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Thinking Outside the Block: Projected Phases of Blockchain Integration in the Accounting Industry

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This paper aims to propound a thorough and circumspect analysis of the implications of blockchain technology in the accounting profession and its broader industry. The analysis begins with a summary of early developments by first movers and how they are harnessing blockchain technology to improve business practices. Concomitantly, the paper will go on to discuss how this technology will streamline accounting processes, specifically as the technology approaches critical mass. Finally, a discussion of its long-term implications will follow through a more philosophical and conceptual dialogue. Throughout the paper, criticisms will be raised to address concerns regarding blockchain's widespread use.

At first glance, the future of blockchain in the accounting industry appears rather paradoxical; due to the system's self-auditing capabilities and immutable nature, blockchain's evolution seems to have the potential to eliminate the accounting profession altogether. However, adopting a more pragmatic outlook can help to elucidate the profound and beneficial impacts the technology will have on innovation across the industry. By studying the current developments underway at major incumbent firms, insights are revealed about blockchain's present uses and how accounting firms are responding to its disruption. Dominant market players such as PwC, Deloitte, EY and KPMG have already begun exploring how to introduce this nascent technology into their business practices. PwC, for example, is using blockchain as a platform to develop digital assets as part of its global client services while Deloitte is exploring blockchain's potential to improve supply chain efficiency. Similarly, EY is also making a unique impact through its experimentation with editable blockchains and, commensurately, KPMG has partnered with Microsoft to provide Blockchain as a Service (BaaS). There have also been discussions vis-à-vis the formation of a blockchain consortium for key industry players to collaborate, coalesce ideas, address emerging concerns and examine potential opportunities associated with the technology's proliferation. Nevertheless, early adopters raise concerns over absent regulatory standards and future technological obsolescence. These emerging fears, however, are being allayed by the ongoing support expressed for the technology by regulatory bodies and governments, as well as the ongoing standardisation efforts across the industry.

As blockchain nears mainstream adoption, the technology can be used to streamline many redundant and vulnerable accounting practices. Most notably, blockchain creates an opportunity for triple-entry accounting, whereby the system automatically confirms the debit/credit entries recorded by each party in a transaction to ensure bookkeeping reliability. Smart contracts also play a crucial role in expediting the recording process by instantaneously updating account information and tracking supply chains via real-time analytics. Additionally, the technology eliminates the need to record taxes retroactively, thereby providing an automated platform impenetrable to many types of tax fraud. While developing and integrating blockchain infrastructure may be costly initially, this can be offset by the cost savings resulting from the long-term, improved efficiency that it yields for corporations. The 2013 stock crisis faced by Dole Food Company Incorporated demonstrates how coupling blockchain's unique capabilities can help overcome traditional problems facing the accounting and finance industries. Nonetheless, blockchain's expansion comes with some barriers, bringing into question issues surrounding cybersecurity and scalability. One method for remedying security concerns on the public blockchain is homomorphic encryption (a controlled approach that allows only designated persons to decrypt information on the blockchain).

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Scalability concerns can be assuaged by outsourcing some of blockchain's computational calculations and limiting what information is recorded to the blocks.

In returning to the broad issues of long-term industry growth or decline, a philosophical analysis of the technology's applications illustrates the innumerable unanswered questions that remain about the uncertain relationship between accounting and blockchain. This portion of the paper discusses the job market impacts (via job creation and job obsolescence) as well as the new skills that accountants will be required to develop alongside the technology's proliferation. Additionally, a discussion still needs to be had regarding blockchain's governance, particularly in times of crisis or ethical quandary. Finally, the juxtaposition of financial sector lobbyists aiming to limit blockchain's capabilities contrasted by first movers piloting blockchain technology further highlights the volatility of blockchain's rapid evolution.

Phase One: Early Adoption (Present)

Overview of technological developments by major accounting firms

A look at the recent blockchain developments by the Big 4 accounting firms (PwC, Deloitte, EY and KPMG) highlights the technology's undoubtedly disruptive nature. PwC is concurrently testing different blockchain technologies and advising clients on their various uses. Most notably, PwC Australia is working in concert with Netki, Bloq and Libra to create Vulcan, a 'multi-asset' blockchain platform that develops interoperable digital assets to be traded with popular cryptocurrencies (Miles 2017). Although currently only a proof-of-concept, PwC hopes to eventually provide Vulcan as a subscription service and increase its features to provide wallet services (allowing users to hold various types of cryptocurrencies) (Rizzo 2016a). The co-founder of Bloq, Matt Roszak, said that there have even been discussions with a central bank to use the Vulcan platform commercially (Rizzo 2016a). Vulcan, however, is not PwC's only attempt at harnessing the blockchain technology. Prior to this, the company engaged in a partnership with Blockstream to provide blockchain services to firms worldwide (Rizzo 2016b). In January 2016, one of PwC's UK offices formed a team of 15 blockchain experts to pioneer the technology. The firm also stated that it intends to expand this number to 40 members, further underlining its commitment to blockchain development (PwC UK 2016). Currently, PwC is also working alongside BitSE to facilitate blockchain integration in the Asia-Pacific market (Ji 2016). These developments illustrate PwC's adoption of a global mindset; rather than concentrating development in one area of the world, PwC is leveraging its global resources to pool talent, monitor responsiveness to the technology and uncover diverse applications for its use across international markets.

Deloitte has also been an aggressive player in internal blockchain development. Like Vulcan, Deloitte started working on its own blockchain in 2014. Its most recognisable platform, Rubix, was created to simplify and speed up the auditing process of blockchain transactions. While Vulcan focused primarily on reuniting Bitcoin (and other established digital fiat currencies) with its blockchain to improve banking, Deloitte is leveraging the applications of blockchains in supply chain management. Specifically, one of the Rubix pilot initiatives tracked a pharmaceutical supply chain for issues regarding safety, product channels and end-consumer issues (Miles 2017). However, to date, the firm has created over 30 prototypes and pilot projects to address issues relating to digital identity and trade, international transactions and banking, and management of loyalty and rewards programs. Deloitte has over 800 employees spanning 20 countries working on blockchain development (Faile 2017). Its Ireland division opened the firm's first blockchain lab in May 2016 and as of January 2017, the professional service company opened a second facility in New York to develop 'ready-to-integrate' blockchains (Faile 2017). These developments highlight Deloitte's commitment to organisation-wide digital transformation. The firm evidently understands the first mover advantages of integrating blockchain technology in its provisioning of client services.

EY has adopted a differentiated approach by experimenting with editable blockchains through a partnership with Accenture. To respond to mistakes and emergencies, Accenture posits that piloting permissioned blockchains that allow for modification can be very useful in combatting unpredictable, real-world events (Redman 2016). Some critics argue that this challenges the very essence of blockchain's decentralised and immutable nature. Nevertheless, even controversial platforms can give rise to new discoveries and diverse perspectives. EY and Accenture's curiosity and risk-taking approach has the potential to uncover many unexplored opportunities and threats to blockchain technologies. EY also announced a six-week long challenge in 2016 for several selected start-ups (BlockVerify, BTL Group, Tallysticks, Adjoint, JAAK and Bitfury) to focus blockchain development in understudied markets and industries, particularly focusing on its applications in the entertainment industry and energy sectors (EY UK 2016). By February 2017, EY unveiled that it will be releasing an identity management blockchain equipped with Know-Your-Customer (KYC) provisions for an Australian client (Keane 2017). These ongoing variegated initiatives accentuate the company's open-minded and abstract approach to blockchain development.

Following suit via its strategic partnership with Microsoft, KPMG has introduced Digital Ledger Services to advise clients on how blockchain can help improve transactional speed and security, cut costs and digitise back-office operations (KPMG LLP 2017). The partnership will do this by providing 'lifecycle support'. This means that from the point of integration, KPMG will help client companies manage their installed blockchain infrastructure (KPMG LLP 2017). Most notably, in February 2017, the partners released Blockchain Nodes: 'Innovation workspaces' that create and simulate cases for blockchain use. The first labs were opened in Frankfurt and Singapore with a location expected to soon open in New York. Blockchain Nodes are backed by Microsoft's Azure cloud platform which the company has been using to provide Blockchain as a Service (BaaS) (Miller and Settles 2017). KPMG's partnership with a leading technology company highlights the importance of early blockchain research.

There is a recurring pattern among all four of these firms: 1) each company acknowledges the disruptive nature of blockchain and is exploring the technology's countless applications and 2) the firms are piloting private, public and permissioned blockchain technologies to better adapt to client needs. The latter point is quite important because it illustrates that firms are gravitating away from the Bitcoin–blockchain association and being responsive to the capabilities of private and permissioned ledgers as well. Consequently, this mutual respect for the technology has led these firms (along with other important industry players like Grant Thorton, the American Institute of CPAs and XBRL US) to consider forming a blockchain consortium for the accounting industry (Del Castillo 2016a). In August 2016, an event was hosted by ConsenSys with a focus on the Ethereum platform and how it can reshape the accounting profession. Balanc3 also provided a discussion on smart contracts and triple-entry accounting (Del Castillo 2016a). It is clear that these pilot projects, partnerships and alliances reflect the growing impact blockchain is already having on the accounting industry.

Arguments against early adoption

When critics allege that blockchain integration suffers from regulatory issues, they are most often referring to two distinct arguments: 1) there is a lack of regulatory standards for interoperability; and 2) regulators themselves will not consider the technology secure enough for widespread use. To address the first point, in February 2017, a coalition of global corporations spanning across diverse industries (including financial, technology, and oil and gas sectors) was created to productise an enterprise-grade Ethereum blockchain (Del Castillo 2017b). As CoinDesk writes, the main purpose of the Enterprise Ethereum Alliance is to create a 'series of standards for Ethereum in the form of best practices, security, privacy, scalability and interoperability' (Del Castillo 2017b). In itself, using the same platform across numerous industries makes creating and policing regulations much simpler. It also makes managing exchanges through interorganisational systems and electronic data interchanges less complicated for regulatory bodies. The Enterprise Ethereum Alliance also has two other important objectives. First, it seeks to simplify compliance with industry regulations while simultaneously improving transaction speed and volume. Second, the alliance is integrating new governance and accountability models. One such model involves creating a board of directors to help oversee the networks (Del Castillo 2017b). The Enterprise Ethereum Alliance illustrates that steps are being taken to facilitate interoperability and ensure uniformity of regulations across industries.

The second criticism (that regulators will not approve of the technology) appears self-defeating and contradictory given that a number of regulatory bodies are already striving to harness the technology. Back in 2015, the Isle of Man Government was one of the first jurisdictions to create a regulatory framework for digital currencies, blockchain auditing, anti-money laundering and KYC services (ICAEW 2016). In 2016, Dubai released a statement saying that it wanted to be the first government to operate on blockchain. In fact, the city wants to transfer all government documents onto blockchain by 2020 (Rizzo 2017). In a more recent example, as of March 2017, the state of Delaware said that it is drafting a new law that would recognise blockchain records (Keirns 2017). Seeing the many initiatives undertaken by the public sector to integrate blockchain technology proves that this argument does little to tarnish the technology's early success. To agree with the blockchain skeptic would be paralogising these findings.

A much stronger criticism exists, however, with respect to early technological obsolescence and organisation-wide integration. It is reasonable to assume that current models could become outdated and that installing upgrades could prove difficult. Likewise, with so many different pilot solutions available, eventually integrating these systems among organisations may be quite challenging. These concerns are just some of the many unavoidable growing pains of technological advancement. Notwithstanding, there are still ways to mitigate some of these unwanted by-products, especially when considering some of the previously discussed initiatives already underway. While integration issues are unique to a firm, industry-wide standardisation can be facilitated by blockchain alliances and associations. For example, following through with a blockchain consortium specifically for the accounting industry (like R3 in the finance industry) would help support the creation of compatible and uniform blockchain platforms. Furthermore, Accenture, Microsoft and ConsenSys

(which are involved with blockchain development at the Big 4) are also part of the Enterprise Ethereum Alliance (Del Castillo 2017b). Given that global organisations, incumbent firms and start-up companies are building the technology together, this will ensure consistency and compatibility across the industry. These alliances give firms the opportunity to collaborate, brainstorm ideas and develop the best strategies for implementation.

It is also noteworthy to mention that this previous critique does not discredit the usefulness of blockchain at its current stages of development; it only suggests that building upon the current models might be challenging. As a result, this does not prevent companies from reaping the rewards of their existing platforms. Despite emerging regulatory issues, threats of early obsolescence and possible integration concerns, it can be concluded that the benefits of the first mover advantage far exceed the risks.

Phase Two: Approaching Mainstream Adoption – Critical Mass in Three to Five Years

Streamlining internal accounting practices and processes

Most of the discussion thus far has been about employing blockchain to improve client services, but blockchain's applications extend to even greater uses in internal accounting management. The Pareto principle implies that 80% of organisational problems can be resolved by streamlining processes and 20% of these solutions are a result of disruptive technologies (Boomer 2016). Therefore, there are a plethora of ways in which blockchain can remove Rube Goldberg (unnecessarily complicated) processes, specifically in areas of tax and assurance (Boomer 2016). The most obvious change involves a shift from double-entry accounting to a triple-entry accounting system. The current bookkeeping method creates an agency problem for accountants. There is a conflict of interest between maximising management's objectives and providing reliable information to the public for decision making (Andersen 2016). Blockchain ensures faithful representation and minimises any room for biased professional judgement by accountants because it adds an additional real-time dimension in which to track entries. While the current double-entry approach requires a party to log a debit and a credit in the company's books, blockchain has the seller/service provider log a debit and the purchaser log a credit (Watson and Mishler 2017). This creates a subsequent movement away from third party trust to a new algorithmic trust, whereby a self-auditing third entry is cryptographically secured by the blockchain platform. Thus, blockchain becomes a congruent and perfectly matched record of transactions. Two well-known start-ups for creating this triple-entry software are Balanc3 and TriplEntry (Bradbury 2015; Wunsche 2016).

The real-time capabilities of blockchain platforms are especially important for assurance providers, advisors and organisational stakeholders. Being able to see entries as they occur ensures integrity and transparency for everyone involved. While this is useful for producing financial statements and reports, having entries recorded in real time also has major implications for productivity and business analytics (Watson and Mishler 2017). Specifically, blockchain creates a new lens for objectively studying a company's performance which is important for both financial and managerial accountants. Being able to track historical data with such accuracy and efficiency helps to paint a clearer picture of a company's financial standing and overall performance. Real-time entries can also help draw attention to hidden accounts and minute details that may have otherwise been overlooked (Tapscott and Tapscott 2016). Accountants can convert these up-to-date figures into useful information for management regarding wasted resources, redundant practices and bottleneck processes that might be hindering performance. The real-time element of the blockchain allows accountants to focus on this kind of value-added work by significantly reducing the time needed to verify a company's accounting entries.

Although this system can still be subject to human error, the overall risk of making incorrect entries is significantly reduced because the transactions are logged by both parties, time-stamped and verified via decentralisation (in the case of a public blockchain). Theoretically, this makes transactions immutable and 'cooking the books' nearly impossible. Furthermore, using present-day methods, assurance providers can generally only audit a small fraction of a corporation's transactions. However, with blockchain, the scope of auditing drastically increases since the audit trail becomes more aggregated and accessible to accountants and other regulators. As such, this will improve auditors' chances of uncovering fraudulent activity (Bradbury 2015). However, given the system's self-auditing nature, this begs the question: Would auditors still be responsible for confirming the authenticity of transactions, or would their role change to audit the system itself? In any case, accountants will need to acquire new skills and hone existing competencies in order to adapt to the industry's dynamic and rapidly changing technological landscape.

Another way blockchain can be used to facilitate efficient practices is through smart contracts. These contracts are self-executing, programmed codes within the blockchain that act in response to a set of conditions. However, this feature of the technology is not limited to legal and managerial implications. It can replace virtually any task that can be automated, including administrative, operational and performance reviewing functions.

This will automatically update accounts, help to confirm whether goals are being met and quicken the preparation of internal and external reports (Wunsche 2016). A common developer of this self-executing software is Ethereum (Wunsche 2016). Supply chain management also becomes simplified with blockchain. The status of raw materials, work-in-process and finished goods becomes more traceable, more accurate and less time-consuming for the accountant to consolidate. The most well-known trailblazer for supply chain management using blockchain technology is Provenance (Wunsche 2016). Smart contracts, supply chain management and real-time analytics work in unison to automate parts of the monthly consolidation process for sustainability and financial reporting. As a result, these features allow accountants to free up more time to interpret information and provide consultations to clients for decision making.

Blockchain also has the power to automate taxation. Using current accounting principles, revenue recognition and tax allocation are done retrospectively. However, blockchain technology has the potential to record each of those instantaneously, in real time. This, in turn, considerably reduces the risk of tax evasion and reporting errors. It also lowers the cost of tax compliance for many firms and regulatory bodies. For example, blockchain can help relieve the duplication of data that government institutions experience with payroll taxes (Frankowski et al. 2017). Each institution has its own register of information, so blockchain's disintermediation could remove the need for employers to calculate and transfer taxes and social security payments from their employees' salaries to these organisations (Frankowski et al. 2017). Coupling the real-time features of blockchain with smart contracts to ensure anti-money laundering (AML) compliance would also make firms less likely to engage in illicit tax practices (Bauerle 2017). There would be more transparency, making it easier for regulators to expose companies engaging in tax fraud.

Specifically, blockchain could reduce value-added tax (VAT) fraud by automatically calculating and paying the VAT portion of an invoice to the tax authority via smart contract technology. Accordingly, the taxpayer would no longer need to deal with calculating the VAT on their tax return since it would be automatically calculated in real time (Frankowski et al. 2017). Blockchain, therefore, makes this process more convenient and faithful for all parties involved. Furthermore, blockchain specifically has the potential to reduce missing trader intra-community fraud (MTIC) and missing trader extra-community fraud (MTEC). The former can only occur in the EU and takes place when one party sells to a second party *excluding* VAT, after which the second party sells to a third party *including* VAT, and then finally the second party disappears thereby avoiding their tax remittance obligations (Frankowski et al. 2017). The latter fraud occurs in the same way, but it involves non-member states of the EU as well. These particular types of tax fraud can be mitigated using blockchain technology. Blockchain can also improve initiatives currently underway such as DICE (the Digital Invoice Customs Exchange) which intends to encrypt digital signatures and other invoice details onto databases that perform risk assessments and confirm transactions (Frankowski et al. 2017). Blockchain can improve this process by offering a single platform that would confirm trades using consensus mechanisms. Additionally, blockchain offers a decentralised solution in contrast to the existing, centralised taxation models. It also creates an opportunity to perform risk analysis and record entries in real time (Frankowski et al. 2017). The UK Government's Chief Scientific Advisor already proposed that blockchain technology be integrated to automatically calculate VAT/goods and services taxes (GST) (Cudahy 2016). By automating these calculations, transactions become less prone to fraud and CPAs and other members of the accounting profession will be able to focus their attention on more value-added work.

These various features of blockchain technology can significantly ameliorate how companies transact. However, accountants will need to familiarise themselves with the new ways in which asset and liability accounts will be presented. Cash and capital asset accounts would benefit by eliminating the need for reconciliation (Wunsche 2016). Since third party records would now be digitised in real time, firms would not have to wait for their transactions to be cleared or balanced by an intermediary. Additional ledgers can also be set up to track repair and maintenance expenditures to capital assets, which can be cited in insurance clauses (Wunsche 2016). To take this a step further, capital asset accounts could integrate smart contracts to regularly depreciate equipment in order to keep the net book value up-to-date. Likewise, accounts receivable/payable, intangible assets, inventory accounts, and long-term and short-term loans will also be redefined by blockchain. Smart contracts could be set up to automatically transfer funds/assets based on commands inputted by users of the software or conditions stipulated in receipts, royalty contracts and payment schedules (Wunsche 2016). Interest payments could also be managed more effectively using smart contracts and additional ledger accounts (Wunsche 2016).

The cost savings resulting from blockchain are another attractive aspect of the technology. Accounting, auditing and compliance costs can be very expensive for firms. Since 2009, the US banking sector alone has paid $200 billion in fines for improperly meeting accounting requirements and standards (Luger and Waddell 2017). With blockchain, these errors and inconsistencies could be dramatically lessened because all the transactions would be recorded into the system automatically, in real time. Tax compliance costs would also be significantly

reduced because the taxation process could be automated via blockchain. How blockchain would meet the Dodd-Frank Wall Street and Consumer Protection Act encapsulates this point quite well. In 2016, analysts announced that industrywide Dodd-Frank compliance could cost up to $10 billion (Wager 2016). Furthermore, according to a 2014 study by the American Action Forum, firms spent $3.6 billion on 'swap data' recordkeeping (Wager 2016). Blockchain, however, would make these expenses unnecessary. These costs could all be avoided by using a decentralised ledger to share information and smart contract technology to self-execute accounting policies.

According to EY's figures, using blockchains for distributed storage and processing (rather than relying on centralised databases) can be 90–95% cheaper (Cudahy 2016). In its 2016 report, Goldman Sachs projected that approximately $2 billion can be saved in cost reductions across banks, the DTCC and broker-dealers. Specifically, it is estimated that blockchain could decrease compensation expenses by up to $900 million (by reducing the amount of individuals needed to manually input transactions). It can save $700 million from IT improvements (by streamlining the overabundance of DTCC platforms onto a unified blockchain and expediting the settlement process by executing smart contracts). It can also retain $500 million in economic savings (due to the reduction in clearing costs effectuated by blockchain) (Schneider et al. 2016). Furthermore, Goldman Sachs detailed that blockchain could ameliorate AML and know-your-customer (KYC) compliance (due to its immutability) resulting in up to a $5 billion decrease in expenses that would otherwise emerge from 'suspicious' transactions (Schneider et al. 2016). Overall, regarding the clearing and settlement of cash securities (specifically as it relates to leveraged loans, repurchase agreements and equities), the company says that there could be savings as high as $12 billion from reduced fees, operating expenses and capital charges (Schneider et al. 2016). Deloitte has arrived at similar conclusions, stating that by 2022, blockchain could save the financial services industry up to $20 billion annually (White and Henry 2017).

A critic might argue that these examples suffer from a cherry picking fallacy or a hasty generalisation and that these cost savings will actually be counteracted by initial (and ongoing) investments in infrastructure. However, it is important to remember that every firm and every industry is unique. There are many factors to be considered before implementation including the size of the firm, the nature of the business, the competitive environment, choosing between internal development or Blockchain as a Service, and the capital resources available. Each company must weigh the cost against the return to decipher whether or not the technology is right for them.

Case analysis: Dole Food Company, Inc.

The accounting and finance sectors are intricately connected; so much so that delays in the financial reporting process and errors in recordkeeping and consolidation can have material impacts on the buying and selling of company stocks. The stock crisis that faced Dole Food Company Incorporated (Dole) can be studied to better understand this relationship and its relevance to blockchain. In 2013, Dole's CEO David Murdock decided to take the company private. Stockholders argued that the shares were worth more than the $13.50 that was paid out per stock. In 2015, the courts ruled that the share prices were indeed understated and that Murdock would have to pay out an additional $2.74 per share (Del Castillo 2017a). This is where the issue emerged: when 4662 shareholders filed their claims to receive the additional compensation, it was discovered that there were approximately 49 million facially valid stocks, yet Dole's accounting records only recognised about 37 million (Levine 2017).

One of the explanations for the 12 million difference between the active shares and the record of stocks was the 'chill' period instigated by the Depository Trust & Clearing Corporation (DTCC). Historically, the purpose of the DTCC has been to reduce the risks and costs of trade while improving market efficiency. The DTCC acts as a record keeper and clearing house for stocks (DTCC 2017). The problem, however, is that it takes three days to settle a trade, so during Dole's going-private merger, the DTCC 'chilled' and did not record these trades. Despite that the closing date for the acquisition was 1 November, the DTCC's centralised ledger and subsequent accounting records did not receive information regarding transactions that took place on 30 October, 31 October and 1 November (Levine 2017). Therefore, if Person A sold a share to Person B on 31 October, the DTCC still thought Person A owned the share, while the brokers of Persons A and B knew that Person B had now become the actual owner (Levine 2017). Reconciliation became challenging because now a single share was facially valid to two different people (giving the illusion of two existing shares). Although the trades could be traced retroactively to identify the true owners, allocating the settlements became a lengthy and arduous process between the DTCC, brokers and share owners involved. This delay was once used to conduct audits to prove that investors actually owned what they claimed. However, as transaction speeds increased, this practice was eradicated, leaving an outdated system for trade (Del Castillo 2017a).

The second issue responsible for the crisis had to do with the short selling of stocks. Short selling occurs when one party loans their shares to a second party. Then, the second party sells these shares to a third party, often without the first owner's knowledge (Levine 2017). When an event like this happens, it results in two

beneficial owners because the first and third parties will claim that they are entitled to the settlement. This creates 'phantom shares': the illusion that there are more stocks issued than there actually are (Del Castillo 2017a). In order to balance and reconcile this transaction, the short seller (the second party) would have to pay the first party the amount of the stock sold (or in other cases, the amount of the dividend). However, in the case of Dole, where over two years had passed, it became difficult to collect payment from the short seller for a variety of reasons. For example, the person may not have had an account with that broker anymore or the hedge funds may have been closed in the meantime (Levine 2017). On 31 October alone, 2.9 million common shares had been shorted, with many more expected to have been sold on 1 November given that the common shares were trading for higher than the merger price (Levine 2017). The Securities and Exchange Commission (SEC) inaugurated 'Regulation AB' in 2004 which stipulates that trustees must be given complete lists of stock beneficiaries, but because short selling creates two beneficial owners, this did little to mitigate the problem (Del Castillo 2017a).

The misrepresented stocks in the case highlight that although the accounting and finance sectors rely on each other, the accounting that underlies the finance sector is often failing to keep pace. Ultimately, the two are not in sync with each other. The tale of the Dole stock crisis resurfaced in February 2017 when the judge overseeing the case issued a memorandum suggesting that this problem could have been averted by using blockchain technology (Del Castillo 2017a). Blockchain could have prevented the situation in two ways. First, the current model is overcomplicated and expensive because it requires collaboration with the DTCC, custodian brokers and the affected parties. The costs to settle, engage in a formal litigation process or solicit help from the DTCC are costly for companies and raise red flags for investors. To put this into perspective, the DTCC charged a $2250 base fee to address the issue, with 'additional consultation fees if difficulties arise' (Levine 2017). In contrast, since all transactions are recorded in real time on blockchain, the traceability, speed and lower cost that the technology provides makes it a more secure and efficient alternative to solving these types of problems.

Second, the immutable aspect of blockchain would make it simple to identify the short sellers at any point in time. Cash could be collected automatically using digital currencies to avoid the risk of not being able to collect payment. Notwithstanding, even if a universal switch is not made to cryptocurrencies, blockchain still creates a transparent platform to track down the parties involved. The internet retailer, Overstock, has already launched one such blockchain platform in October 2014 called tØ, which seeks to solve the problems of the current financial trading system (Del Castillo 2017a). Blockchain has the potential to realign these two industries by overcoming the obstacles created by the DTCC and short sellers. This translates to fast, traceable and ethical transactions for investors.

Criticisms to refute

One of blockchain's main assets is its transparency. However, for many firms, this raises questions about privacy protection. To resolve this issue, it is important to draw on the distinction between private, permissioned and public blockchains. The solution for the former two is simple: control and regulate accessibility by issuing unique access keys to users of the information and restricting or enabling their roles accordingly (Wunsche 2016). In contrast, public blockchains could solve this by using one-way homomorphic encryption. This means that transactions would still be recorded in the ledger, but only authorised personnel would be able to decrypt the details (Bradbury 2015). Therefore, the public ledger continues to balance without compromising a company's privacy. This is crucial because companies would not have to expose sensitive information that could thwart their competitive advantage, yet auditors and regulators would still have easy access to important information. Blockstream is currently working on developing ways for firms to transfer transactions onto a public blockchain. Specifically, it is looking to do so through the use of sidechains (clusters of multi-blocks that allow for asset transfers) (Higgins 2014a). Factom is also developing a recordkeeping network and using notary chains to create proof-of-existence and proof-of-process layers (Higgins 2014b).

Commensurately, cybersecurity is another major concern for organisations. Although the technology should theoretically be immune to hacking and resistant to any adulteration, infiltration of the DAO (a decentralised autonomous organisation) in June 2016 proves otherwise. Owing to a vulnerability in the smart contract code underlying the program, a hacker was able to seize $50 million of the $150 million raised through crowdfunding (Siegel 2016). Despite this, the incident actually does little to discredit blockchain's security. To understand why, it is important to first make the distinction between the DAO and blockchain. The DAO is a program that runs on the Ethereum blockchain, thus blockchain is the foundation upon which the project was built. The 'recursive call bug' that resulted in the hack was a weakness in the DAO, *not* the Ethereum blockchain. In fact, the Ethereum platform, which is also comprised of smart contracts and contains more than $1 billion worth of ether (cryptocurrency), has never been hacked (Siegel 2016).

The hack actually occurred because the founders of the DAO made some avoidable mistakes. First, they did not anticipate that the crowdsale would be as successful as it

was, so the DAO stored all its ethers in a single address (Siegel 2016). This was a bad idea because it put all the funds at risk in the case of a hacking attempt. Furthermore, any smart contracts able to transfer large sums of currency should expect (and be prepared for) an attack. This vulnerability was discovered in the Maker DAO and was resolved while the program was still being piloted (Siegel 2016). This concept has become common knowledge to smart contract developers (Siegel 2016). Consequently, during the crowdsale, critics already warned that the DAO had bugs that could make it powerless to an attack (Ethereum Classic 2017). While it is understandable that technologists must often adopt a 'ready, fire, aim' approach to releasing software, these vulnerabilities should have, and could have, been identified and solved prior to the initial coin offering (ICO).

Although investing in the DAO is really no different than other real-world investments (venture capitalists assumed the risks of the DAO upon contributing their funds), blockchain still offered solutions to mitigate or completely rectify the problem. One option was a soft-fork (stopping the movement of ether) and the other a hard-fork (miners restoring all the ether by reversing the theft) (Siegel 2016). While the bug was an issue of the DAO, blockchain still provided solutions to undo the problem. At the end of the day, the issue was not 'Can the money be retrieved from the hacker?' but rather, '*Should* the money be retrieved and what is the most ethical way to respond to the hack?' Even so, other blockchain platforms (like Ethereum Classic) have since emerged with additional monetary policies, having learned from the mistakes of the DAO and how Ethereum was forced to respond (Ethereum Classic 2017).

Finally, blockchain scalability is a concern for many firms. It is necessary to reiterate that scalability is more of an issue for the public blockchain, rather than private and permissioned versions. With enterprise-grade distributed ledgers and private interorganisational blockchains, fewer nodes are involved, thus reducing the computational intensity needed to validate transactions. Storage space is also of no concern given that the current Bitcoin blockchain takes up about 118GB of disk space to download (Blockchain Luxembourg S.A. 2017). This may seem large in size for a personal computer, but for corporate use it is more manageable. The current Bitcoin blockchain grows at about one megabyte per hour. However, if Visa were to start using blockchain to process its 2000 transactions per second, growth would increase to one *giga*byte per hour. This is the equivalent of 8TB per year. Consider other large organisations moving to blockchain, and an obvious scalability issue emerges (O'Donnell 2017).

Nevertheless, there are many solutions being developed to scale the public platform. One example involves storing only the UTXO (unspent transaction output) instead of the entire blockchain history. This can be achieved by coupling data structures similar to Patricia trees with pruning techniques (James-Lubin 2015). Specifically, what is known as the OP_RETURN function can be used to identify data storage operations that can be pruned from the system (James-Lubin 2015). 'Light clients' are another option. Simply put, this means that users only store lightweight proofs of existence rather than the whole blockchain or the UTXO set (James-Lubin 2015). Sharding is another popular alternative that involves partitioning the blockchain into smaller segments. With respect to proof-of-stake algorithms, this process could involve randomly selecting a set of miners for different segments of the blockchain (James-Lubin 2015). In this case, an attacker would need to infiltrate a large portion of the system to invalidate a single shard. This process therefore requires fewer miners in the system without compromising security (James-Lubin 2015).

One important development is TrueBit by Ethereum which 'outsources the verification of computations' (Hertig 2017). TrueBit shifts the responsibility of computing smart contracts from nodes to any participant of off-blockchain computers. These users are referred to as 'solvers'. Other users, called 'validators', confirm their computations. TrueBit is trustworthy because the blockchain can reconcile the inputs by the solvers and validators to identify any discrepancies between their entries. This is what the creators call the 'verification game' and what ensures security and immutability while offloading computational intensity (Hertig 2017). The purpose of these examples is to highlight that there are many feasible solutions being tested to address blockchain's scalability issue.

Phase Three: Global Adoption – Maturity by 2025

Blockchain technology has the potential to completely reshape capital markets. At its early stages, blockchain will streamline accounting through triple-entries and smart contracts, allowing CPAs to concentrate on more value-added work. In finance, it can make transferring financial instruments much more efficient. However, in the long term, asset exchanges, global remittance networks and foreign exchanges could all be moved to blockchain through peer-to-peer lending (Bradbury 2015). Nonetheless, a widespread decentralised financial trading system has many unpredictable and far-reaching social, political and ethical implications. How will blockchain impact the job market for accounting positions? What governance models will be instigated to resolve oversight issues and ethical dilemmas? Is private sector lobbying a threat, and if so, how will it be overcome? Many aspects of blockchain's future still need to be investigated.

Blockchain can have profound effects on long-term job creation. Despite the fact that many roles will be made obsolete by the technology, jobs requiring the human element, such as performance improvement, IT risk and other advisory roles, will grow in demand. It is important that firms are adaptive and proactive in responding to these changes in market conditions. Most incumbent firms have acknowledged the disruptive capabilities of blockchain technology and are searching accordingly to turn any potential threats into opportunities. In a 2016 report by EY, the company's Global Technology Sector Leader in Tax Services, Channing Flynn, gave the example of a 'taxologist' (Cudahy 2016). This could be a future role that works alongside governments to ensure that public authorities properly account for and collect taxpayer money that is due. Similarly, Hywel Ball, the UK Head of Audit at EY, postulates that although the future role of the auditor is unclear, the role may need to be modified to audit the technology or work alongside blockchain auditors, rather than confirming particular transactions (ICAEW 2016). These forward-thinking examples are meant to showcase that firms are already preparing for an age where accounting and finance may be embedded in the blockchain.

Blockchain's decentralisation means that no one party can have control over the system. While this is useful for ensuring security and transparency, it raises questions regarding how large-scale changes to the program will be handled and who will make important ethical decisions. Revisiting the DAO incident, it is evident that blockchain technology has already experienced ethical issues. Although the Ethereum platform was able to provide solutions to undo the theft of $50 million, it forced nodes to agree on creating a 'fork' in the chain of blocks, thereby compromising the integrity of the program. The DAO originally decided on a soft-fork solution, which is a temporary divergence in the blockchain created by following new consensus rules (We Use Coins 2016). The purpose of this was to stop the thief from being able to actually claim the stolen ethers. When the fork is implemented, the nodes need to reach at least a 51% agreement on the new rules and miners need to reach a specific percentage of the network hash rate (Siegel 2016). If a consensus is reached among the new chain, the old chain is deemed invalid. However, the DAO ultimately ended up having to use a hard-fork because of newly discovered security vulnerabilities in the soft-fork method (Ethereum Classic 2017). The difference between these two methods is that the hard-fork alternative is permanent. It creates two parallel chains that cannot transact with one another. This creates dual-funds, whereby each chain receives a copy of the same coin. Ideally, one chain would then have a majority consensus. If not, the value of the cryptocurrency becomes volatile and the politics surrounding the divergence become blurred (We Use Coins 2016).

The hard-fork essentially returned the stolen ether to its token holder, reversing the theft and causing the DAO to collapse. However, blockchain is axiomatically immutable, so artificially reversing the transactions by the hacker contradicts this fundamental attribute of the technology. On one hand, recognising that blockchain records can be invalidated in emergency situations provides some relief that a problem can always be rectified. On the other, it raises further questions: under what circumstances is a hard-fork solution appropriate? Should any major breach of the system result in a hard-fork solution? What governance models can be instituted and who will make these decisions? Could these forks be manipulated to facilitate large-scale collusion? Proactively, the blockchain community is already responding to this issue, and in August 2016, created the Muskoka Group (an assembly of blockchain executives) that are working collectively to address the platform's governance issues. Their mission is to harbour a healthy, well-organised blockchain ecosystem suitable for industrial, governmental, and societal uses (Del Castillo 2016b). The Enterprise Ethereum Alliance, discussed earlier, has similar objectives. As blockchain outgrows its infancy stage, regulations on how to solve problems like these in the future will continue to emerge. Associations like the Muskoka Group and the Enterprise Ethereum Alliance prove that initiatives are underway to address these ambiguities.

Another interesting discussion revolves around the financial sector's resistance to blockchain proliferation. Given the lobbying power of wealthy corporations, it is hard to foretell how politics will be swayed and how political and corporate agendas will influence the scope of blockchain integration. Already, there have been talks that many global banks are fighting against emerging legislation that would give more power to financial technology (FinTech) firms. Specifically, this comes in response to the revised Payment Service Directive (PSD2) expected to be enacted in 2018 by the EU, which removes the banking sector's monopoly in providing payment services and managing client account information (Campbell 2017). This gives more freedom to the consumer by allowing them to reach out to other third-party FinTech providers, but creates an obvious threat to banks. Traditionally, banks only had to compete against each other, but with the PSD2, they risk losing market share to new entrants. With AISPs (account information service providers) and PISPs (payment initiation service providers) peer-to-peer transactions will become more common in the future. Consequently, banks are expected to lose 9% of revenue from retail payments by 2020 alone as a result of these developments (Hellström 2017). Banks are not the only players with an incentive to lobby against blockchain. The short sellers and back-office Wall Street workers discussed in the Dole case are another example of industry actors that earn their profits from the current system. Despite that blockchain's

expansions might better serve the public, politicians may be persuaded by these lobby efforts to veto against pro-FinTech laws and keep the technology at bay.

Despite their efforts, it appears even the organisations inclined to lobby against the technology realise its potential. A 2016 study by IBM revealed that 65% of banks intend to rollout blockchain solutions by 2019 (the company studied 200 global banks to arrive at this conclusion). Of those 200 banks, 15% said they want to integrate 'full-scale, commercial blockchain solutions' in 2017 (IBM 2016). From the study, it was also determined that 70% of early adopters are prioritising blockchain development to help create new business models and markets. It seems that banks and other intermediaries are turning the potential threats of blockchain into opportunities to improve their own services. Nevertheless, the financial technology industry is expected to grow beyond $150 billion in the next three to five years (Hellström 2017). Thus, in the case that the financial sector does decide to lobby governments, FinTech firms should have the resources to fight back. Each player's ability to influence politicians may play a critical part in blockchain's growth.

It is safe to say that with the prominent number or early adopters and state governments (like Delaware and the UAE) pioneering the way in blockchain integration, there will definitely be a future for the technology. According to a survey by the World Economic Forum, 10% of global GDP could be stored on blockchain by 2025 (Wunsche 2016). Research and Markets (the largest market research database in the world) released a report in March 2017 predicting that blockchain technology will be used by up to 65% of enterprises by 2020 (Wood 2017). Likewise, a second IBM study that surveyed 200 financial market institutions revealed that 14% of respondents said they would also like to implement scalable and commercialised solutions by 2017 (IBM 2016). These statistics highlight that blockchain is undoubtedly growing in momentum and that industries across the board are recognising its potential. Referring again to the Dole case, the DTCC announced as of January 2017 that it too plans to move $11 trillion worth of derivatives to blockchain (Del Castillo 2017a). Furthermore, both the NASDAQ and the ASX have been working on launching their own blockchains. These examples illustrate once again that the platform is stirring up an unstoppable wind of technological change.

Concluding Remarks

As witnessed through blockchain initiatives by first movers, the technology can be applied by professional service firms and other incumbents of the accounting industry to better meet client needs. Creations like Vulcan (for managing digital assets), Rubix (for ameliorating supply change management), editable blockchains and Blockchain as a Service are a few testaments to the commitment by accounting corporations like PwC, Deloitte, EY and KPMG to integrate blockchain into their financial services. Blockchain's rapid growth has sparked industry-wide curiosity and consequently there have been talks to create a blockchain consortium in the accounting sector. Naturally, the nascent state of the technology engenders some deterrents to early adoption, predominantly the lack of regulatory standards and the likelihood of technological obsolescence with many competing pilot projects underway. These issues, however, can be overshadowed by the numerous governments and regulatory bodies that have already expressed interest in integrating the technology.

In the years to come, blockchain could be used regularly by CPAs and bookkeepers to manage a company's records, transactions and performance. Triple-entry accounting could become integral to the accounting industry by providing a tertiary destination that automatically verifies transactions for bookkeeping. Smart contracts could execute repetitive tasks relating to supply chains, administration, recordkeeping and/or legal matters, thus freeing up time for accountants to focus on value-added work. Automated taxation is another way blockchain could streamline accounting processes. In particular, blockchain could help attenuate tax evasion by providing an immutable platform through which taxes could be collected in real time. This would also eliminate the need to record taxes retroactively since they could be managed instantaneously grâce à blockchain. In studying cases like Dole, a greater understanding is developed for the potential applications of the technology to overcome the plights and pitfalls of current transactional and managerial systems. Analysing previous cyber hacks, such as the theft of $50 million on the DAO, can help palliate fears relating to cybersecurity by highlighting that although blockchain is axiomatically unalterable, solutions still exist to combat criminals, glitches and loopholes that could threaten the platform. Furthermore, leveraging concepts like homomorphic encryption could add an additional layer of protection to public blockchains. Similarly, scalability concerns can be assuaged by recording only UTXO, using pruning techniques, and outsourcing calculations to limit the computational intensity of running a blockchain.

While the technology has the potential to reshape capital markets as a whole, a dialectic still needs to be had regarding the social and political barriers impeding blockchain's proliferation. Accountants will need to acquire new skills to adapt to the shifting job requirements for existing and emerging accounting positions. New governance models will also need to be established to ensure ethical decision making and effective crisis management. The controversy of financial sector lobbyists fighting to stifle blockchain's germination contrasted

with the eagerness of many industry players to adopt the technology illustrates the ongoing push and pull for and against blockchain integration. Though no one can confidently predict the magnitude of blockchain's growth, one thing is for certain: accounting is just one block in the chain of industries being dramatically redefined by this disruptive technology.

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