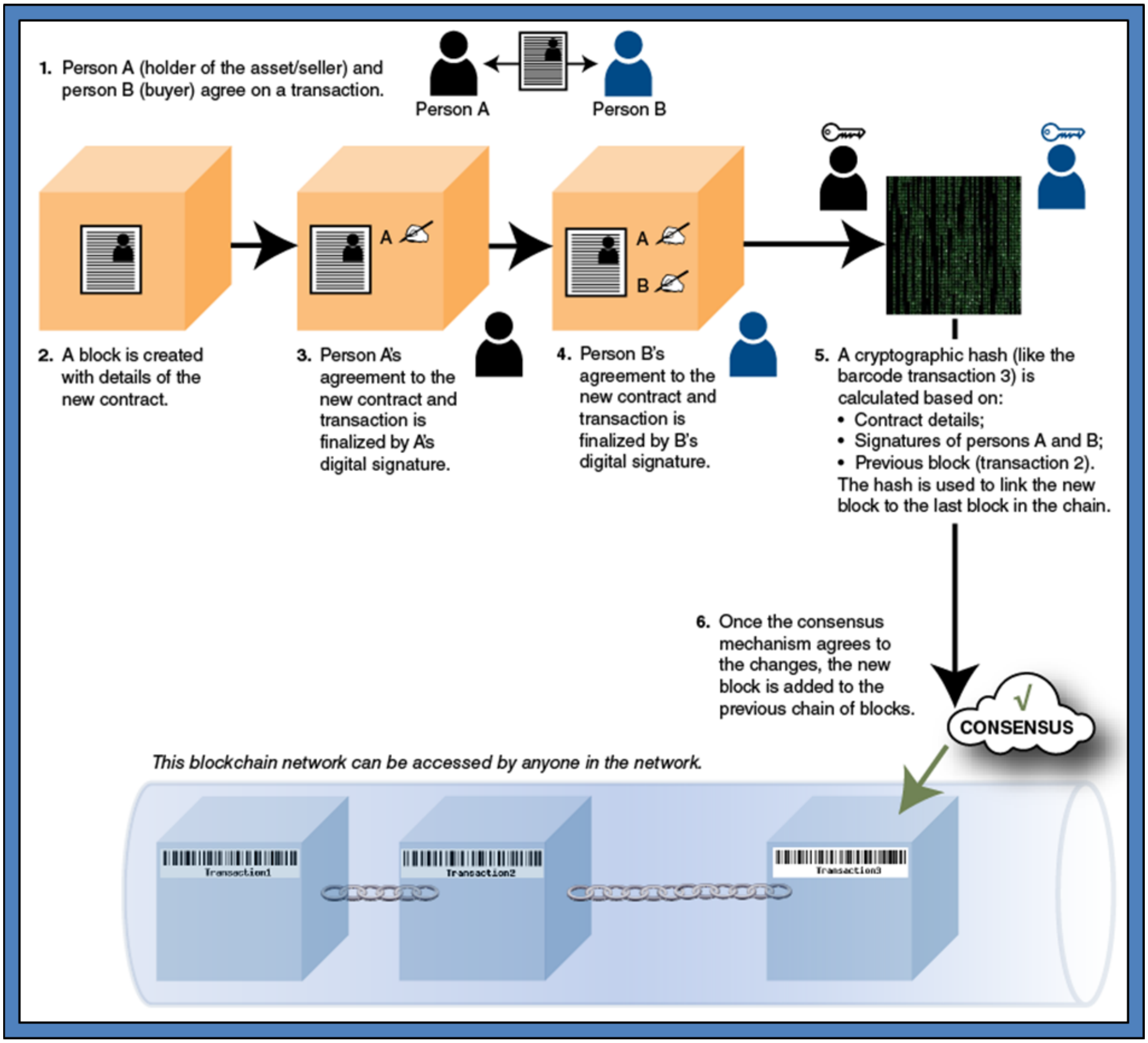
Figure 4
Distributed Ledger (DL) Network – Reconciliation and Consensus Achieved



Source: Financial Markets Group, Federal Reserve Bank of Chicago.

Next, the transaction is confirmed using the blockchain's consensus mechanism (step 6). After confirmation, the transaction is added to a block of recent transactions. This block is then "chained" to the previous blocks of transactions through a reference to the most recently created block in the chain. The updated blockchain would then be transmitted to all participants in the network so that everyone has a matching copy of the master ledger.

Figure 5
Blockchain (DL) Network – Stylized Example of a Transaction



Source: Financial Markets Group, Federal Reserve Bank of Chicago.

Permissionless Networks

Blockchain technology was first used in 2009 to implement the digital currency bitcoin. The bitcoin blockchain is an example of a public network: it is open to any user who wishes to transact, and all users can see all transactions on the blockchain. The network is also permissionless: new transactions are added to the blockchain through a cryptographic consensus mechanism requiring vast amounts of computing power to confirm transactions. The chief advantage of a permissionless network is that it does not require a central authority to confirm or deny specific transactions; individuals who do not trust one another or any single central authority can transact on the permissionless network, relying on a consensus mechanism to ensure the ledger's accuracy. This avoids the need for users to have their own database that they periodically reconcile against those of their counterparties. Instead, all transactions are recorded on a single database. Each user stores a copy of the database, so there is no single point of failure as exists with traditional relational databases. Once they are added to the blockchain transactions cannot be undone, making the ledger an immutable record of all previous transactions. Figure 6 on the next page provides an illustration of a permissionless and public blockchain network.

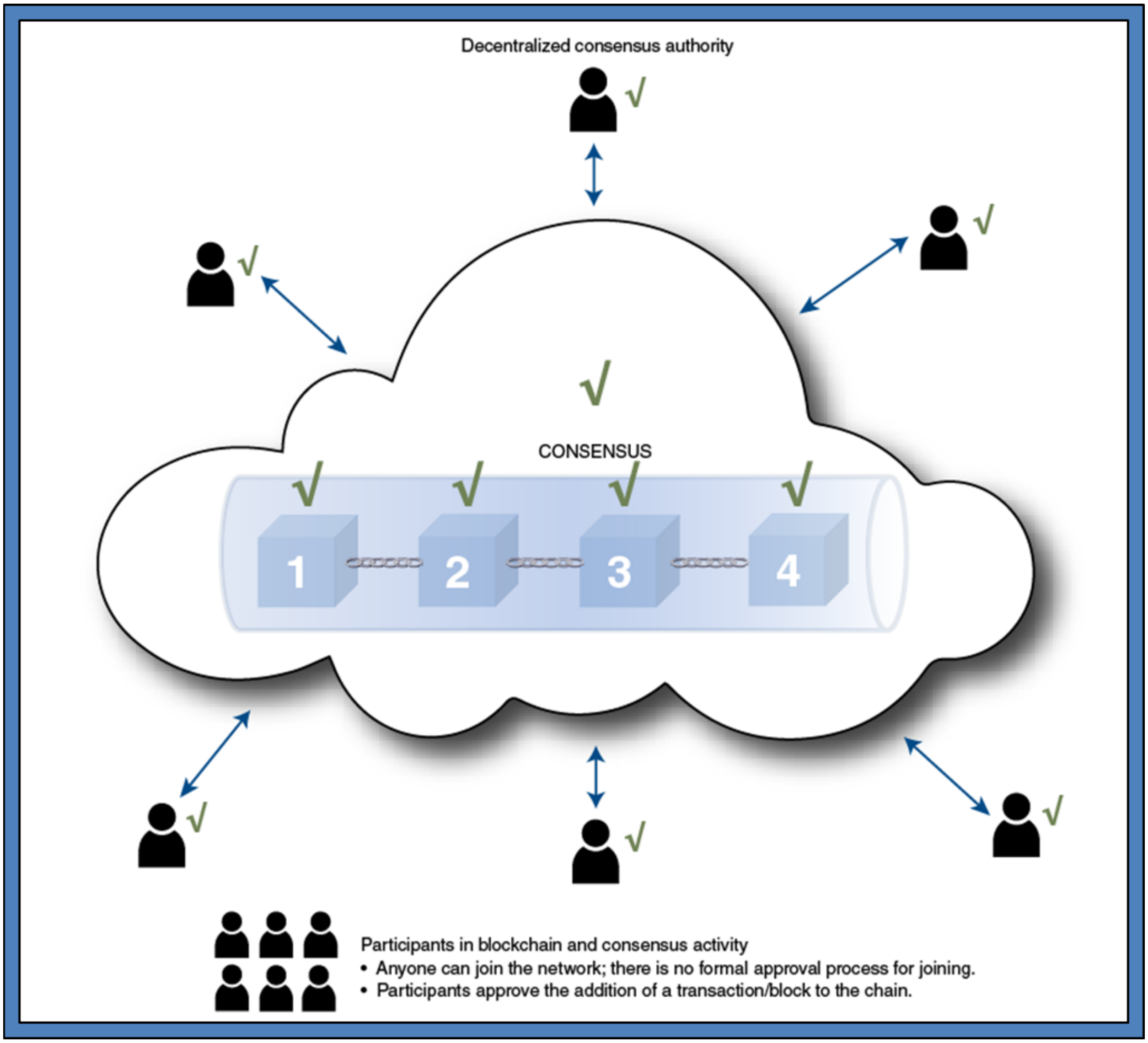
Permissioned Networks

Many see broad accessibility and a lack of a need for centralized control as two of blockchain's key benefits relative to traditional database architectures. However, for applications in financial markets where 1) there are trusted intermediaries, 2) complete transparency is not always desirable, and 3) participants must comply with regulatory requirements, this decentralized system has shortcomings. It is likely that applications of blockchain technology in financial markets will instead use private and permissioned blockchains. Private blockchains are only open to those participants that meet the membership criteria of the network, in contrast to public blockchains in which anyone is able to participate. Permissioned blockchains allow certain members to control the confirmation of transactions. These permissioning members (consensus authorities) can exert control in various ways depending upon the network design. They could be responsible for explicitly approving transactions. Another option would be to designate the permissioning members as the sole members of the network able to participate in a cryptographic consensus mechanism. Figure 7 on page SF10 provides an illustration of a permissioned and private blockchain network.

As in Kaminska (2016), some argue that a permissioned blockchain removes "a major benefit of the blockchain system: the system works between parties that do not need to trust each other. If the concept is to implement permissioned distributed ledgers between trusted [parties] … why would you use blockchain technology when more efficient alternatives are available?" However, permissioned blockchains retain many key features and benefits of permissionless blockchains, including the decentralized storage of the database and the (near) real-time reconciliation of all copies of the database. They also alleviate some of the problems posed by the permissionless system, including its need for substantial computing resources to confirm transactions.

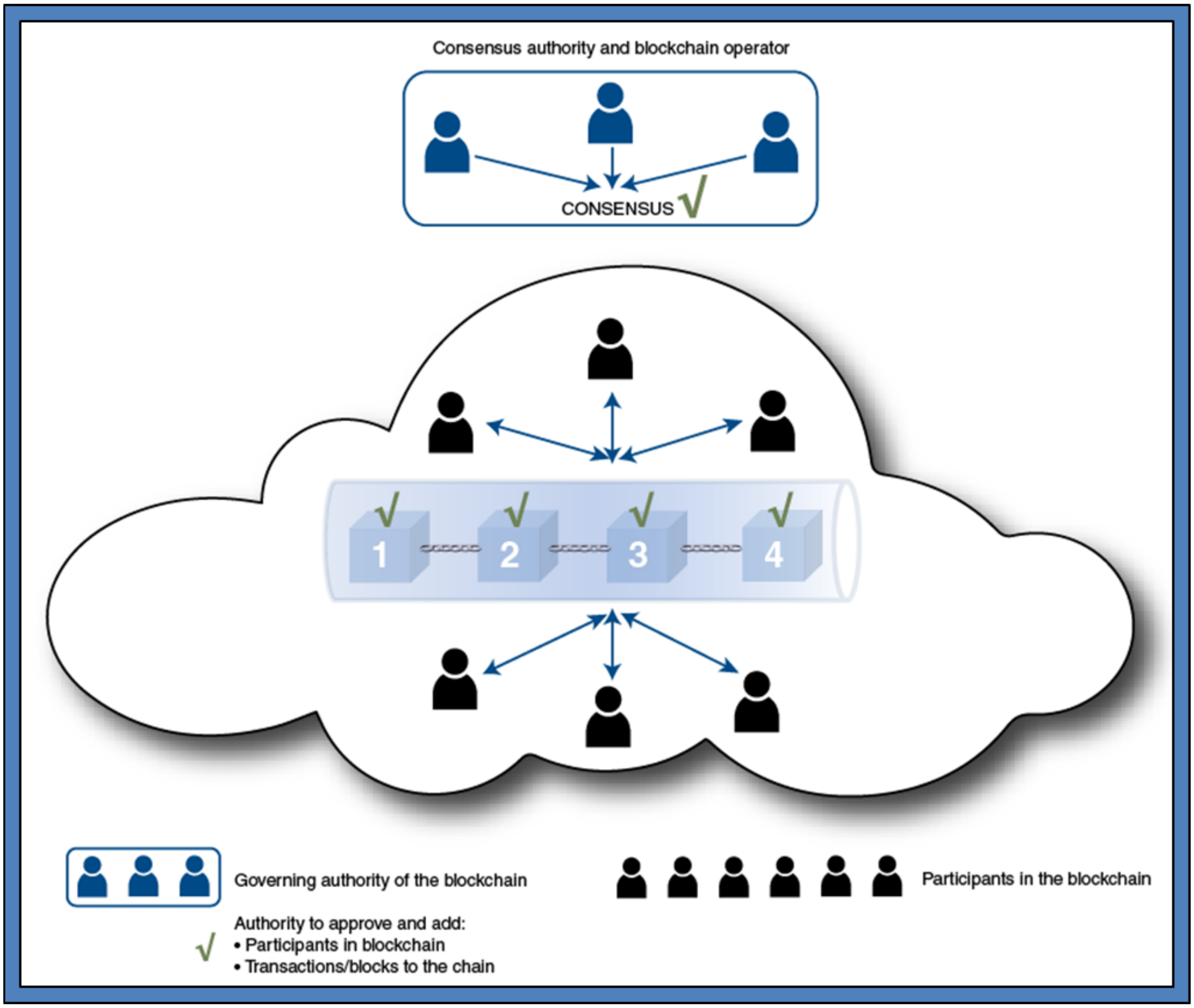
Regulatory imperatives such as Know Your Customer (KYC) and Anti-Money Laundering (AML) requirements provide further reasons to prefer permissioned blockchains for financial applications, as transactions on a fully public, permissionless blockchain are anonymous and open to all, while private systems can limit participants to those who are pre-approved and trusted.

Figure 6
Permissionless/Public Blockchain Network



Source: Financial Markets Group, Federal Reserve Bank of Chicago.

Figure 7
Permissioned/Private Blockchain Network



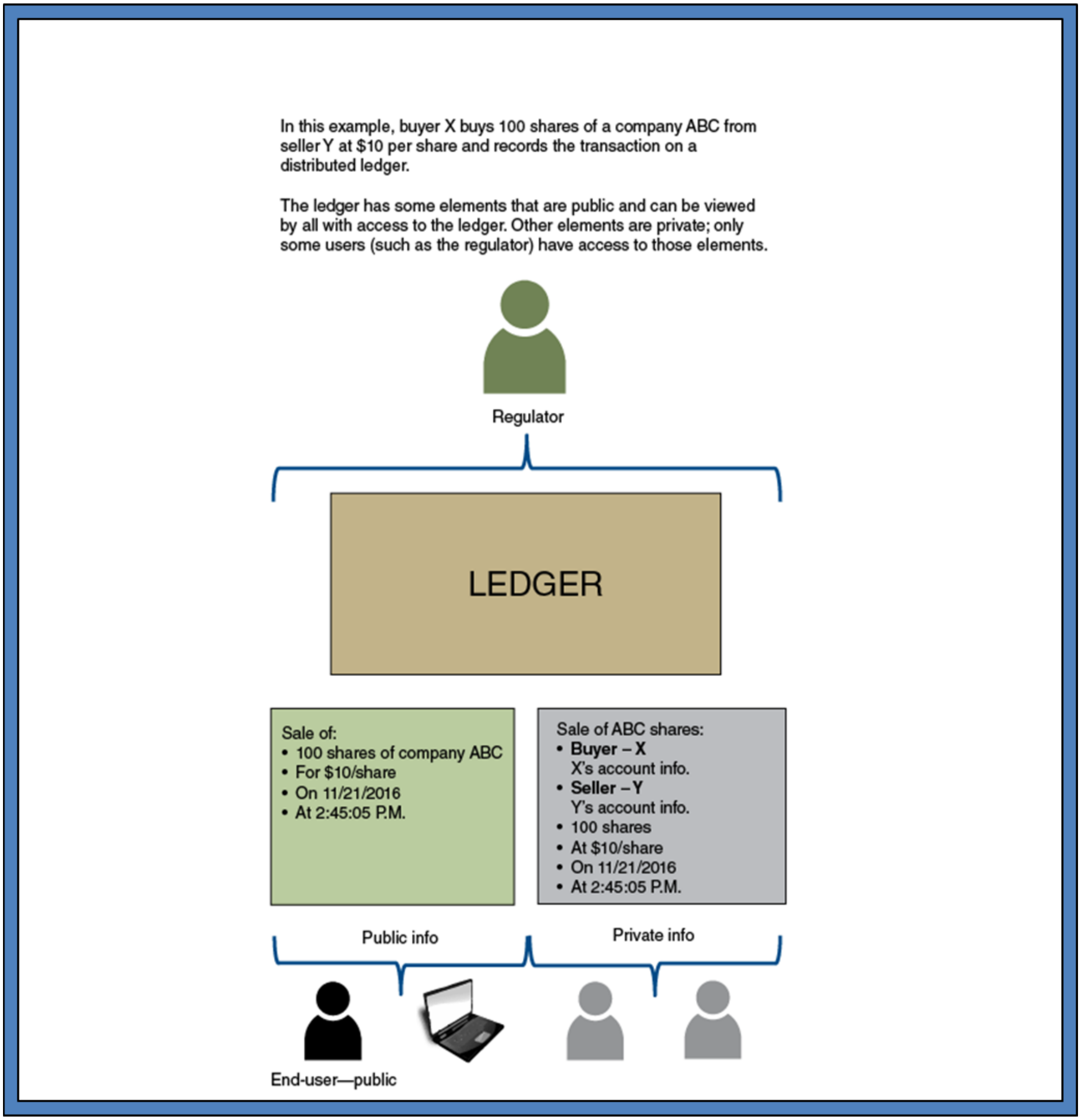
Source: Financial Markets Group, Federal Reserve Bank of Chicago.

In permissioned blockchains, it is also possible to put controls in place to allow varying levels of access to the information in the ledger. For example, regulators could be allowed to view all the details of a transaction in the ledger but not add any transactions, while users might be allowed to view selective details of the transactions depending on their access level; see Figure 8 on the next page.

Consensus Mechanism

All blockchains have a consensus mechanism that is used to add new blocks to the database. The consensus mechanism will differ depending upon the design of the blockchain, especially whether the blockchain is permissioned or permissionless. If the blockchain is permissioned, the degree to which participants in the network are willing to trust one another also has an effect on the consensus mechanism. In a permissioned blockchain, once the transaction is submitted by the two parties involved, it would then be confirmed by a permissioning member of the blockchain or by some cryptographic consensus mechanism accessible only by permissioning members. Trust in transactions is maintained because users trust the network member(s) with the power to confirm transactions.

Figure 8
Ledger Properties



Source: Financial Markets Group, Federal Reserve Bank of Chicago.

Permissionless blockchains rely on their network of participants to confirm transactions, using a variety of algorithms to ensure the validity of transactions. One implementation of a permissionless blockchain, the bitcoin blockchain, uses a Proof of Work consensus mechanism. On the bitcoin blockchain, individuals known as miners compile submitted transactions into blocks. They confirm that those spending bitcoins in each transaction received those bitcoins from some earlier transaction recorded on the blockchain and race to solve a difficult computer problem; the first miner to solve the problem confirms their block and adds it to the blockchain. The miner is awarded a certain number of bitcoins in return. Because every user on the blockchain has access to the entire ledger, users can confirm for themselves that the latest block of transactions added to the chain records valid transactions, that is, that the users spending bitcoins in the latest round of transactions received them in some earlier transaction and have not yet spent them.

A relatively automated consensus mechanism allows for the near-instantaneous update of every copy of the ledger — once a transaction is added to the blockchain, all ledgers reflect this change. There is no need for further post-trade reconciliation. The way in which blocks are added to the ledger also creates an essentially immutable database. Since blocks of transactions are chained together, the older the transaction is, the more difficult it becomes to fraudulently change it. To fraudulently change a block, an actor would have to replace that block with a new block and regenerate all of the subsequent blocks in the chain. The consensus mechanisms ensure that regenerating blocks is difficult, either due to the oversight of permissioning members or to the time and energy required to create a block (in a permissionless system.) The farther back in the chain a block is, the more difficult a change becomes because the number of blocks that an actor would have to regenerate increases. Thus, network members' confidence that a transaction will never be changed increases as the number of transactions following it increases.

Blockchain's Applications, Benefits, and Challenges

Blockchain technology has the potential to provide large efficiency gains in businesses that currently require costly intermediation, including financial services. However, any implementation will also face a number of challenges. Regulators and policymakers, including the Committee on Payments and Market Infrastructures, have been looking into both the potential applications of blockchain technology and the challenges that may arise (Bank for International Settlements, 2017).

Applications and Benefits

Possible applications of blockchain technology include:

Digital assets — Physical assets (real estate, stock certificates, gold, etc.) require a great deal of verification and examination every time they are traded, which prolongs the transaction and settlement time for each trade. DLT has the potential to transform the physical assets into a digital form for transactional and recordkeeping purposes. Such digitized assets could essentially function as online financial instruments that change hands each time the owner of the asset recorded in a ledger changes.

Digital currencies — We are already in the era of online banking, payments, and transactions, all of which are carried out with little use of physical currencies. In recent years, various forms of cryptocurrencies have been adopted for real-world transactions. Cryptocurrencies rely on encryption techniques to generate, transact, and verify their value. They operate independently of a central bank's authority and are not backed by the central bank. Some central banks around the world (for example, China, the U.K., South Africa, and the Netherlands) are experimenting with issuing digital state-sponsored fiat currencies backed by the central government.

Digital record keeping — One of the key benefits of blockchain is that it keeps an audit trail of each and every transaction and the details of the parties involved. If designed and executed well, blockchain databases will create records that are standardized, immutable, and easy for interested parties to query.

Smart contracts — In order to achieve their full potential, implementations of blockchain technology will likely be accompanied by smart contracts. Smart contracts are legal contracts written in computer code that execute automatically once certain conditions, specified in the contract, are fulfilled. Smart contracts can be added to distributed ledgers to self-execute on the basis of information in the ledger. This will allow for the automation of processes that currently require manual interventions.

Benefits that may arise from the use of blockchain technology include:

Reduction in settlement period (post-trade) — Settlement periods (the time between the execution of a trade and the performance of all duties necessary to satisfy all parties' obligations) can be drastically reduced with the swift record of submissions and their confirmation on a blockchain. This may foster greater liquidity in certain types of trades that currently face lengthy settlement cycles and may promote better capital usage. At present, the title to most financial assets can only be settled against payment when banks are open for business. If there were one blockchain that accounted for the ownership of money and another that accounted for the ownership of securities, then, assuming that buyers had sufficient funds and sellers had sufficient shares, a settlement versus payment of funds could occur at any time on any date in a matter of seconds, with legal finality and certainty.

Faster payments—Global payments systems require multiple regulatory checks and lengthy settlement cycles. The foreign exchange industry is one of the most intermediated markets in the world, requiring settlement banks and commercial banks to facilitate movement of currencies. A DLT service with digital identities for the parties involved in a trade could be used to shorten settlement times.

Challenges

The challenges posed by blockchain technology fall into two broad categories: technical and business; and regulatory.

Technical and business challenges

Achieving consensus — There is a need for consensus among a blockchain network's members. Since the ledger is distributed among all participants in the blockchain, any protocol changes must be approved by all. A potential solution, possible in a permissioned network, would be to allow one or a few participants the authority to make protocol changes that were binding upon the entire network. This, however, requires significant trust in the authorized participants.

Standardization — There is also a lack of standardization of blockchain network designs, which can cause major issues in their implementation and acceptance by businesses. Many national and international organizations are trying to establish generally accepted technical standards.

Interoperability — Current businesses will face challenges related to interoperability of blockchain platforms with their existing internal systems. Externally, it remains to be seen how blockchains from multiple businesses might operate with each other.

Scalability — The need to increase the scale of distributed ledger systems also represents a challenge, especially for permissionless blockchains that use a race to solve a computer problem in order to confirm a transaction. The race takes a large amount of computing power, limiting the speed with which new transactions can be confirmed. All networks, permissioned or permissionless, will require a large amount of storage resources, as each node in the network will maintain its own copy of the distributed ledger.

Efficiency — There will be trade-offs between the efficiency of a blockchain and its ability to avoid relying on trusted parties. A complex computational system to confirm transactions is less efficient than a system more reliant on the discretion of permissioning nodes in the network but offers the advantage of not needing everyone in the network to agree to trust certain parties.

Immutability — Once added to the blockchain, a transaction is permanent. "Fat-finger" trades, or trades that regulators demand be reversed, can only be changed by submitting an equal and offsetting trade, which the parties involved in the original trade will both need to accept.

Legal uncertainty — Currently, firms do not have clarity over the laws and regulations that will apply to DLT implementations in cases of fraud, bankruptcy, and other failure scenarios. This is especially a problem for firms that operate in multiple jurisdictions.

Security — While the reduced reliance on a central authority and the fact that copies of the ledger are stored in more than one place ameliorate the single point of failure problem present in many legacy systems, blockchain's distributed nature also creates security concerns. The more participants in the network, the more points of attack there are for cybercriminals to target. If cybercriminals are able to steal the information of a user necessary to submit a trade, they could create fraudulent, and immutable, transactions.

Liquidity — The use of a blockchain for title transfers could drastically reduce the risk associated with current settlement conventions, but it will increase the importance of liquidity; funds and assets must be in proper form and location for such expedited settlement.

Privacy — Blockchain's potential impact on the confidentiality and speed of information transfer about record changes may also be of concern to some users. For example, in finance, the acquisition and analysis of data are key to a firm's competitive advantage. Some firms may be reluctant to participate in a shared database in case of information leakage that could cost the firm's business.

Intellectual property — Blockchain technology may be subject to legal challenges and costs that could impede innovation. Industry participants involved in blockchain research are increasingly patenting blockchain-related technologies; the number of blockchain-related patents filed doubled between January and November 2016 (Kharif, 2016). The patents could make firms working with blockchain technologies vulnerable to legal challenges and prevent new firms from entering the market.

Regulatory challenges

Uncertainty — There is currently uncertainty over rules across various regulatory agencies. Existing regulations may be major hurdles for DLTs. To enable innovation, regulatory agencies should work alongside DLT firms as they test new products and services.

Currency control — Central banks will have to find ways to maintain control over digitized currencies. If central banks were to allow commercial banks to place money in special accounts and then digitize the money on the bank's blockchain, regulators would need a mechanism for overseeing its use and ensuring that the digital currency issued did not exceed the amount held as central bank reserves.

Conclusion

While much work remains to be done, blockchain represents a promising source of future innovation in financial markets. DLT technology possesses the capability to improve the efficiency and security of financial markets, provided it is implemented in the right way. In the near future, we will see the development of specific applications of DLT that are likely to enable better cooperation between the public sector and private sector and improve transparency, trust, information sharing, and audit trails.

Endnote

This article is reproduced from the Federal Reserve Bank of Chicago's *Economic Perspectives*, Vol. 41, No. 7, July 2017.

References

Bank for International Settlements, Committee on Payments and Market Infrastructures, 2017, "Distributed Ledger Technology in Payment, Clearing and Settlement: An Analytical Framework," February. Accessed via website: http://www.bis.org/cpmi/publ/d157.pdf on February 17, 2019.

Church, Z., 2017, "Blockchain, Explained," MIT Sloan School of Management, *Ideas Made to Matter*, Digital Currency, May 25. Accessed via website: http://mitsloan.mit.edu/ideas-made-to-matter/blockchain-explained on February 17, 2019.

Economist, 2015, "Blockchain: The Next Big Thing or Is It?", Special Report, May 9. Accessed via website: https://www.economist.com/special-report/2015/05/09/the-next-big-thing on February 17, 2019.

Kaminska, I., 2016, "How I Learned to Stop Blockchain Obsessing and Love the Barry Manilow," *Financial Times*, Alphaville, August 10.

Kharif, O., 2016, "Who Owns Blockchain? Goldman, BofA Amass Patents for Coming Wars," *Bloomberg*, December 21. Accessed via website: http://www.information-management.com/news/data-management/who-owns-blockchain-goldman-bofa-amass-patents-for-coming-wars-10030542-1.html?CMP=OTC-RSS on February 17, 2019.

Morgan Stanley, 2016, "Blockchain in Banking: Disruptive Threat or Tool?", Global Financials/FinTech, Morgan Stanley Global Insight, April 20, p. 28.

Meunier, S., 2016, "Blockchain Technology—A Very Special Kind of Distributed Database," *Medium*, December 29. Accessed via website: https://medium.com/@sbmeunier/blockchain-technology-a-very-special-kind-of-distributed-data-base-e63d00781118 on February 17, 2019.

Author Biographies

REBECCA LEWIS
Former Analyst, Federal Reserve Bank of Chicago.

Ms. Rebecca Lewis is currently a student at Yale Law School. She was a financial markets analyst at the Federal Reserve Bank of Chicago from 2016 to 2018 where she researched public policy issues relating to financial market infrastructures and central counterparty risk management. She graduated from Williams College in 2016 with a degree in Economics.

JOHN McPARTLAND
Senior Policy Advisor, Federal Reserve Bank of Chicago

Mr. John McPartland is a senior policy advisor in the economic research department. He advises senior management of the Federal Reserve Bank of Chicago on matters involving international netting systems, settlement systems for fixed income and equity securities in G-5 countries, exchange-traded derivatives, privately negotiated derivatives, risk mitigation techniques, especially bilateral collateralization of foreign exchange and derivatives instruments, margining systems of derivatives exchanges in G-10 countries, idiosyncrasies affecting U.S. securities markets, payment initiatives and issues relevant to collateralizing or clearing over-the-counter (OTC) derivatives instruments or issues raised by high frequency trading. Mr. McPartland also contributes to the Federal Reserve's position on public policy issues involving netting systems, supervisory oversight of exchange-traded and OTC derivatives, international competitiveness and the appropriate regulatory structure of domestic financial markets. He serves as a technical expertise resource that can be seconded to other national authorities.

RAJEEV RANJAN
Senior Vice President, Citi and Former Policy Advisor, Federal Reserve Bank of Chicago

Mr. Rajeev Ranjan is a Senior Vice President at Citi, managing operational risk for electronic trading for global Citi businesses. His research interests include risk management, market-microstructure, algorithmic trading, exchange-traded derivatives, financial market infrastructures and fintech. Prior to Citi, Mr. Ranjan was a policy advisor and business economist in the economic research department at the Federal Reserve Bank of Chicago where he contributed to the Federal Reserve's position on public policy issues involving financial markets. Prior to joining the Fed, Rajeev worked for G H Financials and DV Trading in various capacities as an algorithmic trader, programmer and quantitative researcher. Mr. Ranjan received his Bachelor's degree in Information and Communication Technology from DA-IICT in India, a Master's degree in Finance from Illinois Institute of Technology and an M.B.A in Economics and Finance from University of Chicago's Booth School of Business.

Three Possible Ways that Blockchain Technology Could Disrupt the Commodities Industry

Alex Cohen
Co-Founder and Managing Director, New Beacon Partners

Luis Quintero
Co-Founder and Managing Director, New Beacon Partners

Introduction

Today we are seeing wide-ranging applications for blockchain technology. From digital payments, to streamlining supply-chains, to the security of votes in elections, each day new applications and real-world use-cases for blockchain technology are being introduced and proposed.

In terms of the commodities sector, blockchain technology has many practical applications that are not hypothetical but rather are possible using technology that exists today. Specifically, blockchain technology can be incorporated into (a) the current United States crop insurance industry, (b) supply chain logistics to help increase food safety and minimize the cost of food recalls, and (c) a new mechanism through which investors can gain direct exposure to commodities and commodity producing assets. In this paper we will investigate these three applications and discuss how the incorporation of blockchain could improve on the status quo.

What is Blockchain Technology?

Blockchain technology provides a way for untrusted or unaffiliated parties to transact using a common shared ledger or record of transactions. The technology can be applied to a variety of "transactions," including payments for goods, votes in an election, and updates to medical records, for example. Additionally, this particular type of technology allows two parties to transact without relying on an intermediary thereby potentially reducing the cost and time of business operations as well as providing the potential for greater operational efficiency.

What is a Smart Contract?

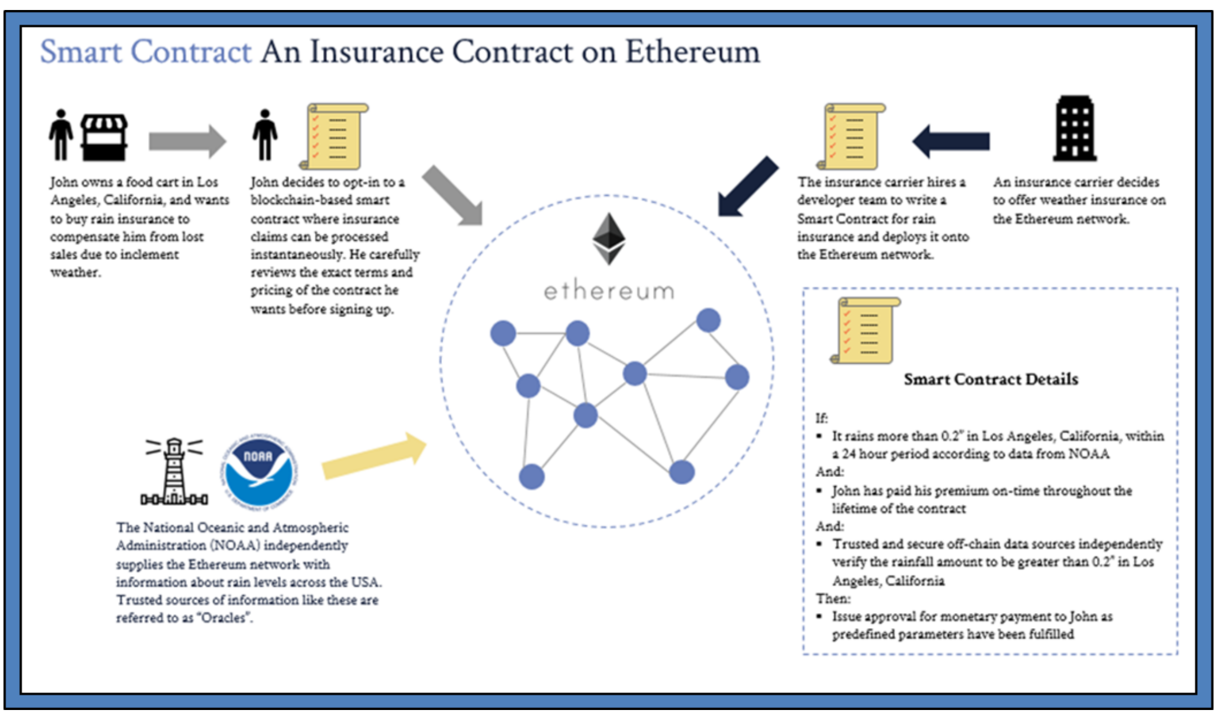
In many cases, we expect blockchain technology to be applied via smart contracts. A smart contract is custom computer code stored on a blockchain and executed by a blockchain network. The blockchain network independently facilitates the verification and enforcement of the contract as well as enabling individuals to track the contract in real-time. In some cases, smart contracts have what is known as a "triggering event." A triggering event is typically a binary outcome whose occurrence can be verified by an independent third-party. In most cases, the contract has a payout associated with the triggering event.

The articles in this Special Feature do not necessarily represent the views of the JPMCC, its sponsors, or donors. The articles are for educational purposes only.

For example, John, a food-cart vendor in Los Angeles, California, could enter into a smart contract with an insurance carrier to insure against inclement weather. In this case, the smart contract would specify the location and specific amount of rain that would have to fall in order to trigger the insurance payout from the carrier to John. John would pay the carrier a monthly premium for this contract and the carrier would place the insurance payout into an escrow account. John and the carrier would specify an independent third-party to act as the trusted-information source. In this case they could select the National Oceanic and Atmospheric Administration (NOAA) as the source for daily rainfall information by specific location. Each day the smart contract automatically checks the NOAA weather database for rain in Los Angeles, California. If one day it rains more than the agreed upon amount, in this example 0.2 inches, and if John had been paying his premium on-time throughout the life of the contract, then the insurance claim would immediately and automatically be paid out to John.

John benefits from entering into the smart contract because unlike a traditional insurance contract the payout is immediate and automatic. He does not need to "trust" the insurance carrier to follow through with his claim or wait out the insurance claim process, which could potentially cause disruptions to his operations. The insurance carrier could also potentially experience significant cost savings for a smart contract policy compared to a traditional policy as much of the administrative work is automated. Additionally, smart contracts could provide insurance carriers with another type of insurance product to sell to their clients. This hypothetical scenario is illustrated in Figure 1 below.

Figure 1
Simplified Smart Contract Example



Source: New Beacon Partners.
Note: Icons courtesy of FlatIcon.

Smart Contracts and the United States Crop Insurance Industry

We can extend the example of John and the insurance carrier to the United States crop insurance industry. Currently, there are two types of crop insurance available to farmers in the United States: Crop-Hail and Multiple Peril Crop Insurance (MPCI). Crop-Hail policies are not part of the Federal Crop Insurance Program and are provided directly to farmers by private insurers. Many farmers choose to purchase Crop-Hail insurance as hail has the unique ability to destroy a significant portion of a farmer's crops while leaving the rest undamaged. In areas of the United States where hail is frequent, farmers often purchase a Crop-Hail policy to protect their high-yield crops. Unlike MPCI policies, a Crop-Hail policy can be purchased at any time during the growing season, according to National Crop Insurance Services.

MPCI policies differ from Crop-Hail policies in that they must be purchased prior to planting and cover loss of crop yields from a number of natural causes including drought, freezing temperatures, disease and excessive moisture. Under the Federal Crop Insurance Program there are currently 15 private companies that are authorized by the United States Department of Agriculture Risk Management Agency (USDA RMA) to write MPCI policies. The USDA RMA oversees and regulates the program as well as sets the rates that can be charged and determines the crops eligible to be insured in different parts of the country. The federal government subsidizes the farmer-paid premiums to reduce the cost for farmers and provides reimbursement to the private insurance companies to offset a portion of the operating and administrative costs. These subsidies ensure that crop insurance remains affordable to the majority of farmers and ranchers, again according to National Crop Insurance Services.

In the insurance industry, one type of insurance, parametric, should be well suited for use with smart contracts. Parametric insurance (also known as index-based insurance) compensates a policyholder when agreed-upon parameters are met. It is essentially an if-then contract for insurance. Payment is tied to predefined parameters, thereby decoupling the insurance policy from an underlying asset. Therefore, parametric insurance differs from traditional insurance because it does not indemnify the actual loss incurred to an asset from a risk-event. In a parametric insurance contract, the insurer makes an agreed-upon monetary payment based on when predefined parameters are met, which makes the payout process predictable and quick (Foggan and Cwiertny, 2018).

Since the crop insurance is based on verifiable data (i.e., weather data), the United States crop insurance market is a suitable candidate for smart contracts. Since Crop-Hail policies are already provided directly to farmers by private insurers instead of through a government program like MPCI policies, Crop-Hail policies represent a better candidate for potential smart contract implementation. Similar to our example of John and the insurance carrier, farmers would be able to enter into smart contracts with private insurers. In this case, the smart contract would work as follows:

1. The farmer and the private insurer would agree to terms of the Crop-Hail policy as they do today; however, the terms of the contract would then be coded onto a blockchain.

2. In the event that hail does occur and is greater than the size defined in the parameters of the contract, the smart contract would automatically verify the hail event with an independent third-party, in this case most likely the NOAA.

3. Once the hail event was confirmed, the farmer would automatically and immediately receive a payout from the private insurer.

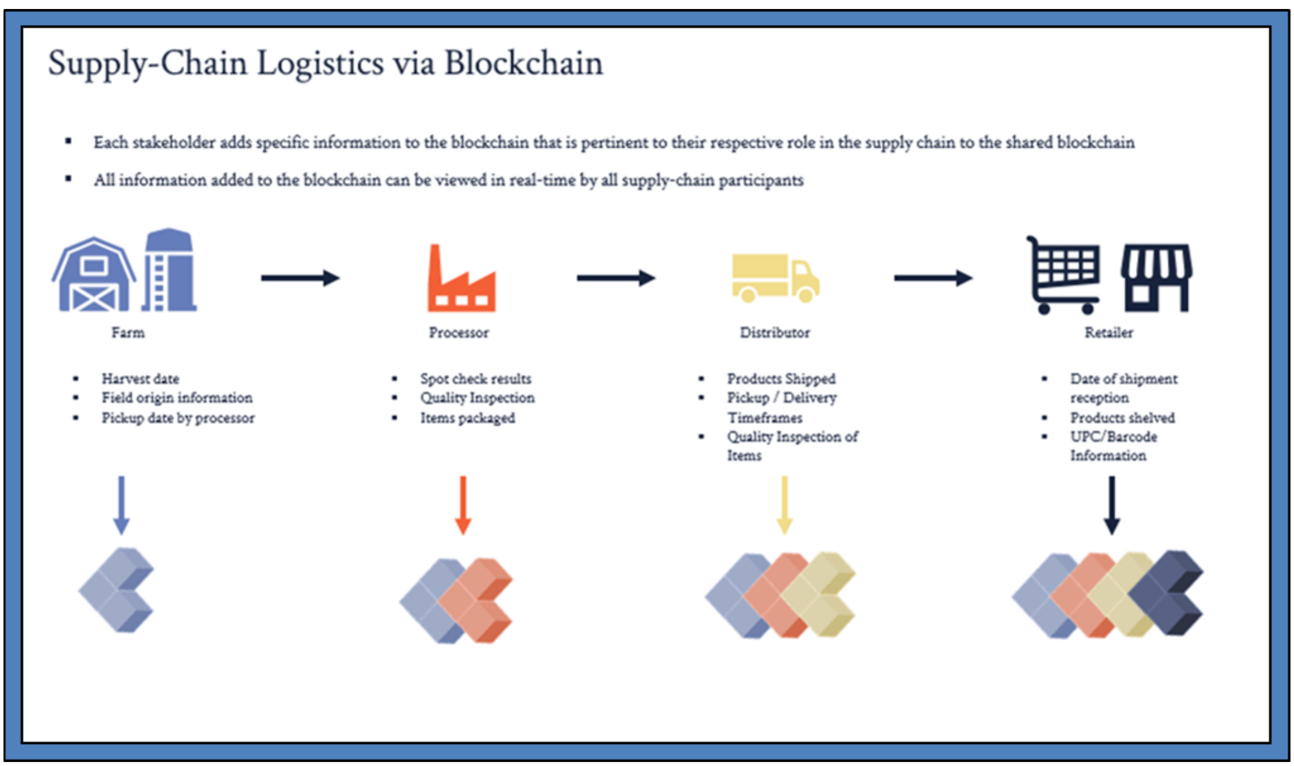
There could be several major impacts from the integration of smart contracts into the crop insurance market, both for the farmer and the private insurers. First, farmers would receive immediate and automatic payouts, meaning that once the event was verified, they would be compensated. Second, since the insurance contract is decoupled from the underlying asset, there would be no need for an insurer to send an adjuster to the farmer's field to examine the damage or even for the farmer to have to report the damage himself or herself to the insurance company (Martin, 2018). Instead, trusted and secure off-chain data sources and indices could be monitored to capture information on the contract parameters and provide approval for automatic payout when the contract parameter is met or exceeded (Foggan and Cwiertny, 2018). Third, enabling farmers to purchase Crop-Hail insurance policies via smart contracts could increase the potential for competition among insurers. Increasing competition among insurers may then lead to decreases in premiums for farmers. Fourth, by implementing Crop-Hail policies via smart contracts a significant cost savings could be experienced by the private insurer, assuming many of the administrative costs of maintaining and monitoring the contract were alleviated, a portion of this cost would presumably be transferred to the farmers in the form of lower premiums. Finally, there would be less room for fraud. Since the information needed for the contracts would be provided by an independent third-party, there could also be less of a chance for the information source to be manipulated.

Minimizing Costs and Impacts from Food Recalls

Every year 48 million Americans are made ill by food-borne pathogens (Kowitt, 2016), and the average impact to an affected food company is typically \$10 million in direct costs (Tyco Integrated Security, 2012) such as notification (to regulatory bodies, supply chain and consumers), product retrieval, storage, destruction of the unsalable product as well as additional labor costs associated with these actions, and all of this is before factoring in brand damage and lost sales. Additionally, the current method with which food companies handle food recalls seems to us inefficient given the technology available. For example, companies release the product name, product code numbers, UPC codes as well as expiration dates and product descriptions to suppliers and customers to try to contain contaminated items. Even if the food company can pinpoint that one particular field or factory as responsible for the contamination, current technology takes more than 6 days to trace back a particular piece of fruit to its farm of origin. If a food company were to utilize blockchain technology to capture supply chain and transportation information this trace-back process is decreased from more than 6 days to less than 2.5 seconds (Walmart, 2017). Furthermore, food companies can also pinpoint where particular items went very quickly. For example, if they knew food items from "Factory X" were contaminated they could instantaneously determine what stores these affected items were shipped to, when they were received and contact the stores to have those items immediately pulled from shelves, and potentially contact customers who purchased that product. This would prevent mass panic over a potential food recall as well as the destruction of unaffected products, associated labor costs as well as mitigate brand impacts from the recall. The advantage of decreasing the trace-back process time cannot be understated for food companies that are trying to trace and mitigate the risks of food recalls to the public. Major corporations are beginning to implement this technology into their supply chains for this exact reason. Walmart has been working with IBM on a food-safety blockchain solution and is now requiring all of its leafy green suppliers to upload their data onto the blockchain by September 2019 (Walmart, 2018).

Blockchain technology would enable food companies to quickly and accurately contain food contamination events. Figure 2 below illustrates how blockchain technology could be utilized to capture data from each stakeholder, thereby allowing the data to be quickly accessed during a recall or trace-back scenario. By being able to trace back food from store to origin in less than 2.5 seconds compared to 6 days, they will be better able to minimize the number of individuals affected as well as in some cases prevent the contaminated items from ever being shelved. Additionally, by being able to determine which stores received contaminated items via their supply chain history, unaffected food items could be sold without generating additional food waste and lost revenue to the food company. Furthermore, consumers would be given a greater sense of confidence that the recall was effective as the technology can empirically show that the infected food items have all been accounted for.

Figure 2
Supply Chain Logistics via Blockchain



Source: New Beacon Partners.
Note: Icons courtesy of Microsoft PowerPoint.

A New Potential Way for Investors to Gain Direct Exposure to Commodities

When an investor decides he or she wants to allocate a portion of his or her portfolio to commodities they typically are faced with the following 5 ways to gain exposure: 1) Directly purchasing the commodity, 2) Use commodity futures contracts to gain exposure, 3) Subscribe to a commodity-focused private placement fund, 4) Buy shares of exchange-traded funds that specialize in commodities or 5) Buy shares of stock in companies that produce commodities.

The most direct way to gain exposure is the first option, to purchase the commodity outright; however, in order to do so an investor would generally need to accept physical ownership of the commodity and store it. Some commodities like precious metals have developed markets for buying a bar or a coin, and these are fairly easy to store; however, what if an investor wants to invest in crude oil or natural gas? In today's markets direct ownership of crude oil, natural gas, or other hard-to-store and hard-to-divide assets is extremely difficult and in some cases not possible for a typical retail investor; however, with blockchain, we argue this becomes possible.

In July, blockchain platform Maecenas partnered with London gallery Dadiani Fine Art to offer fractional stakes in Andy Warhol's *14 Small Electric Chairs (1980)*. 31.5% of the Warhol work was offered for sale via cryptocurrencies and the minority shares were distributed to winning bidders paying in cryptocurrencies. The sale and subsequent trading of these minority shares are tracked via blockchain and effectively create a transparent and real-time marketplace for the artwork (Randall-Stevens, 2018).

This model of "tokenization" can be applied to many types of asset classes outside of art and has already been employed in real estate. In 2018, the St. Regis hotel in Aspen sold 18.9% of the resort for $18 million via digital tokens (Carroll, 2018). This sale enabled investors to gain direct exposure to a real estate asset, that without tokenization, they would never have been able to hold in their portfolio.

Like the St. Regis hotel in Aspen, this model of "tokenization" could be specifically applied to hard-to-store and hard-to-divide assets and potentially introduce both a new type of product to the commodities market as well as a new type of product provider. Currently, the majority of Exchange Traded Funds (ETFs) and Exchange Traded Notes (ETNs) that provide exposure to hard-to-divide or hard-to-store commodities such as crude oil and natural gas by holding futures contracts and not the actual physical asset. This could change with the utilization of blockchain technology by ETF and ETN managers as these managers could warehouse hard-to-divide or hard-to-store commodities using traditional storage methods and digitally "divide" them into tradeable tokens. Like the Warhol painting, blockchain technology could allow an asset typically only owned by one buyer to be owned by many. This additional liquidity could potentially provide an incentive for managers to begin to offer this type of a product.

Using blockchain technology would not avoid other costs such as transportation, storage, insurance or enforcement-of-contract legal fees; however, it would enable investors to obtain direct exposure to commodities without having to invest through a traditional ETF or ETN. Blockchain technology could enable fund companies to expand their offerings to investors, thereby allowing investors to obtain direct exposure to a particular asset in fractional amounts and without having to take delivery of the particular asset.

Additionally, the "tokenization" model could be applied to locations where commodities are mined, drilled or produced. For example, an owner of a gold mine, oil field or farm could digitally "divide" their mine, field or farm and sell a percentage of their commodity producing asset via digital tokens, just as the St. Regis hotel did in Aspen. By selling a percentage of their mine, field or farm via digital tokens, the owner could experience a monetization event while providing investors direct access to a commodity producing asset that would typically only be available to them indirectly through an ETF or ETN. In this particular case, the owner of the mine, field or farm would continue to operate the asset while the owners of the digital token would share in the profit / loss of the commodity producing asset.

By applying the tokenization model, a new type of commodities-linked product could be created and begin to give investors a greater degree of flexibility as well as opportunity to invest directly in commodities and commodity producing assets.

Conclusion

In the above discussion, we noted our belief that blockchain technology can bring positive change to the commodities industry; however, what is most important is that it is possible to implement this technology today. The applications discussed above are not unsubstantiated or purely speculative applications, but rather are applications that either are already being implemented or have a clear path towards implementation. Blockchain technology should not be thought of as a strange or obscure technology but instead as the next technological innovation capable of creating better and more secure ways to transact goods and services. Just as the internet revolutionized the way that market participants interacted, we argue that blockchain too will similarly impact the status quo.

References

Carroll, R., 2018, "In $18 Million Deal, Nearly One-Fifth of St. Regis Aspen Sells through Digital Tokens," *Aspen Times*, October 9. Accessed via website: https://www.aspentimes.com/news/local/in-18-million-deal-nearly-one-fifth-of-st-regis-aspen-sells-through-digital-tokens/ on January 14, 2019.

Foggan, L. and C. Cwiertny, 2018, "Blockchain, Smart Contracts and Parametric Insurance: Made for Each Other," *Thomson Reuters Westlaw*, November 16. Accessed via website: www.crowell.com/files/20181116-Blockchain-Smart-Contracts-And-Parametric-Insurance-Made-For-Each-Other.pdf on January 14, 2019.

Kowitt, B., 2016, "Why Our Food Keeps Making Us Sick," *Fortune*, May 6. Accessed via website: http://fortune.com/food-contamination/ on January 14, 2019.

Martin, A., 2018, "What Is Parametric Insurance?", Swiss Re Corporate Solutions, August 1. Accessed via website: http://corporatesolutions.swissre.com/insights/knowledge/what_is_parametric_insurance.html on January 14, 2019.

Randall-Stevens, K., 2018, "Andy Warhol's 14 Small Electric Chairs to Be Sold in Blockchain Art Auction," Maecenas.co, June 7. Accessed via website: https://blog.maecenas.co/andy-warhols-14-small-electric-chairs-to-be-sold-in-blockchain-art-auction on January 14, 2019.

Tyco Integrated Security, 2012, "Recall: The Food Industry's Biggest Threat to Profitability," *Food Safety Magazine*, 2012. Accessed via website: https://www.foodsafetymagazine.com/signature-series/recall-the-food-industrys-biggest-threat-to-profitability/ on January 14, 2019.

Walmart, 2017, "'Outside the Box' Breaks Down Blockchain," June 20. Accessed via website: https://blog.walmart.com/business/20170620/outside-the-box-breaks-down-blockchain on January 14, 2019.

Walmart, 2018, "Walmart and Sam's Club to Require Real-Time, End-to-End Food Traceability with Blockchain," September 24. Accessed via website: https://corporate.walmart.com/media-library/document/leafy-greens-on-blockchain-press-release/_proxyDocument?id=00000166-0c4c-d96e-a3ff-8f7c09b50001 on January 14, 2019.

Author Biographies

ALEX COHEN
Co-Founder and Managing Director, New Beacon Partners

Mr. Alexander Cohen is Co-Founder and Managing Director of New Beacon Partners. Prior to co-founding New Beacon Partners, Mr. Cohen worked in the Technology, Media & Telecommunications Investment Banking group at Wells Fargo Securities in New York, focusing on the Media and Education Sectors. In his role at Wells Fargo Securities, Mr. Cohen sat on the Strategic Initiative and Leadership Committee as well as completed over $10+ billion of transactions.

Previously, Mr. Cohen was an Assistant Vice President at Bank of America Merrill Lynch in the Alternative Investments Group focusing on the creation, structuring, onboarding and support of Private Equity funds for the Merrill Lynch Wealth Management, Merrill Lynch Private Banking and Investment Group (PBIG) and U.S. Trust platforms.

Mr. Cohen received a B.A. in Economics as well as a B.A. in Environmental Studies from New York University.

LUIS QUINTERO
Co-Founder and Managing Director, New Beacon Partners

Mr. Luis Quintero is Co-Founder and Managing Director of New Beacon Partners. Prior to co-founding New Beacon Partners, Mr. Quintero worked in the Technology, Media & Telecommunications Investment Banking group at Wells Fargo Securities in New York. In his role at Wells Fargo Securities, Mr. Quintero completed over $10+ billion of transactions as well as sat on the Strategic Initiative and Leadership Committee.

Previously, Mr. Quintero received an M.B.A. from the Yale School of Management where he focused on the application of artificial intelligence and machine learning on quantitative financial investing. Prior to attending Yale, Mr. Quintero worked for the Volatility and Exotics (VolEx) trading desk at Goldman Sachs in New York.

Mr. Quintero received a B.S. in Engineering in Operations Research and Financial Engineering (ORFE) from Princeton University.

Digital Assets: The Era of Tokenized Securities

Brian Leiberman
Chief Operating Officer and Head of Global Capital at MLG Blockchain (Canada)

Dave Mirynech
Director of Research and Blockchain Consultant at MLG Blockchain (Canada)

Introduction

The advent of bitcoin and other cryptocurrencies have recently pushed the topic of digital assets to the forefront of many conversations in finance and technology. It is our belief that these assets stand as an effective fundraising mechanism, enable access to global investor pools, unlock liquidity in many assets, and represent an opportunity for regulators to be proactive in compliance. Perhaps what is not widely appreciated is that these assets have actually been prevalent for over a decade and have had an impact in a variety of industries.

Digital assets initially included everything from pictures, video, news media, and music. The emergence of the internet marked the first time these digital asset files could be shared peer-to-peer over the web. What happened that was so threatening to established industry players is that the sharing of these files and assets, particularly music, was facilitated through copying and replicating, effectively crippling their value on the market by removing their scarcity. This led to disruptive new business models like Napster, large regulatory involvement from the U.S. Federal Communications Commission, and the creation of digital copyright laws to attempt to protect the incumbents. The companies that succeeded during these early beginnings included those that successfully utilized technology to master the distribution of these assets. YouTube and Netflix enabled consumers to stream content from their homes instead of going to the video rental store, Instagram and Snapchat have allowed people to share pictures with friends globally and instantaneously without having to get the images developed, while Facebook, Yahoo!, and Twitter have aggregated news content from different sources in one easily accessible location bypassing traditional media sources.

While digital assets were absolutely transformative for these other mediums, currency and money never quite experienced a positive relationship because as most people hopefully know, money shouldn't be copied and shared. That's counterfeit. As a result, many of the earliest forms of internet money or digital cash did not survive. That did not mean that money and value transfer could not benefit from the fungibility, or how easily tradable digital assets are, someone just had to figure out how this money could not be spent twice.

___

The articles in this Special Feature do not necessarily represent the views of the JPMCC, its sponsors, or donors. The articles are for educational purposes only.

Bitcoin and the Double-Spend Problem

In 2008, in response to the financial crisis, an anonymous author (or authors) with the pseudonym of Satoshi Nakamoto published a white paper titled, "Bitcoin: A Peer-to-Peer Electronic Cash System." The paper was groundbreaking because through a combination of cryptography and mathematics, an effective solution was proposed to solve the double-spend problem. Essentially, the ideas ensured digital money or value traded over networks could maintain their worth. Since then, blockchain, its underlying technology, has slowly become the platform where digital tokens or assets could be created and programmed to represent the value of anything from currency, commodities, common shares, and real estate. These assets could then (potentially) benefit from digital distribution, built-in compliance, global investors, 24/7 trading, and be traded instantaneously between peers.

Ethereum and Initial Coin Offerings

In 2014, a 19-year old student from the University of Waterloo (Canada), Vitalik Buterin, received the opportunity of a lifetime. Buterin was obsessed with Bitcoin, but saw several key limitations to its effectiveness as anything beyond currency or a store of value. Buterin sought to create the underpinnings of a new economic system, Ethereum, where complex financial transactions could be built, programmed, and autonomously executed according to a set of coded conditions. Peter Thiel, founder of PayPal and early investor in Facebook, saw the potential of this system and gave Buterin the start-up money he needed to drop out of school and pursue its development. When this money ran dry, Buterin needed an additional source of financing. He decided to issue digital assets on his blockchain known as ether (ETH), and sell them to the public in a crowdsale so owners of this asset would be able to participate and have access to this new financial system. In just over a month, Buterin raised $18.4M USD and set the stage for a new way of financing known as an Initial Coin Offering (ICO). Other companies soon followed suit and ICOs became a cost effective and fast way for companies to raise capital. In the past twelve months alone companies have raised more than $10 billion from these public crowdsales, as of the writing of this article.

Issues with ICOs

However, ICOs do come with their own set of risks. It was clear from investor behavior that many were investing in these new assets expecting to see a return meeting the definition of a security outlined by the Howey Test. Essentially the Howey Test is a four-part litmus test used by the U.S. Securities and Exchange Commission (SEC) to determine if assets meet the standards of an investment contract. This test states that if money was invested, and it was invested into an enterprise, and the investment came with a reasonable expectation of profits from the investor, and lastly that this realization of value was due to successful operation of the business, then the standards have been met to determine that this asset is a financial security.

Failure to comply with U.S. federal securities laws can yield punishment from the SEC as we have recently seen in the case of Paragon and Airfox, which were two companies who conducted an ICO in 2017 and misrepresented their tokens as a utility and not a security as defined by the Howey Test. Neither Airfox nor Paragon registered their ICOs pursuant to the federal securities laws, nor did they qualify for an exemption to the registration requirements. The SEC found both companies in violation of securities laws and has forced them to register their tokens as securities pursuant to the Securities Exchange Act of 1934 and file periodic reports with the Commission for at least one year (Palley, 2018).

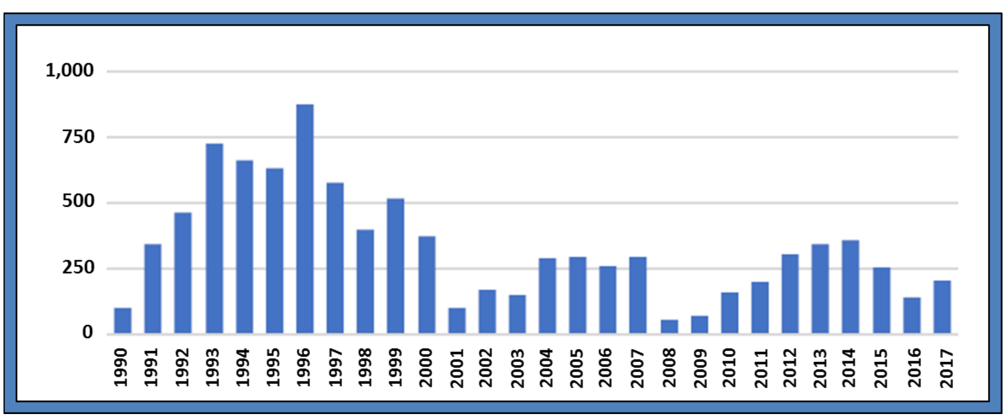
Tokenized Securities

As the SEC begins to adjudicate on ICOs, companies are taking notice and have begun issuing tokens that comply with securities laws and exemption requirements. These token generation events have been called Security Tokens Offerings or Digital Securities Offerings. As the name implies, these tokens, powered by blockchain technology are coming to market with compliance built into their issuance. These tokens are powered by a handful of new protocols and issuance platforms. These include the Polymath Protocol, Hyperion, Securrency, Swarm, and Harbor to name a few. Many platforms are still being developed and are looking to launch in the near term. Most platforms do not restrict themselves to only private share issuance; they are also aiming to tokenize real estate, debt, and importantly for this publication, commodities, among other assets. In our view, tokenized securities are transformative for a number of reasons.

The Need for Alternative Fundraising Strategies

Capital is the lifeblood of any business. It is essential in order to grow, finance an acquisition, pay employee salaries, develop product, and fund operations. Despite this obvious need, capital is becoming increasingly harder to find. The number of initial public offerings (IPOs), one of the most common ways to raise money in capital markets, has fallen by over 70 percent since its peak during the dot-com bubble, as shown below in Figure 1. Due to the development of legislation like the Sarbanes-Oxley Act in 2002, the process of undertaking a public offering and doing it compliantly has become incredibly lengthy, resource intensive, and expensive. The IPO process for a typical company lasts anywhere between six to nine months if all goes according to plan. Firms must also pay underwriter fees as well as significant legal expenses.

Figure 1
Number of IPO's, USA, 1990 - 2017

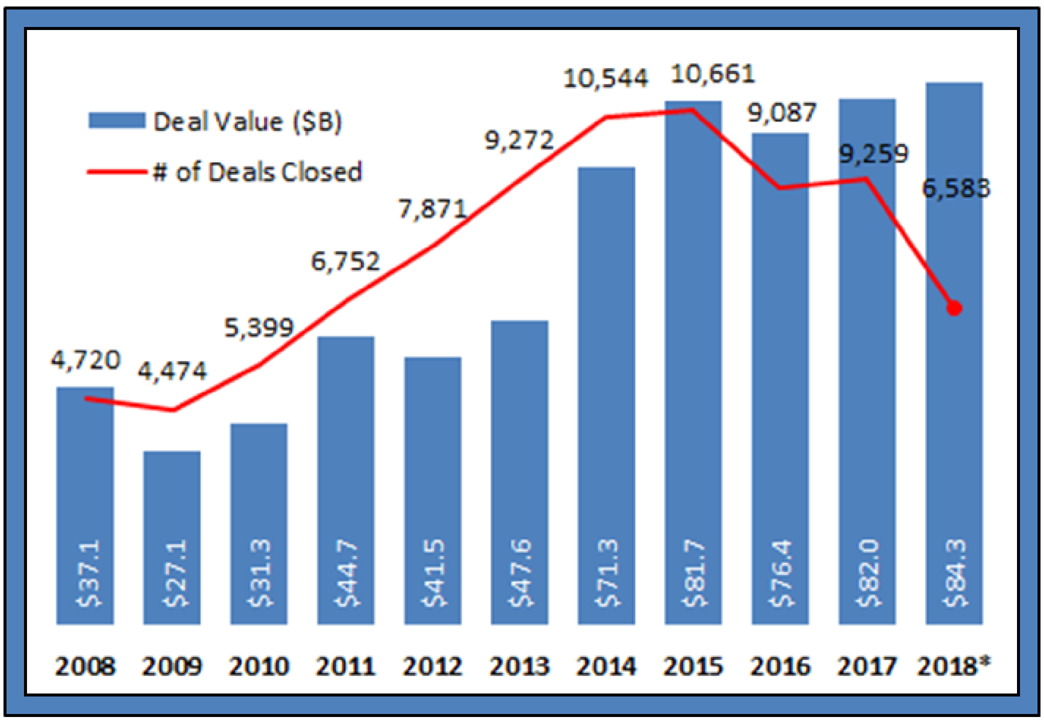


Source: Lux and Pead (2018).

Voter control has been a contentious issue that has caused some firms to rethink going public. In 2017, Snap Inc.'s IPO drew criticism for not giving shareholders any voting rights. The London Stock Exchange went so far as to refuse to list them for this reason. However, keeping voting power is a sentiment shared by a growing number of tech start-ups. Companies do not wish to see their vision for their product undermined by a desire to achieve profits in the short term.

The situation with private capital is also affecting public markets. The industry at large has undergone a significant amount of consolidation. Larger funds with over $1 billion to invest are beginning to become increasingly pervasive and dominate the landscape (Aberman, 2017). The consequences of this concentration of capital mean that although ticket sizes may be larger, the number of deals actually being handed out to companies is also on the decline, as shown below in Figure 2.

Figure 2
U.S. Venture Capital Activity



Source: *PitchBook Venture Monitor 3Q2018*
* As of September 30, 2018

The result of these trends is that firms are increasingly looking for alternative ways of raising capital that are less restrictive, time efficient, and cost effective. Reverse Takeovers (RTO), the process of going public by purchasing a shell-company that is already listed on an exchange, are becoming more popular as it is seen as a quicker and more cost effective way to have shares publicly traded. In April 2018, Spotify went public through what is known as a direct listing. By doing so they did not end up procuring the services of an investment bank to underwrite the deal and did not sell any new shares. It is estimated that by going through this process they saved around $63 million (Pisani, 2018). This scenario, in addition to other strategies such as equity crowdfunding and the formation of Capital Pool Companies (CPC), demonstrates the desire on the market for alternative fundraising methods. Tokenized securities offerings can fill this void due to quicker and cheaper deal execution, programmable governance and voting rights, as well as access to global pools of capital.

Proactive Regulatory Compliance

Another large change that may come about with the inception of security tokens is a new ability for regulators to take a proactive approach to compliance. The law and technology experience have an interesting relationship. Common law is a legal standard practiced in Canada, the United States, the United Kingdom, and Australia among others. It is based on the principle of *stare decisis*, also known as legal precedent. Judgements in the courts are made based on the outcomes of past cases and applied to the situation at hand. In this way, the law evolves by looking to the past to inform the future. This evolution is also painstakingly slow, and decisions and outcomes can take weeks while new legislation can span months and years.

Juxtaposed to these cumbersome and backward-looking processes is technological innovation. Innovation only pushes in one direction: forward acceleration. Google's Chief Futurist and Director of Engineering, Ray Kurzweil, calls this the "Law of Accelerating Returns." This theory predicts the exponential growth of diverse forms of technological progress. Given this rapid technical acceleration in relation to how legal decisions progress, the law is frequently slow to develop frameworks that can adequately compensate for the speed of technological development.

In the digital asset industry this dichotomy is very prevalent. After the ICO boom in late 2017, the SEC raced to govern the use of innovative new cryptocurrencies and digital assets with an adequate regulatory framework and ended up with the application of securities laws that date back to the 1940s.

However, due to the customizable and programmable characteristics of tokenized securities, regulators can actually use these assets as vehicles to enforce regulation proactively in the issuance of the token itself. While normal standard legal contracts can be seen as agreements between a number of parties with certain agreed upon terms, their conditions can only be enforced externally by regulators, lawyers, courts, or in the event of the parties actually holding up to their end of the bargain. In comparison, the defining feature of a smart contract deployed by a blockchain is a guarantee of execution. Contracts do not need to be enforced by some third-party authority: their terms are coded into the contract itself. In that way, when certain conditions are met, they are autonomously executed. What this means for tokenized securities is that securities law and legal terms can essentially be programmed into the issuance of the token itself to ensure that throughout the asset's life, it is constantly abiding by the rules. Other features such as voting rights and dividend payments can experience these same benefits. These rules form the backbone of popular security token standards.

This progressive approach is in stark contrast to the backward-looking approach of the law but represents an opportunity for regulators, for once, to get out in front of innovation. We feel that this ability is of such magnitude that regulators may one day make it mandatory for any securities issuance.

Global Access and Networked Investor Pool

The power of financing companies using networked technologies was first demonstrated during the ICO boom. In early 2017, Brendan Eich, the former Chief Executive Officer of Mozilla Firefox, raised $35M in 30 seconds to finance Brave, his new blockchain-based Internet browser. Meanwhile, Bancor, a digital asset liquidity provider, raised $153 million in just under 3 hours. We are not aware of any investments of this magnitude being accomplished in such an efficient manner.

While the replacement of financial intermediaries with automated services plays a large role in this, other factors are also important in allowing for these speedy capital raises. The other factors include (a) the ability to be educated on a sound investment opportunity using information dissemination on the web, and (b) the ability to actually invest in the new venture itself using the blockchain. These features result in the inclusion of retail investors and a free-market exposure to large global pools of capital.

Larger global investor pools are also realized by enabling financial access and participation. One of the defining features of tokenized securities involves a concept known as fractional ownership, as also covered in Cohen and Quintero (2019). This is where investors can experience the right to purchase a certain percentage of an asset. Where this may have the greatest impact is in unlocking liquidity in instruments that would have been otherwise frozen or hard to trade, as well as in assets that are too expensive too solicit investment from most investors. The most commonly cited examples include gold, diamonds, and rare artwork, which are assets that are inherently expensive but also come with significant storage and security costs. Others include high-value real estate and even ownership in professional sports teams, assets that have typically only been available to the few. Tokenizing these assets invites financial inclusion and participation, democratizing access to high-value investment opportunities for those that at least meet accredited investor laws.

Issues

Nevertheless, compliant token issuers still face challenges in the nascent market as secondary market exchanges do not yet have the promised liquidity pool needed to truly capture the full value of security tokens. Currently, to be able to trade security tokens compliantly, exchanges must have an Alternative Trading System (ATS) license. There are only a handful of companies that have these licenses and even fewer that are live. Only Open Finance and Tzero are actively trading these tokens and volumes have been low at the start. If one were to offer a security token today, there would be no secondary market to trade on. In addition, token holders would most likely have to hold the token between six-to-twelve months given the type of exemption the security has been filed under.

As holding periods are lifted and exchanges go live, only then can the promise of security tokens be realized. We would argue that we are not far away: we estimate that by 2020, more than ten security token exchanges will be live with hundreds of tokens traded. Security tokens hold promise for a new wave of adoption in the blockchain space. We recommend that market participants stay abreast of these advancements over the next few years because of their potentially large impact on capital markets in general and commodity investing in particular.

References

Aberman, J., 2017, "The Disrupters in the Venture Capital Industry are Ripe for Disruption," *Washington Post*, March 6. Accessed via website: https://www.washingtonpost.com/news/capital-business/wp/2017/03/06/the-disrupters-in-the-venture-capital-industry-are-ripe-for-disruption/?noredirect=on&utm_term=.062604f5f3f2 on February 13, 2019.

Cohen, A. and L. Quintero, 2019, "Three Possible Ways that Blockchain Technology Could Disrupt the Commodities Industry," *Global Commodities Applied Research Digest*, Special Feature: Cutting-Edge Innovation in the Cryptosphere, Vol. 4, No. 1, Summer, pp. SF17-SF24.

Lux, M. and J. Pead, 2018 "Hunting High and Low: The Decline of the Small IPO and What to Do About It," M-RCBG Associate Working Paper Series, No. 86, Harvard Kennedy School, April. Accessed via website: https://www.hks.harvard.edu/sites/default/files/centers/mrcbg/working.papers/86_final.pdf on February 13, 2019.

Palley, S., 2018, "The SEC Cracks Down on Two ICOs, Creating a Template for Future Enforcement," *The Block*, November 17. Accessed via website: https://www.theblockcrypto.com/2018/11/17/the-sec-cracks-down-on-two-icos-creates-a-template-for-future-enforcement on February 13, 2019.

Pisani, B., 2018, "Spotify's IPO Disrupted Wall Street: What Lies Ahead Now for Unicorns Looking to go Public," *CNBC*, May 22. Accessed via website: https://www.cnbc.com/2018/05/22/spotifys-ipo-disrupted-wall-street-what-lies-ahead-now-for-unicorns-looking-to-go-public.html on February 13, 2019.

PitchBook Venture Monitor 3Q2018, 2018, National Venture Capital Association (NVCA), October 8. Accessed via website: https://pitchbook.com/news/reports/3q-2018-pitchbook-nvca-venture-monitor on February 13, 2019.

Author Biographies

BRIAN LEIBERMAN
Chief Operating Officer and Head of Global Capital at MLG Blockchain (Canada)

Mr. Brian Leiberman is the Chief Operating Officer and Head of Global Capital at MLG Blockchain, a global venture creation firm with technical development capabilities as well as broker-dealer capabilities. Mr. Leiberman also serves as an advisor to the Holt Fund, a fintech accelerator and family office in Montreal. He holds a degree in Finance and International Business from the Desautels Faculty of Management at McGill University. Mr. Leiberman can be reached at brian@mlgblockchain.com.

DAVE MIRYNECH
Director of Research and Blockchain Consultant at MLG Blockchain (Canada)

Mr. Dave Mirynech is the Director of Research and a Blockchain Consultant at MLG Blockchain. He originally joined the industry by founding the Blockchain Education Network (BEN) at the University of Western Ontario (UWO) where he currently serves as a Director. Prior to his role at MLG, Mr. Mirynech worked at Charlesway Corporation Ltd., a private equity firm based in Southern Ontario. He has since gained experience researching the intersection of artificial intelligence, robo-advising, and wealth management at the Scotiabank Digital Banking Lab at the Ivey Business School, UWO and as a Research Lead for the Blockchain Research Institute. Mr. Mirynech is a graduate of the University of Western Ontario in Communications and Information Systems.

GLOBAL COMMODITIES
APPLIED RESEARCH DIGEST

The *Global Commodities Applied Research Digest* (*GCARD*) is produced by the J.P. Morgan Center for Commodities (JPMCC) at the University of Colorado Denver Business School.

The JPMCC is the first center of its kind focused on a broad range of commodities, including agriculture, energy, and mining. Established in 2012, this innovative center provides educational programs and supports research in commodities markets, regulation, trading, investing, and risk management.

Subscriptions to the *Global Commodities Applied Research Digest* are complimentary because of a generous grant from the CME Group Foundation: http://www.jpmcc-gcard.com/subscribe/.

The *GCARD* is edited by Ms. Hilary Till, the JPMCC's Solich Scholar, http://www.jpmcc-gcard.com/hilary-till, who can be contacted at hilary.till@ucdenver.edu.

Copyright © 2019 University of Colorado Denver Business School

J.P. MORGAN CENTER FOR COMMODITIES
UNIVERSITY OF COLORADO DENVER BUSINESS SCHOOL

Physical Address

J.P. Morgan Center for Commodities

University of Colorado Denver Business School

1475 Lawrence Street
Denver, CO 80202

Mailing Address

J.P. Morgan Center for Commodities

University of Colorado Denver Business School

Campus Box 165
P.O. Box 173364
Denver, CO 80217

Web

business.ucdenver.edu/commodities

Contact

Mr. Matthew Fleming

Program Manager

J.P. Morgan Center for Commodities

University of Colorado Denver Business School

matthew.fleming@ucdenver.edu
1.303.315.8019

Business School
UNIVERSITY OF COLORADO DENVER