The Journal of Alternative Investments

Blockchain: *Data Malls, Coin Economies, and Keyless Payments*

Zura Kakushadze and Ronald P. Russo, Jr.

JAI 2018, 21 (1) 8-16
doi: https://doi.org/10.3905/jai.2018.21.1.008
http://jai.iijournals.com/content/21/1/8

Blockchain: *Data Malls, Coin Economies, and Keyless Payments*

Zura Kakushadze and Ronald P. Russo, Jr.

Zura Kakushadze
is president, CEO, and co-founder of Quantigic® Solutions LLC in Stamford, CT and a professor at the Free University of Tbilisi in Tbilisi, GA.
zura@quantigic.com

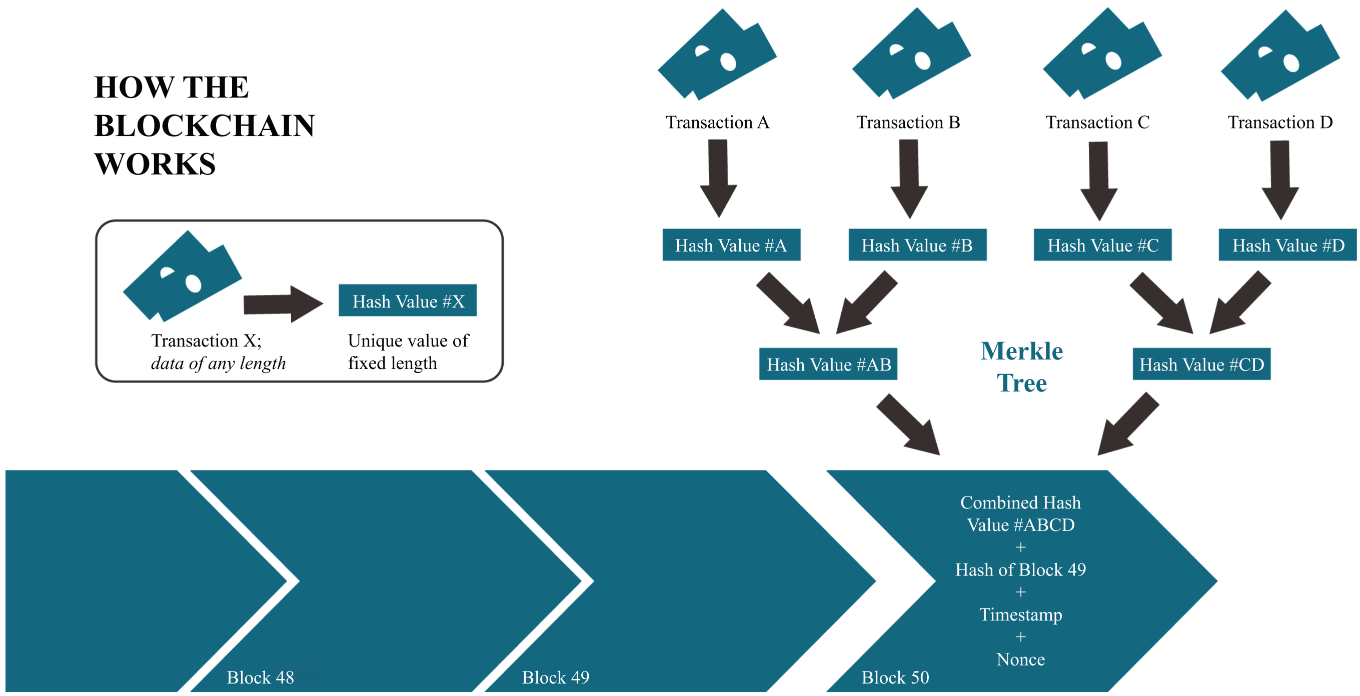
Ronald P. Russo, Jr.
is founder, CEO, and social equity officer at Global Listing Exchange in Palm Beach, FL.
rr@glx.com

Blockchain is a ledger for keeping a record of all transactions. It is a time-sequential chain of blocks containing transaction records. Blocks are linked using cryptography and time-stamping (see Exhibit 1). The data in a given block cannot be altered retroactively without altering all subsequent blocks, which makes blockchain resistant to modification of data by design. For historical reasons (Nakamoto 2008), transactions in blockchain are usually thought of as relating to peer-to-peer (P2P) payments with blockchain as a distributed ledger maintained by a P2P network that itself validates new blocks. However, blockchain is not synonymous with payments or decentralization. A priori, blockchain can record other types of transactions. In addition, blockchain need not be maintained by a P2P network but, instead, could be managed by a centralized authority.

In decentralized blockchain-based cryptocurrencies such as Bitcoin (BTC) and Ethereum (ETH), verification of transactions by a P2P network is achieved via mining, a process whereby GPUs/CPUs solve computational problems. As part of this process, miners (among others) maintain copies of blockchain. Miners receive fees in respective cryptocurrencies. Mining is computationally intensive, with high energy costs, and has been argued to be inefficient and possibly even unsustainable as blockchain grows (see, e.g., Bariviera 2017; Kostakis and Giotitsas 2014; Nadarajah and Chu 2017; Urquhart 2016; and Vranken 2017) In contrast, anticipated centralized government-issued cryptocurrencies (e.g., CryptoRuble) do not require mining and in some sense are more "efficient" as transactions are verified by a centralized authority (e.g., a central bank, Kakushadze and Liew 2017). In government-issued cryptocurrencies, one of the main allures of decentralized cryptocurrencies—anonymity of transactions—is gone. However, employing blockchain (vs. traditional bank ledgers) can help prevent or reduce fraud, errors, and so forth.

The decentralized vs. centralized cryptocurrency example highlights that, as with most things in life, whether using blockchain for solving a particular problem adds value or not depends on practical considerations and the answer can vary from instance to instance. In this article, we discuss some potential applications of blockchain outside of cryptocurrencies from a pragmatic viewpoint. We mostly focus on three areas: the role of coin economies for data malls, data provenance, and what we term "keyless payments". We also touch upon applications for voting. A sizable number of references and some comments are relegated to Supplemental Materials.

Exhibit 1
A Schematic Depiction of Blockchain



Source: By B140970324 (Own work) [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], via Wikimedia Commons. Image Source: https://upload.wikimedia.org/wikipedia/commons/3/3a/Blockchain_workflow.png.

DATA MALLS

The idea of a data marketplace (see Supplemental Materials, Note 1) in the context of the Internet of Things (IoT) has recently gained traction with the IOTA Data Marketplace (IOTADM) (Schiener 2017; Sønstebø 2017) launched by the IOTA Foundation (Ponciano 2017), which circulates its own coin MIOTA. The technology underlying MIOTA and IOTADM is the so-called "Tangle," which is a distributed ledger, a form of a direct acyclic graph (Bang-Jensen and Gutin 2009), as opposed to blockchain. IOTADM is an open and decentralized data lake (see, e.g., insideBIGDATA 2017; Ramakrishnan et al. 2017) accessible to any paying party. Its scope is broad.

One of the challenges of broad data marketplaces is precisely their breadth of scope. It would be difficult, for example, to convince a mainstream capital markets professional to purchase stock market pricing data from a data marketplace that is a hodgepodge of vastly disparate data types (hypothetically) ranging from measurements made by a sensor mounted on a weather balloon hovering somewhere above Antarctica to some quantitative properties of bacteria found in the guts of livestock in remote regions of Tibet and everything in between. Furthermore, such broad data marketplaces based on data lakes would normally store data in its raw, unprocessed form, so the burden of making sense of such data (cleaning it, formatting it, etc.) falls on the end-user. For some applications (and industries) this may work well. But in other cases, such as capital markets, finance, and quantitative trading, end-users desire more of a plug-and-play type of data, which they can utilize without expending prohibitive effort.

More specialized outlets, which we refer to as "Data Malls," would appear to be better suited for this purpose.[1] A Data Mall can act as a decentralized marketplace

[1] The term "Big Data Mall" was used in (Informatica [2011]). However, there it was used in the sense of a mall for Big Data in a marketplace (which is not a data marketplace) that offers other (non-data) products and services.

for various types of financial data (and datafeeds), but is not as disparate as our previous example of a general, hodgepodge type of a data marketplace. Furthermore, each data provider can normalize and format its data according to the adopted industry practices, so that the data is marketable and easy to use. This is not to say that all data must be in the same format—this too would be impracticable as data types vary. In some cases, it may be beneficial to have normalized data descriptions (or "abstracts") for ease of searching, classification, and other processes, with (automated) centralized verification. Such data need not be hosted in a data lake. Instead, it can be hosted on private nodes that the providers control. They choose what content to make public and what content to keep private. Decentralization then is not in dumping data using some kind of a distributed ledger—in most cases this is impracticable for a variety of reasons, including the fact that data can be huge in size, not to mention issues that can arise with data provenance, disparate formatting, and so on. Instead, decentralization centers on creating a network that allows users to buy and sell data from each other directly, without a middleman. This is precisely where Coin Economies can play a pivotal role.

To summarize, hodgepodge data marketplaces will likely have a hard time getting traction. Here we advance the idea of more specialized Data Malls instead. Furthermore, decentralization and blockchain are not practically useful for actual data hosting/storage per se. What they can be useful for is creating a network without a middleman, and Coin Economies can be beneficial in this regard. However, here too some nontrivial issues arise, which we discuss pragmatically in the next section.

COIN ECONOMIES

In some sense, Data Malls provide a middle ground, a hybrid model, between the status quo and the radical idea of completely unstructured data marketplaces based on data lakes. Blockchain and similar distributed ledger technologies can provide decentralized user networks connecting data sellers and buyers. A Coin Economy is a simple way of achieving this.

Thus, blockchain-based Ethereum smart contract technology (see Supplemental Materials, Note 2) has been used to create P2P networks of users with common interests. Here are two examples (Xie [2017]). Augur is a decentralized prediction market with an Ethereum token called Reputation (REP). REP is used to reward decentralized reporters, which are all REP holders, of the prediction market event outcomes. Those who report outcomes incorrectly are penalized by taking away some of their REP holdings. Majority of REP holders have incentive to report outcomes correctly: otherwise REP would lose value. Another example is Golem, a network for renting out spare computing power to others, with its own token called Golem Network Token (GNT), which is used for payments on this network.

Much in the same spirit, Coin Economies can also be useful for decentralized Data Malls. The payments on a decentralized Data Mall network are made through its coin issued, say, via Ethereum. (By "coin" we mean coin or token and vice-versa, as may be most applicable.) If this coin is exchange-traded, then a data vendor can convert tokens received from data sales into fiat currency, so in this case there is no issue with liquidity. Instead, there can be an issue with volatility—if the exchange-traded coin is volatile, the vendor can end up receiving less if the coin value drops (or more, if the coin value rises). There are ways to mitigate this, through employing derivatives hedging strategies, for example, which could include buying put options on the coin (if such options are available for it), known as a "protective put" or "married put" strategy (see, e.g., Cohen 2005; Figlewski, Chidambaran, and Kaplan 1993). Alternatively, the vendor can hedge by selling futures (exchange traded) or a forward contract (over-the-counter) (see, e.g., Hull 2012), if there is a market for such derivatives, thereby forgoing the upswing upside.

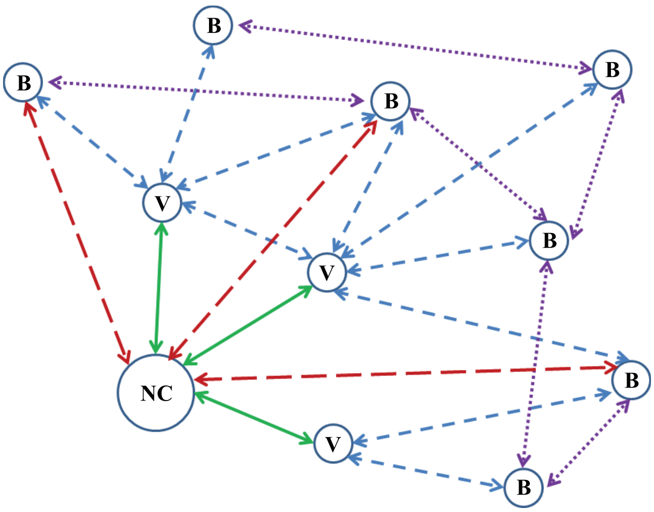
If the coin is not exchange-traded, then liquidity becomes an issue. After all, the vendor wishes to monetize its data, not just to acquire illiquid tokens. There is an old-fashioned simple solution for this, akin to good old Chuck E. Cheese tokens. Suppose a vendor collected S dollars worth of tokens through sales. With proof of sale, the token issuer will swap these tokens for P dollars in fiat money,[2] where

$$P = S \times (1 - C) \quad (1)$$

[2] In practice, with, for example, Ethereum-based tokens, this payment can be made in ether (ETH) and then the vendor can convert ETH to fiat money. Both the vendor and network creator have exchange rate exposure (see the discussion in the text).

Exhibit 2

A Schematic Depiction of a Data Mall Network



Notes: NC = network creator; V = data vendor; B = data buyer. Solid lines represent token payments from vendors to the network creator and fiat money (or exchange-traded coin) payments from the network creator to the vendors. Smaller dashed lines represent token payments from buyers from vendors and data provision by vendors to buyers. Larger dashed lines represent miscellaneous interactions between buyers and the network creator. Dotted lines represent miscellaneous interactions between buyers. Each buyer may acquire data from more than one vendor. A vendor can also be a buyer and acquire data from another vendor.

(Also see Exhibit 2). Here C is some reasonable predefined percentage. In essence, C resembles a sales commission percentage and the token issuer makes Q dollars from the vendor's sale, where

$$Q = S \times C \tag{2}$$

Except that Q is paid not for sales, but for access to the network: the vendor "outsources" sales to the network, it is not required to hire salespeople, and so on. The network creator gets rewarded for creating the network, just as with Auger or Golem, for example. Let us mention that Eqns. (1) and (2) do not capture all transaction fees associated with the sale. With Ethereum-based tokens, for example, each user needs a wallet to transact in such a token, and transaction fees are paid to the Ethereum blockchain miner of the block containing the user's smart contract. These transaction fees are paid in ETH (Ethereum 2018) and used to be small, even recently (Young 2017). However, the cryptocurrency prices have skyrocketed lately, and so have the fees, including for ETH (see BitInfoCharts 2018, for example). One issue with rapidly rising absolute (as opposed to relative to the ETH price) transaction fees is their adverse effects on the viability of micropayments using Ethereum.

Increasing transaction fees, so long as they remain within reason, albeit unpleasant, do not affect big-ticket data sales (e.g., a datafeed that costs $100,000/yr). But they can adversely affect small deals requiring micropayments. This includes pay-per-use cases such as access to blogs or research reports, which can be valuable to a number of users provided that they are reasonably priced (with monetization through volume rather than high margins). Being able to make micropayments without incurring prohibitive transaction costs is paramount to such uses.

Are networks such as Ethereum going to adjust to the changing reality (cryptocurrency prices skyrocketing) and change the transaction fee structure? It is unclear how realistic this is, considering that micropayments are not the biggest sources of revenues for the miners. There are efforts to fill this niche, for example, µRaiden (MicroRaiden), which specializes in micropayments on the Ethereum network (Silver 2017). Unsurprisingly, this is an "off-blockchain" solution. In this regard, a Data Mall network creator may as well consider implementing its own solution. In fact, one may further argue that the entire blockchain solution can be implemented organically as opposed to using a network such as Ethereum. We can take this line of reasoning further and consider an organic blockchain solution with no mining: all transactions are verified by a central authority (the network creator), thereby completely eliminating transaction fees in P2P or B2B (business-to-business) payments. Micropayments are then no less viable than large payments. The network creator's efforts are compensated via the fees collected from vendors (see Equation [2]). Thus, one solution is to have two tokens: Ethereum-based "class A" for liquidity, and internal "class B" for transactions. The "class B" token need not be blockchain-based. It can be maintained in any database by the central authority.

Would this not defy the purpose of blockchain—decentralization—in the first instance? This is not an "ideological" question, but a pragmatic one (many cryptocurrencies/coins/tokens are not mined—see Supplemental Materials, Table S1). To the network creator, the appeal of the blockchain technology is mainly in that it does not have to reinvent the wheel and can use an open source solution as opposed to building its own ledger from scratch. For the users (both the vendors and the data consumers) it is not important that the transactions are mined—so long as the accounting is done right, it does not really matter whether it is done by miners or in a centralized fashion. In the context of a Data Mall, the users simply want a solution with lower costs. Blockchain can still play a sizable role from the users' perspective (as opposed to that of the network creator) in this essentially "hybrid" approach: i) it provides a backbone for a decentralized Data Mall; and ii) it can record all transactions for transparency (without mining).

We emphasize that the "hybrid" approach we discuss above is not confined only to Data Malls, but can have much broader applicability to other types of networks. Also, blockchain is not the only available approach and others have both been proposed and implemented. Ripple, for instance, is not based on blockchain; instead, it is a consensus based payment protocol (see, e.g., Armknecht et al. 2015). We already mentioned the IOTA Foundation's Tangle technology above. There are other alternative technologies as well: Hashgraph (more centralized but also reportedly more scalable than blockchain), (Baird 2016), the Ceptr project (P2P Foundation 2017), etc. A pragmatic approach to a given problem should dictate a solution; it is not an ideology.

DATA PROVENANCE

Data provenance/validation is one of the contemplated applications of blockchain (see Supplemental Materials, Note 3). In this context, not all data can be treated on the same footing. Generally, when discussing large datasets, as we have alluded to previously, it would be incorrect to assume that such datasets are stored in blockchain, as this is simply impracticable. Furthermore, a P2P, or even a B2B, network is simply not suited for validating many types of datasets in the first instance. Consider financial data, such as intraday tick data from the New York Stock Exchange. This dataset is large. Furthermore, the data is not something an average user can validate. There can be issues with this dataset as provided by a vendor or the exchange itself because errors can and do occur, without any malice or ill-intention on any actor's part. Depending on the type of error, it may or may not be corrected, and such a correction usually occurs at the institutional level. More generally, data vendors retroactively do correct errors in datasets and this is a well-known issue in quantitative trading, for example, where such retroactive corrections introduce "in-sampleness" into historical data. Thus, a quantitative researcher attempting to backtest a strategy may be working with different data than what would be available at the time the trading took place historically, and this can introduce biases into the backtest that are not even measurable. Usually such biases are small and one just lives with them. *Así es la vida.* It would be utterly impractical to put such a process on blockchain.

However, there are cases where blockchain could play a role in data provenance. In this regard, it is important to take a pragmatic approach and accept as a fact of life that populating blockchain with large data is impracticable. What is practicable is to place some much smaller metadata on blockchain. This metadata can describe the changes made to the data. Wiki databases are viable examples of this application. Such databases can contain large amounts of data and it is impracticable to put it all on blockchain. Nor is there any pressing need to do so from a pragmatic viewpoint. However, recording the history/metadata associated with edits to such a wiki database can very well be practicable (assuming the recorded data is reasonably concise). The history of Wikipedia entry edits could possibly be recorded on blockchain, for example. In fact, Everipedia is planning to convert to EOS blockchain, which will store not all of the information, but will encompass the lighter data, while using the Interplanetary File System (IPFS) for storing data-heavy files such as images and videos (Del Castillo 2017; Hertig 2017; Rubin 2017; Stanley 2017).

This kind of approach, which in principle is practicable, can be applied to other types of networks, including Data Malls. Whether using IPFS is required would depend on a given situation: notwithstanding the hype, there is nothing intrinsically wrong with private entities storing their data on secure servers, properly backed up, with failover protocols in place, and so forth. Not everything needs to be decentralized. Pragmatic considerations should be the guide in this.

Everipedia, which is Wikipedia's main competitor, will use its own token called "IQ" for payments on its network. IQ will be used to incentivize content creation and it will be minable: it will be mined by editors, curators, and others, by making accurate, valuable contributions to "the encyclopedia of everything," as Everipedia refers to itself. This too is a Coin Economy.

KEYLESS PAYMENTS

With a proliferation of cryptocurrencies and tokens, things got a bit "messier" than before. If one wishes to transfer, say, BTC (or any other cryptocurrency or token) to another person or entity, one needs to know the recipient's virtually-impossible-to-remember BTC address. This very issue—conceptually, that is—existed well before cryptocurrencies: bank account numbers are also not something people carry in their memory. PayPal has a simple solution: A PayPal account is linked to an email address and bank account numbers are stored internally, so sending money to any user with a PayPal account requires knowing only the recipient's email address.

The Venmo mobile app is similar to PayPal. (Venmo was first acquire by Braintree in 2012, and PayPal acquired Braintree in 2013 [Gillette 2014].) Various big banks internally provide a similar service using clearXchange/Zelle app technology (Robin 2016). Apple Pay users can send money to each other using Apple iMessage (Chowdhry 2017), Facebook Messenger users can use the app to send money via PayPal (Gajanan 2017), and so on. All of these services allow users to associate an email addresses or some other easy-to-remember ID/handle with a digital wallet that stores the required banking information (account numbers, routing numbers, etc.).

With cryptocurrencies and tokens, one also deals with digital wallets. However, there is no service similar to PayPal or others described here where all one needs is the recipient's email address or some other easy-to-remember ID/handle (see Supplemental Materials, Note 4). A mobile app providing such a service would be very convenient. Just as with PayPal, for example, users would create digital wallets, which would include their various cryptocurrency addresses (and can also include bank accounts). Each wallet would have what we refer to as a "Keyless Handle"—an email address and/or some other easy-to-remember ID/handle—associated with it. Sending cryptocurrency (or fiat money) would require only knowing the recipient's Keyless Handle. This is what we refer to as "Keyless Payments." In this day and age, while a web-based service might be a plus, a mobile app would be required for Keyless Payments. This app can be a multimedia messenger and in that case, sending BTC, ETH, other cryptocurrencies, tokens, and fiat money would be as easy as sending a message. (See Supplemental Materials, Note 5.) Such a messenger may or may not be blockchain-based. In certain contexts, a blockchain-based messenger can be useful, for example, if messages must be indelibly logged for compliance purposes.

Let us emphasize that any centralized conversion service such as Keyless Payments is prone to being hacked. However, this is no different from blockchain not being an infallible solution when it comes to practical applications. Thus, while blockchain per se may be impractical to hack, the exchanges where blockchain-based cryptocurrencies are traded can be (and have been) hacked. Mt. Gox's infamous $460M disaster (McMillan 2014) is only one example of cryptocurrency exchanges being hacked. The same applies to any digital wallet, whether it contains cryptographic

Exhibit 3
A Partial List of the Areas with (potential) Blockchain Uses

Use	Some References (also see references therein)
Decentralized cryptocurrencies	See Introductory Remarks and Supplemental Materials, Note 8
Government-issued cryptocurrencies	See Introductory Remarks
Financial transactions (other than cryptocurrencies)	See Supplemental Materials, Note 9
Supply chains	See Supplemental Materials, Note 10
Social networking	See Supplemental Materials, Note 11
Business processes/management	See Supplemental Materials, Note 12
Governance	See Supplemental Materials, Note 13
Prediction markets	See Coin Economies
Voting	See (Proxy) Voting
Proxy voting	See (Proxy) Voting
Medical records	See Supplemental Materials, Note 14
Smart contracts	See Coin Economies
Data Malls	See Data Malls and Coin Economies
Data marketplaces (IoT)	See Data Malls
Shared computing	See Coin Economies
Company incorporation/ registration	See Supplemental Materials, Note 15
Copyrighted works distribution	See Supplemental Materials, Note 16
Data storage/transfer	See Supplemental Materials, Note 17
Data provenance	See Data Provenance
Decentralized Autonomous Organizations	See Supplemental Materials, Note 18

keys, bank accounts, or other sensitive information. A foolproof way of storing a cryptoasset is to deliberately forget its key. However, in that case it also becomes utterly useless. In this regard, at least conceptually, Keyless Payments would be no different from PayPal, albeit one's bank account enjoys robust protections from fraudulent activities and offers dispute resolution, among other security protections, which cryptoassets do not afford.

(PROXY) VOTING

A desire to apply blockchain to voting is natural considering its fraud-resistant nature (see Supplemental Materials, Note 6). Here we will not delve into voting in the political context. Instead, we focus on corporate (proxy) voting. It is no secret that small shareholders are effectively disenfranchised for all intents and purposes (see, e.g., Kakushadze 2015; Mourning 2007; Wilcox 2004; and Wink and O'Leary 2009), as they either do not actually vote or, if they do, it is done though a proxy vote. This archaic process, especially when a proxy ballot and a proxy statement are sent by mail is cumbersome, is not environmentally efficient in terms of paper consumption, and many small shareholders do not even bother to vote. Large shareholders—the movers and shakers—then control the company without input from the smaller shareholders, who effectively are disenfranchised, even if unintentionally.

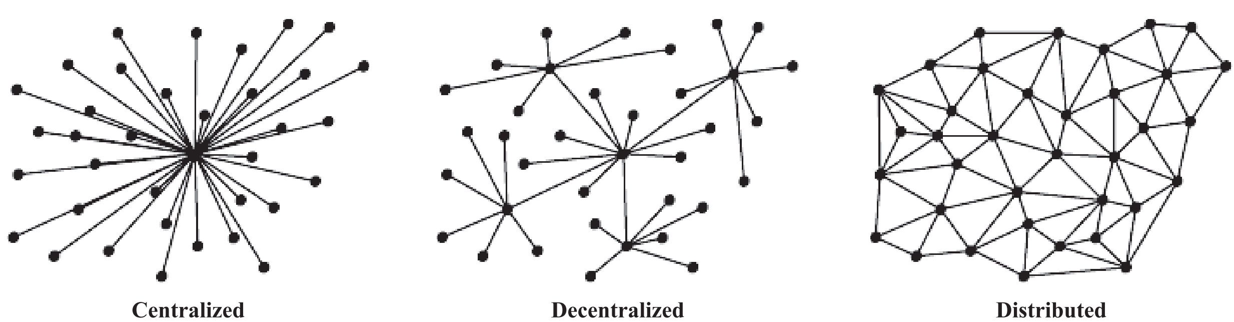
A foolproof online voting system would allow shareholders to be more engaged. This is where blockchain technology can be useful. There appears to be concrete progress made in this direction (see Supplemental Material, Note 7). This is an interesting application of blockchain technology. What remains to be seen is if it catches on. It is important to consider that without mining "many in-house blockchain solutions will be nothing more than cumbersome databases" (Hampton [2016] and Stinchcombe [2017]).

CONCLUDING REMARKS

In this commentary we discussed some applications and aspects of blockchain. Other applications have been contemplated. Exhibit 3 summarizes a partial list of areas where blockchain has been or may be implemented. Some of these applications will probably withstand the test of time, some may not. What is clear is that blockchain technology has already made a huge impact—even though some of this impact could be very transient—and is likely to continue to do so for years to come, as it appears to appeal to and excite scores of enthusiasts, entrepreneurs, both individual small investors and professional investors, technologists, scholars, futurists, and so on. Perhaps one of the reasons for blockchain's popularity is captured in by-now-iconic schematic depiction of "centralized vs. decentralized vs. distributed" (see Exhibit 4). Let us conclude with our message: Pragmatism over ideology!

EXHIBIT 4

A Schematic Depiction of "Centralized vs. Decentralized vs. Distributed"



Source: Illustration courtesy of Wikimedia, https://upload.wikimedia.org/wikipedia/commons/b/ba/Centralised-decentralised-distributed.png.

REFERENCES

Armknecht, F., G. O. Karame, A. Mandal, F. Youssef, and E. Zenner. 2015. "Ripple: Overview and Outlook." In *Trust and Trustworthy Computing*, edited by Conti, M., M. Schunter and I. Askoxylakis. Lecture Notes in Computer Science, 9229, 163–180. Cham, Switzerland: Springer.

Baird, L.C., III. 2016. "The Swirlds Hashgraph Consensus Algorithm: Fair, Fast, Byzantine Fault Tolerance." *Swirlds, Inc. Technical Report SWIRLDS-TR-2016-01.* http://leemon.com/papers/2016b.pdf.

Bang-Jensen, J., and G. Z. Gutin. 2009. *Digraphs: Theory, Algorithms and Applications,* 3rd ed. London, UK: Springer-Verlag.

Bariviera, A. F. 2017. "The Inefficiency of Bitcoin Revisited: A Dynamic Approach." *Economics Letters* 161:1–4.

BitInfoCharts. 2018. "Ethereum Average Transaction Fee Historical Chart." https://bitinfocharts.com/comparison/ethereum-transactionfees.html.

Chowdhry, A. 2017. "How to Use Apple Pay Cash." *Forbes,* December 19, 2017. https://www.forbes.com/sites/amitchowdhry/2017/12/19/how-to-use-apple-pay-cash/#4b0d2821c1fb.

Cohen, G. 2005. *The Bible of Options Strategies: The Definitive Guide for Practical Trading Strategies.* Upper Saddle River, NJ: Financial Times Prentice Hall.

Del Castillo, M. 2017. "Encyclopedia Blockchainica: Wikipedia Co-Founder to Disrupt His Own Creation." *CoinDesk*, December 6, 2017. https://www.coindesk.com/encyclopedia-blockchainica-wikipedia-co-founder-disrupt-creation/.

Ethereum. 2018. "Create Your Own Crypto-Currency with Ethereum." https://www.ethereum.org/token.

Figlewski, S., N. K. Chidambaran, and S. Kaplan. 1993. "Evaluating the Performance of the Protective Put Strategy." *Financial Analysts Journal* 49(4): 46–56.

Gajanan, M. 2017. "PayPal Now Lets You Use Facebook Messenger to Send and Receive Money." *Fortune,* October 20, 2017. http://fortune.com/2017/10/20/facebook-messenger-paypal-send-money/.

Gillette, F. 2014. "Cash Is for Losers!" *Bloomberg,* November 21, 2014. https://www.bloomberg.com/news/articles/2014-11-20/mobile-payment-startup-venmo-is-killing-cash.

Hampton, N. 2016. "Understanding the Blockchain Hype: Why Much of It Is Nothing More Than Snake Oil and Spin." *Computerworld,* September 5, 2016. https://www.computerworld.com.au/article/606253/understanding-blockchain-hype-why-much-it-nothing-more-than-snake-oil-spin/.

Hertig, A. 2017. "Ethereum Meets Zcash? Why IPFS Plans a Multi-Blockchain Browser." *CoinDesk*, April 29, 2017. https://www.coindesk.com/ethereum-meets-zcash-why-ipfs-plans-a-multi-blockchain-browser/.

Hull, J. C. 2012. *Options, Futures and Other Derivatives.* Upper Saddle River, NJ: Prentice Hall.

Informatica. 2011. "Big Data Mall Opens On The Informatica Marketplace." *Informatica.com*, June 6, 2011. https://www.informatica.com/about-us/news/news-releases/2011/06/20110606-big-data-mall-opens-on-the-informatica-marketplace.html#fbid=K0-xv9-EHUV.

insideBIGDATA. 2017. "What's in a Name? Data Lakes and 'Bazaars.'" *Inside Big Data*, December 5, 2017. https://insidebigdata.com/2017/12/05/whats-name-data-lakes-bazaars/.

Kakushadze, Z. 2015. "On Origins of Alpha." *Hedge Fund Journal* 108:47–50.

Kakushadze, Z., and J. K. S. Liew. 2017. "CryptoRuble: From Russia with Love." *Risk,* January 2018.

Kostakis, V., and C. Giotitsas. 2014. "The (A)Political Economy of Bitcoin." *tripleC: Communication, Capitalism & Critique. Open Access Journal for a Global Sustainable Information Society* 12 (2): 431–440.

McMillan, R. 2014. "The Inside Story of Mt. Gox, Bitcoin's $460 Million Disaster." *Wired,* March 3, 2014. https://www.wired.com/2014/03/bitcoin-exchange/.

Mourning, J. R. 2007. "The Majority-Voting Movement: Curtailing Shareholder Disenfranchisement in Corporate Director Elections." *Washington University Law Review* 85 (5): 1143–1194.

Nadarajah, S., and J. Chu. 2017. "On the inefficiency of Bitcoin." *Economics Letters* 150:6–9.

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

P2P Foundation. 2017. "Ceptr." *P2P Foundation Wiki*. Available online: http://wiki.p2pfoundation.net/Ceptr.

Ponciano, J. 2017. "IOTA Foundation Launches Data Marketplace for 'Internet-of-Things' Industry." *Forbes,* November 28, 2017. https://www.forbes.com/sites/jonathanponciano/2017/11/28/iota-foundation-launches-data-marketplace-for-internet-of-things-research/#26e028bbf52b.

Ramakrishnan, R., B. Sridharan, J. R. Douceur, P. Kasturi, B. Krishnamachari-Sampath, K. Krishnamoorthy, P. Li, M. Manu, S. Michaylov, R. Ramos, N. Sharman, A. Xu, Y. Barakat, C. Douglas, R. Draves, S. S. Naidu, S. Shastry, A. Sikaria, S. Sun, and R. Venkatesan. 2017. "Azure Data Lake Store: A Hyperscale Distributed File Service for Big Data Analytics." In: *Proceedings of the 2017 ACM International Conference on Management of Data (SIGMOD'17).* (New York, NY: ACM), 51–63.

Robin, S. 2016. "America's Biggest Banks Have a New Name for Their Venmo-Killer: Zelle." *The Wall Street Journal*, August 24, 2016. https://www.wsj.com/articles/americas-biggest-banks-have-a-new-name-for-their-venmo-killer-zelle-1472047872.

Rubin, P. 2017. "The Wikipedia Competitor that's Harnessing Blockchain for Epistemological Supremacy." *Wired*, December 6, 2017. https://www.wired.com/story/everipedia-blockchain/.

Schiener, D. 2017. "IOTA's Data Marketplace: Setting the Record Straight." https://blog.iota.org/iotas-data-marketplace-setting-the-record-straight-576fbf0b4513.

Silver, A. 2017. "Loose-Change Payment Network Microraiden Launches on Ethereum." *The Register*, December 1, 2017. https://www.theregister.co.uk/2017/12/01/micropayment_transaction_scaling_solution_microraiden_comes_to_ethereum/.

Sønstebø, D. 2017. "IOTA Data Marketplace." https://blog.iota.org/iota-data-marketplace-cb6be463ac7f.

Stanley, A. 2017. "EOS: Unpacking the Big Promises Behind a Possible Blockchain Contender." *CoinDesk*, June 25, 2017. https://www.coindesk.com/eos-unpacking-the-big-promises-behind-a-possible-blockchain-contender/.

Stinchcombe, K. 2017. "Ten Years In, Nobody Has Come Up with a Use for Blockchain." *Hackernoon*, December 22, 2017. https://hackernoon.com/ten-years-in-nobody-has-come-up-with-a-use-case-for-blockchain-ee98c180100.

Urquhart, A. 2016. "The Inefficiency of Bitcoin." *Economics Letters* 148:80–82.

Vranken, H. 2017. "Sustainability of Bitcoin and Blockchains." *Current Opinion in Environmental Sustainability* 28:1–9.

Wilcox, J. C. 2004. "Shareholder Nominations of Corporate Directors: Unintended Consequences and the Case for Reform of the U.S. Proxy System." Chapter 6 in Shareholder Access to the Corporate Ballot, edited by Bebchuk, L.A. Cambridge, MA: Harvard University Press.

Wink, S. P., and M. O'Leary. 2009. "The Unintended Disenfranchisement of Shareholders (How Certain Everyday Practices of Broker-Dealers Have Detrimental Consequences for Shareholders)." *Bloomberg Corporate Law Journal* 4 (1): 214–222.

Xie, L. 2017. "A Beginner's Guide to Ethereum Tokens." *The Coinbase Blog*, May 22, 2017. https://blog.coinbase.com/a-beginners-guide-to-ethereum-tokens-fbd5611fe30b.

Young, J. 2017. "$44 Million in Ethereum Moved with $0.13 Fee, How Can Bitcoin Reach Similar Scalability?" *CoinJournal,* August 23, 2017. https://coinjournal.net/44-million-ethereum-moved-0-13-fee-can-bitcoin-reach-similar-scalability/.