SHAREHOLDER VALUE IMPLICATION OF BLOCKCHAIN

RECORDKEEPING OF STOCK OWNERSHIP

by

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Blockchain technology offers a novel way of recordkeeping. The paper examines whether blockchain recordkeeping of stock ownership can be beneficial for shareholders. I explore an event associated with a legislative change that allows Delaware-incorporated firms to maintain shareholder records using blockchain. Consistent with blockchain recordkeeping of stock ownership having the potential to curtail errors in proxy voting, I find a more favorable stock price reaction for firms whose proposal approval or rejection is more sensitive to proxy voting errors. This relation does not hold for non-Delaware-incorporated firms. Furthermore, the result is more pronounced for firms with a higher likelihood of proxy voting errors and firms with relatively poor performance. The study is among the first to provide empirical evidence on shareholder value implication of blockchain recordkeeping.

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CHAPTER 1

INTRODUCTION

Accurate and verifiable transaction records help secure property rights, enable large-scale economic exchange, and facilitate modern capitalism (De Soto, 2000; Basu and Waymire, 2006; Basu, Kirk, and Waymire, 2009). However, because of the complexity of modern economic transactions, recordkeeping is often costly and prone to errors. Blockchain technology has the potential to revolutionize the entire recordkeeping practice (Yermack, 2017). A blockchain maintains records of transactions collectively through a decentralized network of economic agents who reach agreement on the true state of the records at a regular interval (Catalini and Gans, 2017). Compared with traditional recordkeeping, blockchain provides potential advantages in information integrity (Yermack, 2017).

Despite its appealing features, blockchain technology comes with costs. One major cost is that blockchain recordkeeping may require significant transaction fees to incentivize the network of economic agents to supply the service. Thus, the adoption of blockchain recordkeeping in practice is not without controversy. For instance, Vermont announced in June 2015 that it was contemplating switching its state public records to a blockchain but abandoned the plan in January 2016, arguing that the costs would outweigh the benefits (Caytas, 2017).

Blockchain technology could potentially change recordkeeping practice in many areas such as digital payments, security ownership, and real estate titles. My study focuses on the use of blockchain technology to keep track of firms' stock ownership records. Accurate stock ownership records help improve the integrity of proxy voting results, which are critical for shareholders' efficient control over corporate decisions and informed managerial decision-making. I examine whether using blockchain to maintain firms' stock ownership records is beneficial for shareholders.

The current stockholding and voting infrastructure in the United States disfavors shareholders due to the complexity of the current nominee system in which Depository Trust Company (DTC) holds stocks certificates on behalf of beneficial owners (Kahan and Rock, 2008). Under the current system, information regarding stock ownership records is dispersed, and consolidating the information and reconciling the records are technically challenging and costly (Chiu and Koeppl, 2018). As a result, proxy voting results are subject to pervasive errors.[1] As a leading Delaware lawyer suggests, "In a contest that is closer than 55% to 45%, there is no verifiable answer to the question 'who won?'" (Kahan and Rock, 2008, p. 1279). Blockchain has the potential to provide more accurate proxy voting results by offering a public ledger. Specifically, stock ledgers are maintained collectively by a peer-to-peer network through a process called consensus.[2] The process enables a globally true state of stock ownership records at each point in time and thus significantly mitigates the need for reconciliations.

To examine whether blockchain recordkeeping of stock ownership can improve shareholder value, I study the stock price reaction to an event associated with a legislative change that allows Delaware-incorporated firms to maintain shareholder ownership records using blockchain.[3] On September 29, 2016, the Vice Chancellor of Delaware Chancery Court, J. Travis

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[1] Throughout the paper, the term "voting result" refers to the recorded count of the votes-for example, 55% shareholder voting support, while the term "voting error" ("error in voting" or "error in proxy voting") refers to the absolute difference between the recorded voting result and true voting result in the absence of errors. For example, voting error is 5% if the recorded voting result is 55% or 65% and the true voting result in the absence of errors is 60%.

[2] See Chapter 2.2 for details.

[3] I describe how I identify this event in Chapter 4.

Laster, gave a keynote speech in a conference held by the Council of Institutional Investors (CII) (the event, hereafter). He discussed how the complexity of the current nominee system does harm to shareholders and spoke out strongly in favor of blockchain technology as the "plunger" that can clean up the proxy "plumbing" (Laster, 2016). According to an extensive search of news articles, the event appears to be the first time the prominent Delaware judge so openly and strongly criticized the nominee system and advocated blockchain technology as a solution. [4] Because when the courts report issues that entail legislative actions, Delaware legislators are often responsive (Hamermesh, 2006), this speech was likely to have raised market expectations about the likelihood of legislation of blockchain recordkeeping of stock ownership in Delaware.

First, I empirically confirm that Laster's speech has increased market expectations about the likelihood of legislation on blockchain recordkeeping of stock ownership in Delaware by examining the stock market reaction for Broadridge Financial Solutions Inc. (Broadridge), the financial institution that almost monopolizes the proxy processing service in the United States (Laster, 2016). Since blockchain technology allows direct communication between the issuers and investors with respect to proxy voting, Broadridge runs the risk of losing its proxy processing services currently required by SEC under the nominee structure. Thus, if Laster's speech increased market expectations about the likelihood of legislation on blockchain stock ownership recordkeeping in Delaware, the stock price of Broadridge is expected to react negatively.

[4] In a case involving Dell (*In re Appraisal of Dell Inc. (Dell Continuous Ownership)*, 2015 WL 4313206 (Del. Ch. July 30, 2015)), some beneficial shareholders requested an appraisal of their shares. However, change in ownership resulting from the nominee system was deemed to have been a case of voluntary transfer, and thus shareholders lost the case as they did not own the stock continuously through the close of the merger, as Delaware law requires. Vice Chancellor Laster believed the result was "absurd" because "this was an example of people doing what they should do and then getting caught up by the system" (Laster, 2016, page 7).

Consistent with this expectation, I find that the return of Broadridge on September 29, 2016 is -287 basis points, which is significantly lower than its average nonevent day returns.

I then examine the average market reaction to the event for firms incorporated in Delaware. Using various stock returns measures, I find that the average cumulative stock returns over the event window is insignificant. Thus, the results are inconclusive about whether the market participants perceive that blockchain recordkeeping of stock ownership increases shareholder value for an average Delaware firm.

Next, I examine whether the stock market reaction is more positive when blockchain recordkeeping of stock ownership is likely to be more valuable to shareholders. As argued above, errors in proxy voting can result in erroneous approval or rejection of a proposal that is detrimental to shareholders' efficient control over corporate decisions and informed managerial decision making, and blockchain could be a powerful tool for curtailing such proxy voting errors. Thus, I expect that the effect of blockchain recordkeeping of stock ownership on shareholder value is more positive for firms whose proposal approval or rejection is more sensitive to errors in proxy voting. I measure the sensitivity of a firm's proposal approval or rejection to proxy voting errors with whether the firm has a recent close vote, a case in which the difference between the recorded vote result and vote requirement is between -5% and 5%. Consistent with my expectation, I find that the cumulative returns over the event window for firms with a close vote are on average 180 basis points higher than the returns for firms without a close vote. The results are robust to size-adjusted and industry-adjusted returns measures.

Despite the economic and statistical significance of these results, a potential concern is that the existence of a close vote is correlated with some omitted variables that predict stock returns. I use two approaches to rule out this alternative explanation. First, the fact that the event affects only Delaware-incorporated firms enables me to use firms that are not incorporated in Delaware to conduct a placebo test. To the extent that the results are driven by omitted variables that are correlated with the existence of a close vote, the stock returns of non-Delaware-incorporated firms should be affected by those variables in the same direction. However, I do not find more positive market reactions related to the existence of a close vote for non-Delaware firms. Moreover, the association between the existence of a recent close vote and stock returns for Delaware firms is significantly more positive than the association for non-Delaware firms. Second, if omitted variables correlated with the existence of a close vote drive the results, the stock returns on days adjacent to the event window should also be affected by those variables. However, I do not observe similar, more positive returns in the adjacent nonevent windows for firms with a close vote.

I further examine the cross-sectional variation of the relation between stock returns and the existence of a close vote. First, I expect that the association is more pronounced when the likelihood of proxy voting errors is higher, for example, when firms have more stock lending activities and when firms' annual shareholder meetings are held in the busy proxy season—that is, the second calendar quarter of the year (Kahan and Rock, 2008). Second, curtailing errors in close-call voting results with blockchain is likely to be more valuable for poorly-performing firms, as for these firms, shareholders can use voting to improve performance if the poor performance is due to agency problems or uninformed managerial decisions (Christoffersen et al., 2007; Aggarwal, Saffi and Sturgess, 2015). The empirical evidence is consistent with these predictions. These analyses pinpoint when blockchain recordkeeping of stock ownership can generate greater benefits for firms whose proposal approval or rejection is more sensitive to errors in proxy voting.

The literature on blockchain in accounting, economics, and finance is in a nascent state (e.g. Yermack, 2017; Chiu and Koeppl, 2018; Cong and He, 2018; Chen, Wu, and Yang, 2018; Cao, Cong, and Yang, 2018)).[5] My study is among the first to provide empirical evidence on shareholder value implication of blockchain recordkeeping. The results suggest that blockchain recordkeeping of firms' ownership records is more beneficial for shareholders of firms whose proposal approval or rejection is more sensitive to errors in proxy voting, supporting Vice Chancellor Laster's view that blockchain can help improve integrity in proxy voting results (Laster, 2016; Laster and Rosner, 2018). The findings are also of interest to regulators, blockchain professionals, and board of directors contemplating the adoption of blockchain for stock ownership recordkeeping.

The reminder of the paper proceeds as follows. Chapter 2 provides institutional backgrounds on proxy voting in the United States and blockchain. Chapter 3 reviews the related literature and develops the hypothesis. Chapter 4 describes the event selection procedure. Chapter 5 presents the empirical analyses. Chapter 6 concludes.

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[5] Chapter 3.1 provides a review of the emerging literature on blockchain in accounting, economics, and finance.

CHAPTER 2

INSTITUTIONAL BACKGROUND

2.1 Proxy Voting Practice in the United States

Under the current stockholding and voting infrastructure in the U.S. stock market, usually DTC holds stock certificates on behalf of beneficial owners (Kahan and Rock, 2008). As illustrated in Figure 1, under the current nominee system, most beneficial owners (e.g., T. Rowe Price), through their custodians (e.g., State Street), register their stocks in the name of Cede & Co., which is the nominee of DTC.[6] The custodians hold accounts in DTC. DTC records ownership transfer by debiting and crediting the accounts of the custodians. This multi-level structure complicates the proxy voting process, which involves several steps described below (Kahan and Rock, 2008).

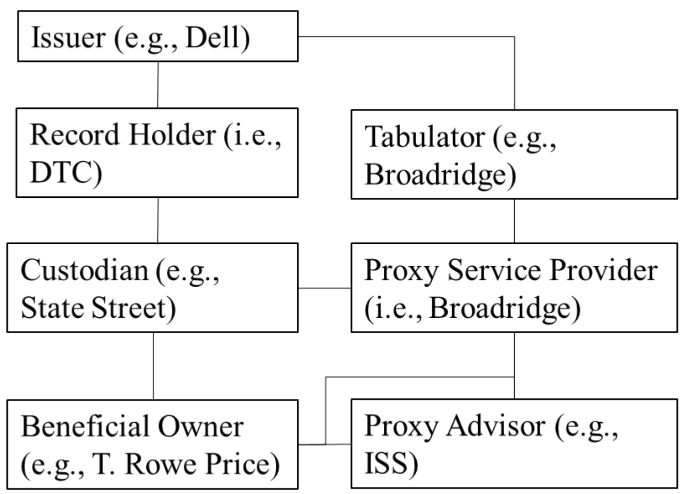

Figure 1: The Current Sharing Holding and Voting Infrastructure
Note: The figure shows the shareholding and voting infrastructure under the current nominee system.

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[6] The nominee system was developed as a solution to the "paperwork crisis" resulting from high security trading volume in the late 1960s (Laster, 2016).

The first step is to identify the beneficial owners. The issuer inquires to DTC about a list of participating custodians. After receiving a response from DTC, the issuer distributes "search cards" to the custodians asking for the number of proxies needed. Typically, custodians delegate proxy processing to Broadridge, who then provides the required information to the issuer. The second step is distribution of the proxy material. The issuer provides Broadridge, the agent of the custodians, with sufficient copies of the proxy packet, which are then forwarded to beneficial owners. Broadridge charges the issuer for the distribution cost. The third step is voting. Broadridge collects voting instructions from the beneficial owners and forwards the proxies to the tabulator. Sometimes, a proxy advisor (e.g., ISS) is retained by the beneficial owners to facilitate the proxy voting. The last step is tabulation. The tabulator (e.g., Broadridge) verifies the proxies received and tabulates the votes.

The sheer complexity of the nominee system described above stifles accurate proxy voting for several reasons (Kahan and Rock, 2008). First, the complexity in finding the beneficial owners results in many cases in which the proxy materials simply do not arrive. Second, the complex voting system makes vote verification impossible. Beneficial owners cannot necessarily obtain end-to-end confirmation that their shares have been voted according to their instructions (also see CII, 2015).[7] Third, beneficial owners typically grant the custodians the right to lend out their shares without notifying them. As a result, over voting often occurs when the beneficial owner casts the votes along with the borrowers (i.e., short-sellers) or their buyers.[8]

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[7] At least until 2016, end-to-end vote confirmation was still not available in most circumstances (see footnote 10 in Laster, 2016).

[8] The standard contract of equity lending is essentially a repurchase agreement. The full legal title is transferred from the seller to a "borrower," who agrees to sell back the security in the future. Thus, if a beneficial owner "lends" its stocks before the record date, the beneficial owner is not entitled to vote (Kahan and Rock, 2008).

Due to the aforementioned reasons, the results of proxy voting are not fully accurate in the United States. Errors in proxy voting are pervasive and sometimes may cause consequences such as erroneously affecting the outcomes of a proxy contest. The recent twist in the hitherto biggest and most expensive proxy contest involving P&G and activist investor Nelson Peltz of Trian Fund Management illustrated the crudeness and imprecision of the voting system. The company had initially claimed victory, but an independent inspector later revealed that the activist had won a thin margin of around 43,000 more votes (0.0016% of the shares outstanding) than an incumbent P&G director.[9] In another example, in Yahoo's 2008 director re-elections, a proxy recount requested by a large shareholder showed that about 20% of the vote was miscounted in favor of the incumbent directors.[10]

2.2. Blockchain Recordkeeping

A blockchain is a growing sequence of data records (i.e., "blocks") that are "chained" together through cryptography. 11 It is a ledger designed to record ownership transfer of a certain asset. However, unlike a traditional ledger that is kept by a central intermediary, blockchain is a distributed ledger that is maintained by a decentralized peer-to-peer network of economic agents. The following example illustrates how blockchain works.

Suppose user A wants to transfer x amount of an asset to user B. The transaction entry including the sender A, receiver B and amount x, is represented in a block. Along with the

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[9] "P&G concedes proxy fight, adds Nelson Peltz to its board", *Wall Street Journal*, Dec. 15, 2017.

[10] "Yahoo vote-counting error overstated support for Yang", *Wall Street Journal*, Aug. 6, 2018.

[11] The original idea of blockchain first appeared in Haber and Stornetta (1991), who proposed procedures for digital time-stamping of electronic documents to prevent users from tampering with records. Nakamoto (2008) seemed to be the first to name this sequential data structure a "chain of blocks" in his design of bitcoin.

transaction entry, the block also contains in its header (i) a hash and (ii) a hash of the previous block. A hash is a fixed length of code transformed from an entry using a hash algorithm. It is like a fingerprint in that it is unique and thus can be used to identify the block.[12] Any change to the entry embedded in the block leads the hash to change. A hash of the previous block effectively enables a chain of blocks. It makes the blockchain secure, because changing the hash of a block will change hashes of all the subsequent blocks and in turn make all these blocks invalid.

However, computers nowadays are fast enough to calculate many hashes per second. One can tamper with a block by recalculating all the hashes in the subsequent blocks and making the blockchain valid again. To prevent tampering, blockchain has a design called "proof-of-work" that can slow down the generation of new blocks.[13] The task, commonly known as "mining", is to find a random number that can be combined with information in the block to generate a hash with a certain number of leading zeros. This design makes tampering with a block difficult because to do so, one needs to complete proof-of-work for all the subsequent blocks, a process that is extremely computationally costly.

Blockchain is maintained by a network of economic agents, called "nodes." These nodes generally have access to the full blockchain. A node that attempts to complete the proof-of-work is also known as a miner. The first miner who completes this task and successfully creates a block later is rewarded with cryptocurrency or a transaction fee. After the miner finishes the proof-of-

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[12] For example, entry "A sends *x* to B." corresponds to a unique SHA-256 hash of 6d6b2973f7bd388f2f5b94e8fd2136c1fb7acf6be24214f3d6103c090cc1003f.

[13] Several alternative designs exist to induce consensus. For example, in "proof-of-stake," a node's probability of being designated as a verifying agent depends on the value of the assets (e.g., cryptocurrency) that it owns. Nodes have disincentive to tamper with the blockchain by bearing the opportunity cost of holding collateral (Chiu and Koeppl, 2018). Saleh (2017) illustrates the feasibility of the proof-of-stake mechanism.

work, verifies the transaction, and creates a block, the block is broadcast to every node in the network. Each node then verifies the transaction in the block.[14] Once verified, the block will be added by each node to its own blockchain. All the nodes in the network thus create a “consensus”, the agreement on the authenticity of the blockchain. Blocks that are tampered with will be rejected by other nodes in the network and the consensus will not be reached. Thus, to successfully tamper with the blockchain, one needs to change all the subsequent blocks in the chain. By doing so, one needs to re-do the proof-of-work for each of these subsequent blocks and take control of at least the majority of the network, which is almost impossible. After the consensus is reached, a new block will be added to the chain and the asset in the amount of *x* will be transferred from A to B.

Through this process, blockchain can accurately record ownership transfer of assets without a central intermediary by providing a public ledger. Verification of this public ledger is effectively delegated to a network of nodes through the consensus process. The proof-of-work design further makes the transaction records tamper-proof. As such, trust is created among the users without a third-party intermediary.

It is noteworthy that a blockchain can be customized to meet the needs of users. For instance, a blockchain does not have to adopt a public network such as the one underlying Bitcoin. Instead, a block can be designed as a private network wherein access to the system is based on permissions. Members in this permissioned blockchain can only see information in ledgers that are related to the members, a protection that is critical for users who want to conceal their identities.

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[14] Verification is much less computationally demanding than completing the proof-of-work.

CHAPTER 3

PRIOR LITERATURE AND HYPOTHESIS DEVELOPMENT

3.1 The Emerging Literature on Blockchain in Accounting, Economics, and Finance

My study falls in the nascent accounting, economics, and finance literature studying the economic impact of blockchain. Yermack (2017) evaluates the potential influence of blockchain on corporate governance and conjectures that blockchain may provide a lower cost of trading, greater liquidity, and more reliable and transparent ownership records for shareholders. Cao, Cong, and Yang (2018) present a model that shows that blockchain-based collaborative auditing increases auditing efficiency, affects audit pricing, and reduces clients' misreporting incentive. Catalini and Gans (2017) suggest that blockchain technology is likely to increase competition and lower barriers to entry in the marketplace. Chiu and Koeppl (2018) model the blockchain-based settlement for asset trading and show its gains relative to an existing settlement system. With respect to blockchain's application in smart contract, Cong and He (2018) show that blockchain-based smart contracts can reduce information asymmetry and increase market competition but may also encourage collusion. Tinn (2018) shows that financing contracts based on smart contract can depend on the timing of positive cash flows and thus reduce cost of capital.

In a closely related study, Chen, Wu, and Yang (2018) use a valuation method that combines market response to patent filings with estimated patent-filing count intensities to show that blockchain is the type of Fintech innovation that yields the most positive value to innovators and is value-increasing for the overall financial sector. However, they also find that blockchain has a negative value implication for banks who are not innovators. While Chen, Wu, and Yang (2018) document positive value implication of blockchain for innovators, they do not show how exactly blockchain creates value for the users. My study focuses on a particular and arguably important type of blockchain application—that is, recordkeeping of corporate ownership—and examines its shareholder value implication for the general population of non-financial companies. In this sense, my study examines an important mechanism through which blockchain can add value to stakeholders.

3.2 Hypothesis Development

The root cause of the "pathologies" discussed in Chapter 2.1 is that information about stock ownership is dispersed among many parties involved in the trading process and that it is technically challenging and costly to consolidate the information and reconcile the records (Chiu and Koeppl, 2018). Blockchain essentially cuts the information-related cost by offering a public ledger that can be shared and updated simultaneously among all participants involved in the trading process (Chiu and Koeppl, 2018). By design of the blockchain "consensus" process, only one globally correct ledger can exist at each point in time. Issuers will be able to identify their stock owners perfectly and send them proxy materials, and owners will be able to obtain end-to-end confirmation from the issuers that their shares have been voted consistent with their instructions. Over voting due to stock lending will not occur as a stock can only be owned by one investor in the ledger at any point in time. As a result, proxy voting will likely be more accurate and verifiable.

Reducing errors in proxy voting is likely to improve shareholder value. First, shareholders' right to vote on corporate matters, such as compensation, election of board of directors, approval of M&A, and issuance of new equity give them control over key firm decisions (Yermack, 2010; CII, 2015). The voting results on a corporate decision reflect shareholders' optimal tradeoff between managers' relative information advantage relative to shareholders on this decision and the extent of agency conflict between shareholders and managers (Harris and Raviv, 2010). Shareholders would likely intervene in corporate decisions by voting against managers when agency cost exceeds information benefit and would agree with managers' decisions by voting for managers when information benefit dominates agency cost. Curtailing errors in proxy voting is thus beneficial to shareholder value because it makes voting results more precisely reflect shareholders' preference concerning whether to intervene. In other words, fewer errors in proxy voting enable shareholders to exercise control on firm decisions more efficiently.

Second, shareholder votes aggregate shareholders' dispersed information about value impact of alternative outcomes related to a corporate decision. Prior studies show that shareholder vote results provide valuable information as to the quality of the proposals and performance of the directors (Ertimur, Ferri, and Stubben, 2010; Fischer et al., 2009). Activist shareholders and various fund managers may have information about corporate decisions that managers do not have. The information advantage could come from these investors' experience with other investee firms. Furthermore, voting rights can move from the less informed investors to the more informed ones through vote trading (Christoffersen et al., 2007). A vote result with fewer errors is thus likely to be more informative for managerial decision-making and improve shareholder value.

Moreover, blockchain may also impose a threat of disintermediation that may change Broadridge's policy on providing the managers with exclusive access to preliminary vote tallies in close to real time before the final vote result is revealed, a practice that is believed to have increased managements' advantage in influencing vote results (Listokin, 2008; CII, 2015; Bach and Metzger, 2018; Babenko, Choi, and Sen, 2018).[15] Thus, blockchain may also have the potential to curtail the private benefits extracted by managers through manipulating votes.

Despite its attractive features, blockchain technology comes with costs. For example, under the proof-of-work protocol, nodes in a blockchain network need to spend computing resources (e.g., infrastructure, equipment, and electricity) to validate a transaction. Thus, transaction fees should be sufficiently high to incentivize the nodes to supply the service. This cost of maintaining a blockchain network, together with the initial cost of setting up a blockchain-based stock ledger, may outweigh the fees currently paid by the companies to DTC and custodians for serving as nominees and to Broadridge for handling shareholder communication in proxy voting. In fact, the experience with blockchain adoption sometimes tells a cautionary story. For instance, Vermont announced in 2015 that it was planning to use blockchain to keep its state public records but abandoned the plan in 2016 concluding that cost would exceed benefits (Caytas, 2017). Nevertheless, the experience of a state government may not extend to companies for which the cost and benefit tradeoffs can be different. Ultimately, whether blockchain recordkeeping of stock ownership would benefit shareholders of corporations is an empirical question.

It is also interesting to examine when blockchain recordkeeping of stock ownership is more likely to add value to shareholders. The discussion above suggests that blockchain recordkeeping of stock ownership is likely to be more value-increasing when reducing the errors in proxy voting is more important. Errors in proxy voting are more detrimental when they have the potential to lead to erroneous approval or rejection of a proposal, which in turn may dismiss (trigger) corporate

[15] However, it is possible that managers still have exclusive access to preliminary vote tallies even with blockchain disruptions as managers still would likely be in charge of the voting process.

changes that should have been approved (rejected) based on accurate voting. As such, I expect blockchain recordkeeping of stock ownership is more beneficial for shareholders of firms whose proposal approval or rejection is more sensitive to errors in proxy voting.

CHAPTER 4

EVENT SELECTION

4.1 Identification of Events Related to Delaware Blockchain Legislation

The Delaware blockchain legislation became effective on August 1, 2017. I identify the events associated with the legislation using a keyword search of "Delaware" and "blockchain" in Factiva, LexisNexis, and Google news from January 2015 to August 2017 and describe these events in chronological order. No public news had been released by the State of Delaware on blockchain until April 5, 2016, when then Governor Jack Markell announced the establishment of the Delaware Blockchain Initiative, a set of programs that sought to promote blockchain by Delaware-incorporated businesses (Candidate Event #1).[16] However, the Delaware Office of the Governor suggested that the details of the initiative would be revealed only in the governor's opening speech at the Consensus conference scheduled for May 2, 2016.

On May 2, 2016, as scheduled, Markell unveiled the plan to the public in a keynote speech at Consensus 2016, a conference in New York City dedicated to blockchain technology (Candidate Event #2). During the address, Markell revealed four key elements of the initiative including (1) ensuring that blockchain companies would not face new regulation in Delaware, (2) establishing a legal infrastructure for distributed ledger shares, (3) appointing Andrea Tinianow, the then State Director of Corporate and International Development, to lead the blockchain initiative program, and (4) committing the state government to using blockchain for archival records.[17]

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[16] "State of Delaware unveils blockchain initiative to leverage potential of smart contracts," *PR Newswire*, Apr. 5, 2016.

[17] "Governor Markell launches Delaware Blockchain Initiative," *PR Newswire*, May 2, 2016.

The next event is the keynote speech delivered by Delaware Chancery Court Vice Chancellor J. Travis Laster in a conference hosted by CII on September 29, 2016 (Candidate Event #3). Laster criticized the current nominee system for being detrimental to shareholder rights and strongly advocated blockchain technology as the "plunger" that could clean up the proxy "plumbing" (Laster, 2016). Since Delaware legislators often take actions to amend the Delaware General Corporation Law (DGCL) when the courts report issues that entail legislative attention (Hamermesh, 2006), the speech delivered by Laster was likely to raise market expectations about the likelihood of blockchain recordkeeping of stock ownership legislation in Delaware.[18]

The Delaware legislators made a series of announcements in the following year. On March 13, 2017, the Council of the Corporation Law Section of the Delaware State Bar Association (DSBA) released draft legislation to amend the DGCL (Candidate Event #4), which was subsequently approved by the Corporate Law Section of the DSBA on March 27, 2017 (Candidate Event #5). The council made key amendments to Section 224 of the DGCL, the statute that specifies the legal requirements for the form of stock ledger in the State of Delaware. The amendments allowed stock ledger to be "administered by or on behalf of the corporation" (versus "maintained by the corporation," as was currently specified in the law) and added particular

[18] Hamermesh (2006) provides two examples to illustrate the responsiveness of the Delaware legislators to the matters reported by the state court. In 2002, the Court of Chancery faced a litigation in which a critical issue was the time of a company filing. The General Assembly promptly passed amendments to DGCL that specified an anti-backdating rule. As another example, in 2000, the Court of Chancery found some confusion regarding "voting stock" in DGCL and expressed the issue in a court opinion. In response to the opinion, DGCL was soon amended to clarify the definition.

wordings permitting “electronic networks or databases” for maintaining a stock ledger (O’Toole and Reilly, 2017). [19]

Following the usual Delaware legislative process, Senate Bill 69 based on the amendments was later introduced to Delaware General Assembly on May 5, 2017 (Candidate Event #6).[20] Typically, amendments to DGCL requires a supermajority support from both the state Senate and the House of Representatives. However, the supermajority voting requirement is symbolic—that is, the amendments to DGCL were not deemed to be a subject for partisan controversy (Hamermesh, 2006). Consistent with this view, Senate Bill 69 obtained nearly unanimous support from the Senate, Judiciary Committee, and House on June 6, 2017 (Candidate Event #7), June 14, 2017 (Candidate Event #8), and June 30, 2017 (Candidate Event #9), respectively, and was subsequently signed into law on July 21, 2017 (Candidate Event #10).

4.2 Event Analysis

An ideal event for addressing my research question should satisfy the following two criteria: (1) the event is solely associated with blockchain recordkeeping of stock ownership, and (2) the event is unexpected or contains information unexpected by the market and the effect of the event is unambiguous to the market. Criterion (1) is established to maximize the likelihood that the wealth effect I document is attributable to news about blockchain recordkeeping of stock ownership rather than other concurrent news the event contains. Criterion (2) is established to

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[19] For the complete document of the amendment, please refer to: https://legis.delaware.gov/json/BillDetail/GenerateHtmlDocument?legislationId=25730&legislationTypeId=1&docTypeId=2&legislationName=SB69.

[20] The history of the bill is available at https://legis.delaware.gov/BillDetail?legislationId=25730.

maximize the likelihood that the event changed investors' expectations on the likelihood of the legislative change and to ensure that I can determine the direction of the expectation change.

Candidate Event #1 is not likely to satisfy criterion (1). While the announcement from Delaware Office of the Governor indicated that the blockchain technology focus team of Pillsbury Winthrop Shaw Pittman LLP (Pillsbury), led by Macro Santori, was developing the legal infrastructure for the state of Delaware, it was not clear from the announcement whether the legal infrastructure was developed specifically for blockchain recordkeeping of stock ownership. For Candidate Event #2, while element (2) of Markell's speech was intended to inform the public that the legislation on blockchain recordkeeping of stock ownership was in progress in Delaware, element (1), (3), and (4) were not directly related to blockchain recordkeeping of stock ownership. Thus, it is also not likely that criterion (1) is met for Candidate Event #2. Candidate Event #3, Laster's speech, is solely associated with blockchain recordkeeping of stock ownership and thus should meet criterion (1). Candidate Event #4 to #10 violate criterion (1) because besides paving the way for the use of blockchain in recording corporate ownership, the draft legislation to amend the DGCL and Senate Bill 69 based on the draft also include revisions to written consents, merger provisions, interested stockholder opt-out and annual reports.[21]

Regarding criterion (2), an important consideration is that the legislation process is largely unobservable and the lawyers and legislators often have extensive communications with the related parties and experts during the process.[22] My discussion with the former staff of the Delaware

[21] For a detailed analysis, please refer to "2017 DGCL Proposed Amendments on Blockchain Recordkeeping, Written Consents, Merger Provisions, Interested Stockholder Opt-Out, and Annual Reports" published by Practical Law Corporates & Securities.

[22] As an example of the consultation during the proposal-drafting process, one article suggests that when Marco Santori submitted the first draft of the proposed amendment to the Delaware Corporation Law Council, the Council "had already been doing its

Blockchain Initiative suggests that the legislation process started even before Candidate Event #1. Also, in the panel discussion after Markell's speech on May 2, 2016 (Candidate Event #2), Marco Santori of Pillsbury suggested that its team had already been working on drafting the proposed amendments of DGCL to allow for blockchain recordkeeping of stock ownership. Thus, it appears that criterion (2) may not be satisfied for these two candidate events. Regarding Candidate Event #3, according to an extensive search of news articles via Factiva, LexisNexis, and Google news, the event appears to be the first time the prominent Delaware judge so openly spoke in favor of blockchain recordkeeping of stock ownership to clean up proxy "plumbing." As one observer noted, "in such a notoriously conservative environment it remains quite a bold statement."[23] This suggests that the speech is likely to have unexpected content that would have raised market expectations about the likelihood of blockchain recordkeeping of stock ownership legislation in Delaware. Candidate Event #4 represents the first-time release of the amendment to DGCL, but the substantial proposal-drafting activities before the draft release could mean that it lacked information content. Candidate Event #5 to #10 are also likely to violate criterion (2) because the approval of the amendment to DGCL, and the subsequent introduction, vote, and signing of the bill based on the amendment typically follow a very routine way (Hamermesh, 2006).

4.3 Event Validation

The event analysis provided in Chapter 4.2 suggests that Candidate Event #3 might be the only event that is ideal for my study. I confirm this conjecture using the return of Broadridge. As

homework for months, talking to experts in order to understand the potential for blockchain technology." *American Banker*, Jul. 5, 2017.

[23] "A New Push for Blockchain Voting from Delaware Judge." *DCEBrief*, Oct.24, 2016.

discussed in Chapter 2.1, Broadridge offers proxy processing service required by SEC rules for the custodians and collects fees from the issuers based on the contract it signs with the custodians. By controlling over 98% of the proxy vote processing service in the United States, Broadridge has monopoly power and charges the issuers the maximum fees that are allowed by the stock exchanges (Laster, 2016). Since blockchain technology allows direct communication between issuers and investors, it has the potential to eliminate the need for Broadridge to coordinate among the issuers, custodians, and shareholders. Even if the issuers still use the services (e.g. proxy distribution) provided by Broadridge, the fees will be lower if blockchain is an accepted alternative. Thus, an event that raises investors' expectation on the likelihood of Delaware blockchain legislation is likely to be perceived as bad news by investors of Broadridge. A finding of significant negative stock return for Broadridge on any of the event dates would increase the confidence that the event has raised investors' expectation on the likelihood of blockchain stock ownership legislation. However, I acknowledge that this approach is subject to several limitations. First, stock return of an individual stock is more likely to be influenced by idiosyncrasies than returns of a portfolio. Second, to the extent that firms will not switch to blockchain to keep their stock ownership and this is rationally anticipated by investors of Broadridge, one may not be able to observe a significant negative return even if the event did increase the likelihood of the legislation.

The results of Broadridge's event stock returns are presented in Table 1. The candidate event, event date and event description are listed in columns (1), (2) and (3), respectively. The event windows vary between two and three days as discussed below. The Candidate Event #1 was distributed by PR Newswire on 9:00 am EST on April 5, 2016. The Candidate Event #2 started at

9:30 am EST on May 2, 2016. The Candidate Event #3 occurred between 12:30 pm and 1:45 pm CST on Thursday, September 29, 2016. To account for the fact that these events occurred before the market closed and for the possibility of information leakage, I define the event window for the Candidate Event #1, #2 and #3 as a two-day window including the day of the event and the trading day before the event. In contrast, the exact timing of Candidate Event #4 to Candidate Event #10 cannot be identified from any public sources. As such, I use as the event window the three-day window including the trading day before the event, the day of the event and the trading day after the event to allow for the possibility of information leakage and the possibility that the news is disseminated after the trading hours of the event dates.

For each window, I examine stock return of Broadridge on each trading day (column (4)) to capture the subtle timing of information dissemination. For each event date, I further search Factiva, LexisNexis, and Google news to confirm that there is no other significant company-specific news (e.g., earnings announcement, earnings forecast, M&A). Column (5), (6) and (7) report the event returns, size-adjusted returns and industry-adjusted returns for Broadridge, respectively. I evaluate whether these return measures are unusually low on the event dates relative to their distribution over nonevent trading days from April 1, 2015 to March 31, 2016, which is the most recent month-end before April 5, 2016, when news about the Delaware Blockchain Initiative appeared in the media for the first time. To assess the statistical significance of the event returns, I calculate the *t*-statistic as the difference between the event return measures and mean of the return measures over these nonevent trading days divided by the time-series standard deviation of the return measures over the nonevent trading days. I find the three return measures of Broadridge to be all significantly lower than the over-time means of nonevent returns on

September 29, 2016. However, I do not find significantly lower returns of Broadridge on other candidate event dates. This result confirms my event analysis in Chapter 4.2. Thus, I focus on Candidate Event #3, referred to as the event hereafter, in the subsequent main empirical analysis.

Table 1: Stock Returns of Broadridge for Each Trading Day for the Ten Candidate Event Windows

Candidate Event	Event Date (Time, if available)	Description	Day	Broadridge		
				Return	Size-Adjusted AR	Industry-Adjusted AR
(1)	(2)	(3)	(4)	(5)	(6)	(7)
#1	April 5, 2016 (9:00 am EST)	Governor Jack Markell announced the establishment of the Delaware Blockchain Initiative.	-1	-74.049 (-0.61)	15.342 (0.08)	-11.293 (-0.10)
			0	-67.819 (-0.56)	36.724 (0.29)	37.184 (0.38)
#2	May 2, 2016 (8:20 am EST)	Governor Markell unveiled the details of the Delaware Blockchain Initiative in a keynote speech at Consensus 2016.	-1	18.416 (0.11)	61.889 (0.55)	102.018 (1.02)
			0	190.508 (1.44)	132.930 (1.26)	119.297 (1.19)
#3	September 29, 2016 (12:30 pm CST)	Delaware Chancery Court Vice Chancellor J. Travis Laster delivered a speech to the CII favoring blockchain.	-1	43.435 (0.30)	-43.186 (-0.51)	6.472 (0.07)
			0	**-286.868 (-2.25)**	**-184.532 (-1.92)**	**-254.098 (-2.51)**
#4	March 13, 2017	The Corporate Council of the Corporation Law Section of the DSBA released draft legislation to amend the DGCL.	-1	30.603 (0.20)	-7.757 (-0.15)	-21.171 (-0.20)
			0	35.036 (0.23)	-2.275 (-0.10)	23.574 (0.24)
			1	4.364 (0.00)	52.518 (0.45)	49.793 (0.50)
#5	March 27, 2017	The Corporation Law Section of the DSBA approved proposed	-1	-36.759 (-0.32)	-45.469 (-0.53)	-21.810 (-0.21)
			0	-30.992 (-0.28)	-28.838 (-0.36)	-20.043 (-0.19)

Candidate Event	Event Date (Time, if available)	Description	Day	Broadridge		
				Return	Size-Adjusted AR	Industry-Adjusted AR
(1)	(2)	(3)	(4)	(5)	(6)	(7)
		amendments to the DGCL.	1	42.930 (0.30)	-33.846 (-0.41)	-7.736 (-0.07)
#6	May 5, 2017	Senate Bill 69 was introduced and assigned to Elections & Government Affairs Committee in Senate.	-1	-28.832 (-0.26)	4.290 (-0.03)	-93.878 (-0.92)
			0	-37.588 (-0.33)	-140.510 (-1.48)	-21.179 (-0.20)
			1	-76.913 (-0.63)	-35.448 (-0.43)	-55.906 (-0.55)
#7	June 6, 2017	Senate Bill 69 was passed by Senate with 20 yes and 1 not voting.	-1	-99.163 (-0.80)	-56.817 (-0.64)	-124.661 (-1.23)
			0	-133.975 (-1.07)	-115.633 (-1.23)	-93.487 (-0.92)
			1	30.323 (0.20)	36.744 (0.29)	35.776 (0.36)
#8	June 14, 2017	Senate Bill 69 was reported out of Committee (Judiciary) in House with 9 on its merits.	-1	136.913 (1.02)	61.566 (0.54)	65.699 (0.66)
			0	-3.990 (-0.07)	47.180 (0.40)	8.228 (0.09)
			1	71.846 (0.52)	118.961 (1.12)	86.934 (0.87)
#9	June 30, 2017	Senate Bill 69 was passed by house with 40 yes and 1 no.	-1	-123.651 (-0.99)	-60.178 (-0.67)	18.168 (0.19)
			0	63.931 (0.46)	43.935 (0.37)	63.760 (0.64)
			1	-46.321 (-0.39)	-106.266 (-1.14)	-36.833 (-0.36)
#10	July 21, 2017	Senate Bill 69 was signed by governor.	-1	-37.071 (-0.32)	-20.784 (-0.28)	-55.329 (-0.54)
			0	1.329 (-0.03)	17.529 (0.10)	-35.555 (-0.34)
			1	96.997 (0.71)	82.254 (0.75)	92.432 (0.93)

Note: The table reports stock returns of Broadridge for each trading day for the ten candidate event windows. Variable definitions are provided in the Appendix A. *T*-statistics are reported in parentheses and are calculated from the empirical time-series distribution of stock returns measures of Broadridge over nonevent trading days between April 1, 2015 and March 31, 2016. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, based on two-tailed tests. Stock returns measures of Broadridge significant at the 0.1 level (two-tail) appear in boldface.

CHAPTER 5

EMPIRICAL ANALYSIS

5.1 Research Design

I infer whether using blockchain to record corporations' stock ownership can improve shareholder value by examining equity market reaction to the event. Because stock returns are correlated cross-sectionally (Kothari and Warner, 2007), I use the time series to calculate *t*-statistics and evaluate statistical significance (Dodd et al., 1984; Kothari and Warner, 2007; Cohn, Gillan, and Hartzell, 2016). The test statistic essentially evaluates whether an estimate is unusual relative to its distribution over nonevent windows. More specifically, the nonevent windows are defined as the non-overlapping two-day windows from April 1, 2015 to March 31, 2016. To assess the statistical significance of a certain estimate, I first calculate the same estimate or run the same regression to obtain the estimate for each nonevent window to generate an empirical distribution for this estimate. I then compute the time-series mean and standard deviation of these estimates for this empirical distribution. The *t*-statistic is calculated as the difference between the estimate and mean of the estimates over the nonevent windows divided by the time-series standard deviation of the estimates over the nonevent windows.

I use raw return as the main stock return measure. Kothari and Warner (2007) show that risk-adjustment in the short-window test is typically unimportant. Furthermore, the design of using the time-series to evaluate the statistical significance of a certain estimate mitigates the effect of risk on the results, since the average factor risk premium and factor loading are captured by the over-time mean and standard error of the empirical distribution of the estimate. To ensure robustness, I also use size-adjusted return and industry-adjusted return as the dependent variables.

5.2 Sample Selection

The sample selection process is summarized in Table 2. To construct a test sample for the average market reaction, I start with 4,338 firms incorporated in the United States with (1) fiscal year ending within one year on or prior to March 31, 2016, (2) nonmissing total assets and market capitalization, and (3) nonmissing industry classifications. I retain 3,902 firms with only a single class of shares as dual-class firms operate under unique corporate governance arrangements and it is difficult to calculate the variable of vote outcome accurately for these firms using ISS Voting Analytics (Babenko, Choi, and Sen, 2018).[24] To maintain constant portfolio membership, I require firms to have nonmissing stock returns for the nonevent trading days from April 1, 2015 to March 31, 2016 and event days of September 28, 2016 and September 29, 2016.[25]

I further exclude duplicate observations, firms that belong to the financials industry (two-digit GICS = 40) or the equity real estate investment trusts industry (REITs) (GICS = 601010) and Broadridge. As financial firms may serve as bank/brokerage custodians, these firms may benefit from the general benefits of blockchain recordkeeping of stock ownership but may also be hurt as blockchain technology has the potential to make these traditional intermediaries unnecessary. I exclude REITs because they have unique corporate ownership and governance structure; I exclude Broadridge because it provides proxy processing service for the custodians and thus also runs the risk of being negatively impacted by blockchain recordkeeping of stock ownership. These

[24] The procedures to identify dual-class firms follow Babenko, Choi, and Sen (2018).

[25] The results are similar if I only require firms to have stock returns for the event dates.

procedures reduce the sample size to 2,523, out of which 1,792 firms are incorporated in Delaware and 731 firms are incorporated in other states.

Table 2: Sample Selection

Step	Description	No. of Firms	No. of Firms incorporated in Delaware	Sample for
1.	All firms incorporated in the U.S. per CRSP/Compustat Merged Dataset with (1) fiscal year ending within one year on or prior to March 31, 2016, (2) nonmissing total assets and market capitalization, and (3) nonmissing industry classifications.	4,338		
2.	Retain firms with a single class of shares.	3,902		
3.	Require nonmissing stock returns for the nonevent trading days from April 1, 2015 to March 31, 2016 and event days of September 28, 2016 and September 29, 2016.	3,307		
4.	Exclude duplicate observations.	3,300		
5.	Exclude firms that belong to the financials industry (GICS=40) or equity real estate investment trusts industry (GICS=601010).	2,524		
6.	Exclude Broadridge Financial Solutions, Inc. (ticker='BR').	2,523	1,792	Table 3
7.	Require at least one vote record within one year on or prior to March 31, 2016.	2,318	1,626	Table 4
8.	Require *ROA.*	2,293		
9.	Require at least one annual meeting date on or prior to March 31, 2016.	2,280		
10.	Require *InstOwn.*	2,262	1,578	Table 6

Note: The table shows a summary of the sample selection procedures for the samples used in the subsequent empirical analyses.

5.3 Average Market Reaction to the Event

Table 3 reports the results of testing the stock market reactions to the event. The raw returns, size-adjusted returns, and industry-adjusted returns are summed up over the two trading days in the event window and are denoted as *CR*, *Size-Adjusted CAR*, and *Industry-Adjusted CAR*, respectively. In column (1) and column (2), I calculate equal-weighted portfolio returns for Delaware- and non-Delaware-incorporated firms, respectively. Column (3) tests the difference in returns between the two portfolios. Across the three columns, I do not find significant portfolio returns for Delaware-incorporated firms or significant difference in portfolio returns between Delaware- and non-Delaware-incorporated firms during the event window. Thus, the results are inconclusive about on average whether the market considers blockchain recordkeeping of stock ownership to be value increasing.

Table 3: Average Market Reaction to the Event

		Delaware = 1	*Delaware* = 0	Difference
		(1)	(2)	(3)
CR	Mean	-18.611	-14.011	-4.601
		(-0.03)	(-0.04)	(0.03)
Size-Adjusted CAR	Mean	-11.547	-7.091	-4.457
		(-0.10)	(-0.26)	(0.04)
Industry-Adjusted CAR	Mean	-3.459	0.757	-4.216
		(0.17)	(0.23)	(0.02)
	N	1,792	731	

Note: The table presents the equal-weighted average of stock returns measures over the event window. Column (1) and (2) present the results for Delaware-incorporated and non-Delaware-incorporated firms, respectively. Column (3) presents differences in average returns between column (1) and column (2). Variable definitions are provided in the Appendix A. *T*-statistics are reported in parentheses and are calculated from the empirical time-series distribution of mean stock returns or differences in mean stock returns over nonevent windows between April 1, 2015 and March 31, 2016. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, based on two-tailed tests.

5.4 Sensitivity of Proposal Approval or Rejection to Voting Errors and Market Reaction: Baseline Results

I measure the sensitivity of a firm's proposal approval or rejection to voting errors with whether a firm has a recent close-call vote. A small error in proxy voting is likely to affect approval or rejection of a proposal when and only when the difference between vote result and vote requirement is small. For instance, a manager-sponsored proposal on executive compensation that passed by a margin of 3% perhaps should have been rejected in the first place had there been no errors in voting, while for the same type of proposal that passed by a margin of 30%, errors in voting probably would not have any direct effect on firm policy. The former case is likely to be more detrimental to shareholder value than the latter and benefit more from blockchain recordkeeping of stock ownership.

Specifically, I define a dummy variable, *CloseVote*, which equals 1 if the firm has at least one close-call vote in the one-year period on or prior to March 31, 2016, where close-call vote refers to the case in which the difference between vote result and vote requirement is between -5% and 5%.[26] Vote result and vote requirement are calculated or obtained from Voting Analytics. Vote result is "Vote For" divided by a company-specific "base," which can be the sum of "Vote For" and "Vote Against," the sum of "Vote For," "Vote Against," and "Abstention," or the number of shares outstanding (Malenko and Shen, 2016). I do not consider votes to be close-call votes when

[26] A maintained assumption underlying the measure is that firms that had a recent close-call vote are more likely to have close-call votes in the future. Indeed, using the universe of firms from ISS Voting Analytics, I find that firms that have a close-vote in year *t* are 24% more likely to have a close-vote from *t+1* to *t+5* than firms that do not. The 5% cutoff point is chosen because Delaware lawyers suggest that within the range of [-5%, 5%] relative to the threshold, the answer to the question "who won?" is not verifiable (Kahan and Rock, 2008, page 1279). The choice is also consistent with the prior empirical studies in proxy voting such as Christoffersen et al. (2007).

the vote requirement is equal to 0.01 in Voting Analytics. These cases typically indicate director election under plurality voting (96.44%) or advisory vote on say-on-pay frequency (1.25%), for which *CloseVote* is not well-defined. 98.68% of the votes have majority (0.5) as the vote requirement. I require firms to have at least one vote record from Voting Analytics within one year on or prior to March 31, 2016 to avoid any database coverage bias. Table 2 shows that after the procedure, the sample is reduced to 2,318 firms, out of which 1,626 firms are incorporated in Delaware and 692 firms are incorporated in other states.

Panel A of Table 4 presents summary statistics for this analysis. Since the event affects only firms incorporated in Delaware, I focus on the summary statistics of the 1,626 Delaware-incorporated firms. Panel A shows the industry distribution for firms with *CloseVote* = 1 (*N* = 79) and firms with *CloseVote* = 0 (*N* = 1,547). Both sets of firms span almost all sectors (two-digit GICS) of the economy.

Panel B of Table 4 reports the results of examining the effect of the sensitivity of proposal approval or rejection to errors on stock returns over the event window by regressing the cumulative return measures (*CR*, *Size-Adjusted CAR*, and *Industry-Adjusted CAR*) on the indicator variable *CloseVote*. Column (1) presents the results for Delaware-incorporated firms. The results reveal that for firms incorporated in Delaware, the cumulative stock returns of firms with *CloseVote* = 1 are 180 basis point higher than firms with *CloseVote* = 0. The estimate is economically large and is statistically significant at the level of 1%. The results are similar using *Size-adjusted CAR* and *Industry-Adjusted CAR* as dependent variables, suggesting that the results for *CR* are not likely driven by size or industry factors correlated with *CloseVote*.

Table 4: Sensitivity of Proposal Approval or Rejection to Voting Errors and Market Reaction: Baseline Results

Panel A: Industry Distribution: Delaware-Incorporated Firms

2-Digit GICS	Sector	*CloseVote* = 1	*CloseVote* = 0	Total
10	Energy	11 13.92%	118 7.63%	129 7.93%
15	Materials	4 5.06%	84 5.43%	88 5.41%
20	Industrials	12 15.19%	251 16.22%	263 16.17%
25	Consumer Discretionary	12 15.19%	225 14.54%	237 14.58%
30	Consumer Staples	1 1.27%	64 4.14%	65 4.00%
35	Health Care	22 27.85%	391 25.27%	413 25.40%
45	Information Technology	15 18.99%	360 23.27%	375 23.06%
50-55	Telecommunication Services and Utilities	2 2.53%	44 2.84%	46 2.83%
60	Real Estate	0 0.00%	10 0.65%	10 0.62%
	Total	79	1,547	1,626

Panel B: Results

Dependent Variable		*Delaware* = 1 (1)	*Delaware* = 0 (2)	Difference (3)
CR	*CloseVote*	179.719***	20.849	158.869*
		(2.87)	(0.21)	(1.76)
	Intercept	-30.666	-13.780	
		(-0.10)	(-0.05)	
	Adj. R-squared	0.008	-0.001	
Size-Adjusted CAR	*CloseVote*	186.433***	22.846	163.587*
		(2.94)	(0.25)	(1.82)
	Intercept	-23.524	-6.361	
		(-0.36)	(-0.24)	
	Adj. R-squared	0.009	-0.001	
Industry-Adjusted CAR	*CloseVote*	137.369**	-64.142	201.511**
		(2.47)	(-0.99)	(2.22)
	Intercept	0.693	6.872	
		(0.21)	(0.36)	
	Adj. R-squared	0.007	0.000	
	N	1,626	692	

Note: The table presents industry distribution (Panel A) and regression results (Panel B) for the analysis of how the market reaction to the event varies with the sensitivity of proposal approval or rejection to errors. Variable definitions are provided in the Appendix A. In Panel B, columns (1) and (2) present the results for Delaware-incorporated and non-Delaware-incorporated firms, respectively. Column (3) shows differences in coefficient estimates between column (1) and column (2). *T*-statistics are reported in parentheses and are calculated from the empirical time-series distribution of coefficients obtained from running the same regression or differences in coefficients over nonevent windows between April 1, 2015 and March 31, 2016. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, based on two-tailed tests.

Untabulated results reveal that the average event *CR*, *Size-Adjusted CAR*, and *Industry-Adjusted CAR* for firms with *CloseVote* = 1 are 149 (insignificant at the conventional level), 163 (significant at the level of 10%), and 138 (significant at the level of 10%) basis points, respectively. Thus, the evidence is mixed as to whether blockchain recordkeeping of stock ownership is on average beneficial for shareholders.

5.5 Sensitivity of Proposal Approval or Rejection to Voting Errors and Market Reaction: Alternative Explanations

One potential concern of the results in Table 4, Panel B is that *CloseVote* is correlated with some macroeconomic shock over the event window that leads to the result. To mitigate this concern, I perform a placebo test by running the same regression for firms that are not incorporated in Delaware (shown in column (2)). If the results are driven by a correlated macro-shock, I should observe that it affects non-Delaware-incorporated firms as well. However, the results fail to show a significant effect of *CloseVote* on stock returns for non-Delaware-incorporated firms. Moreover, as shown in column (3), I find that the coefficient estimate on *CloseVote* for Delaware-incorporated firms and non-Delaware-incorporated firms are significantly different. Collectively, the results are consistent with the view that market participants perceive blockchain recordkeeping of stock ownership as incrementally beneficial for firms whose proposal approval or rejection is sensitive to errors in proxy voting.

Another potential alternative explanation is that *CloseVote* proxies for some risk factor that drives the results. The design of the significance test using the time-series of coefficient estimates obtained from running the same regression over nonevent windows mitigates this concern, because the risk factors should have caused the same pattern for the coefficient before *CloseVote* during nonevent windows. In fact, the t-statistic of 2.87 suggests that a coefficient estimate as large as 180 is rarely observed during the nonevent windows. I further evaluate whether the relation between *CloseVote* and stock returns over the days in the event window (i.e. t and $t - 1$) is large compared with the relations between *CloseVote* and stock returns during the adjacent days (i.e. $t - 10$ to $t - 2$ *and* $t + 1$ *to* $t + 10$). The analysis helps further rule out the alternative explanation that omitted variables correlated with *CloseVote* drive the results. Since the alternative explanation is not specific to the event window, significant coefficient estimates before *CloseVote* should also be observed over the windows adjacent to the event window if the alternative explanation is true. In contrast, the finding that significant coefficient estimates on *CloseVote* are observed only over the days in the event window would help rule out the alternative explanation.

I examine the effect of *CloseVote* on stock returns measures for the days -10 through +10 relative to the event date. The coefficients obtained from regressing return measures on *CloseVote* are portrayed in Figure 2 and detailed in Table 5. Figure 2 shows a "spike" of estimated coefficients that appears unique to Day -1 and Day 0. The visual evidence is confirmed in Table 5. Column (1) reveals that the coefficient estimates obtained from regressions using raw returns are as high as 94 and 87 for Day -1 and Day 0, respectively, both of which are significant at the conventional level as shown in column (2). In contrast, significant coefficients are not observed outside the event window (i.e. Day -1 and Day 0). Column (3) to column (6) further evaluate the results using alternative stock returns measures including size-adjusted abnormal returns and industry-adjusted abnormal returns. The results show that regression coefficients obtained from all the return measures are never consistently positive and significant on adjacent dates. The evidence suggests that the alternative explanation that the results are driven by omitted variables correlated with *CloseVote* is very unlikely.

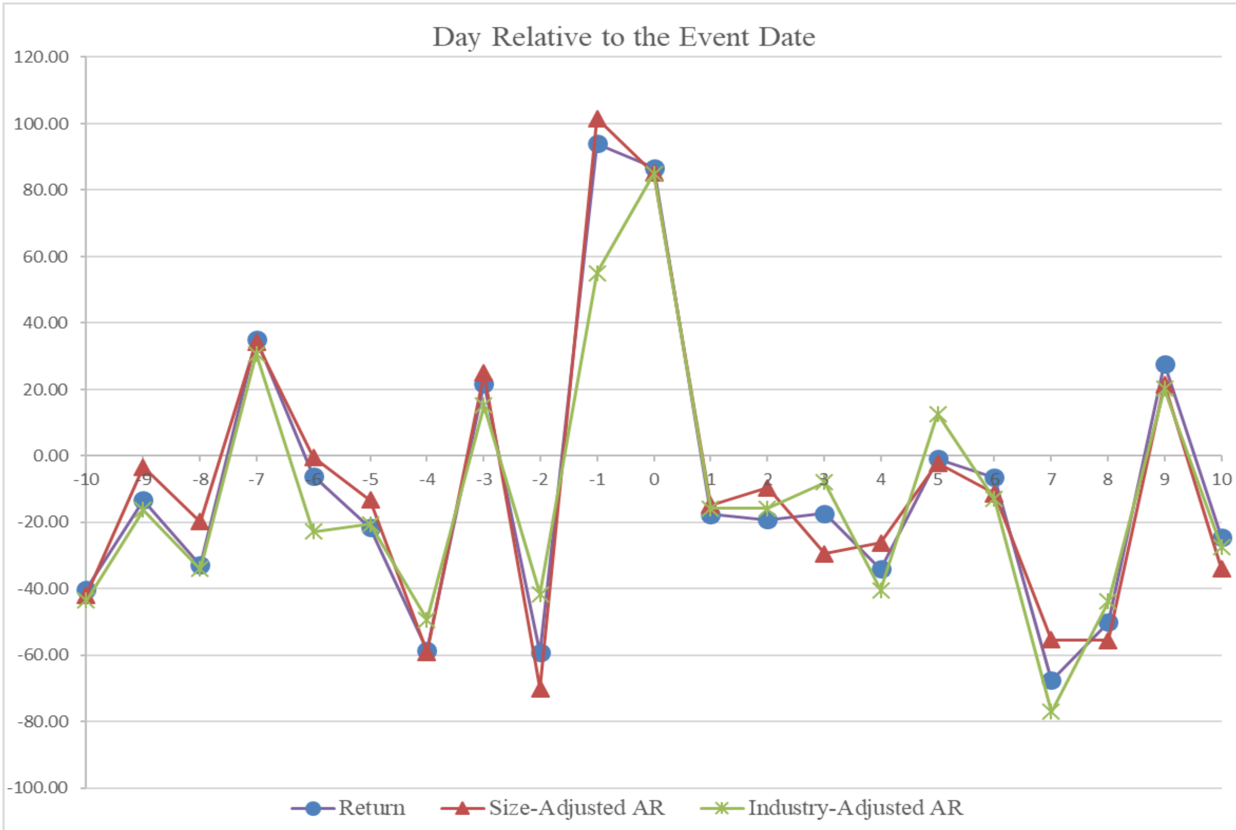

Figure 2: Sensitivity of Proposal Approval or Rejection to Voting Errors and Market Reaction: A Time-Series Analysis

Note: The figure shows a plot of coefficient estimates by day from regressions of stock return measures on *CloseVote* for Delaware-incorporated firms. Variable definitions are provided in the Appendix.

Table 5: Sensitivity of Proposal Approval or Rejection to Voting Errors and Market Reaction: Time-Series Analysis

Day Relative to the Event Date	*Return*		*Size-Adjusted AR*		*Industry-Adjusted AR*	
	coefficient	*t*	coefficient	*t*	coefficient	*t*
	(1)	(2)	(3)	(4)	(5)	(6)
-10	-40.020	-0.91	-41.929	-0.92	-43.487	-1.12
-9	-13.236	-0.30	-3.277	-0.04	-16.187	-0.41
-8	-32.854	-0.75	-19.756	-0.42	-33.977	-0.88
-7	35.142	0.82	34.265	0.82	30.788	0.81
-6	-5.973	-0.13	-0.363	0.03	-22.759	-0.58
-5	-21.543	-0.49	-13.339	-0.27	-20.486	-0.52
-4	-58.442	-1.34	-59.098	-1.31	-49.317	-1.27
-3	21.822	0.51	24.889	0.60	15.243	0.41
-2	-59.236	-1.36	-70.014	-1.56	-41.609	-1.07
-1	**94.044**	**2.18**	**101.493**	**2.35**	55.093	1.44
0	**86.667**	**2.01**	**85.053**	**1.97**	**84.905**	**2.22**
1	-17.645	-0.40	-14.727	-0.30	-15.748	-0.40
2	-19.169	-0.43	-9.506	-0.18	-15.833	-0.40
3	-17.277	-0.39	-29.402	-0.64	-7.982	-0.20
4	-34.055	-0.78	-26.178	-0.56	-40.354	-1.04
5	-0.790	-0.01	-2.136	-0.01	12.621	0.34
6	-6.472	-0.14	-11.336	-0.22	-12.947	-0.33
7	-67.547	-1.55	-55.348	-1.23	**-76.911**	**-1.99**
8	-49.947	-1.14	-55.479	-1.23	-43.770	-1.13
9	27.703	0.65	21.488	0.52	20.247	0.54
10	-24.387	-0.55	-33.887	-0.74	-27.291	-0.70

Note: The table presents coefficient estimates and corresponding *t*-statistics by day from regressions of stock returns measures on *CloseVote* for Delaware-incorporated firms. Variable definitions are provided in the Appendix A. *T*-statistics are calculated from the empirical time-series distribution of returns measures of coefficients obtained from running the same regression for nonevent trading days between April 1, 2015 and March 31, 2016. Coefficient estimates significant at the 0.1 level (two-tail) appear in boldface.

5.6 Sensitivity of Proposal Approval or Rejection to Voting Errors and Market Reaction: Cross-Sectional Variation

I further explore the factors that influence the relation between stock returns and sensitivity of proposal approval or rejection to errors. First, I expect that the relation is more pronounced for firms with higher likelihood of proxy voting errors. In the extreme case in which no error occurs in a firm's proxy voting, I would not find blockchain recordkeeping of stock ownership to be beneficial for shareholders even if the proposal approval or rejection is sensitive to errors. Second, I expect that the relation is more pronounced for firms with worse performance. Curtailing errors in proxy voting results using blockchain recordkeeping is likely to be more pivotal for poorly-performing firms in the industry, because for these firms, decision making based on reliable voting results can improve performance if poor performance is due to agency problems or uninformed managerial decision making. The use of performance is motivated by prior studies that show that voting is more important for bad performers. Using the setting of the equity lending market, Christoffersen et al. (2007) show that vote trading is greater for firms with worse performance, especially when these firms have close-call votes. Aggarwal, Saffi, and Sturgess (2015) show that share recalls by institutional investors are significantly larger for firms with worse performance.

I measure the likelihood of proxy voting errors with a firm's short interest and whether a firm's annual meeting is held in the busy proxy season—that is, second quarter of the calendar year. Short-sellers must "borrow" shares first to sell the stocks at a price they believe will decline in the future.[27] However, equity lending often causes errors in voting. As discussed in Chapter 2.1,

[27] As discussed in footnote 11, the standard contract of equity lending is essentially a repurchase agreement (Kahan and Rock, 2008).

beneficial owners usually grant the custodians the right to lend out shares without notifying these owners. Consequently, overvoting often occurs when the beneficial owner casts the votes along with the borrowers (i.e. short-sellers) or their buyers (Kahan and Rock, 2008). Regarding the second measure, Kahan and Rock (2008) estimate that there are around 17,000 reporting companies and most of them need to comply with the proxy rules mandated by SEC when they solicit proxies. Furthermore, most of the annual meetings of these companies take place during the second calendar quarter of the year (Broadridge, 2007). The sheer large number of companies and the clustering of proxy seasons are likely to subject the proxy voting results to errors. As Kahan and Rock (2008, page 1249) wrote, "It is an accident waiting to happen." I use both industry-adjusted stock returns and industry-adjusted return-on-assets to measure firm performance.

To examine how the likelihood of proxy errors and firm performance affect the relation between sensitivity of proposal approval or rejection and stock returns during the event window, I estimate the following equation.

$$\begin{aligned} CR = \alpha &+ \beta_1 CloseVote \times CVAR + \beta_2 CloseVote \times Size + \beta_3 CloseVote \times BM \\ &+ \beta_4 CloseVote \times InstOwn + \beta_5 CloseVote + \beta_6 CVAR + \beta_7 Size \\ &+ \beta_8 BM + \beta_9 InstOwn + \varepsilon, \end{aligned} \tag{1}$$

where *CR* and *CloseVote* are as defined above. *CVAR* indicates one of the conditioning variables including *SI*, *Busy*, *LagReturn*, and *ROA*. *SI* and *Busy* measure the likelihood of proxy errors. *SI* is short-interest ratio measured as the daily open short interest divided by total shares outstanding averaged across one year on and prior to March 31, 2016. $Busy$ is a dummy variable that equals 1 if the firm's most recent annual meeting prior to March 31, 2016 is held in the second calendar quarter of the year and 0 otherwise. *LagReturn* and *ROA* measure firm performance. *LagReturn* is one-year buy-hold industry-adjusted stock return ending March 31, 2016. ROA is industry-adjusted operating income after depreciation divided by lagged total assets as of the most recent fiscal-year end on or prior to March 31, 2016. *Size*, *BM* and *InstOwn* are control variables, where *Size* and *BM* are risk factors and *InstOwn* proxies for short-sale constraints that also explain the cross-section of stock returns (Nagel, 2005). *Size* is calculated as the natural logarithm of market value of equity (in millions) as of March 31, 2016. *BM* is the ratio of book value of equity to market value of equity as of the most recent fiscal-year end on or prior to March 31, 2016. *InstOwn* is the percentage of outstanding shares held by institutional investors as of the most recent calendar-quarter end on or prior to March 31, 2016.

Table 2 shows that after requiring the availability of the conditioning variables and control variables, the sample is reduced to 2,262 firms, out of which 1,578 are Delaware-incorporated firms. Panel A of Table 6 presents the summary statistics for Delaware-incorporated firms. I find that firms with *CloseVote* = 1 have a larger mean of market capitalization, industry-adjusted return-to-asset, institutional ownership and median of market capitalization than firms with *CloseVote* = 0. The average firm with *CloseVote* = 1 (*CloseVote* = 0) has a short interest of 0.061 (0.056), a one-year buy-hold industry-adjusted return of −15.63% (−18.34%), an industry-adjusted return-to-asset of 7.0% (1.5%), a market capitalization of 16.746 billion (4.934 billion), a book-to-market of 0.526 (0.474) and an institutional ownership of 60.8% (56.5%); 77.6% (77.0%) of the firms with *CloseVote* = 1 (= 0) have their annual meetings held in the second calendar quarter of the year.

Columns (1), (2), (3), and (4) of Panel B of Table 6 present the results from estimating equation (1) for Delaware-incorporated firms and for each of the four conditioning variables.

Consistent with the predictions, column (1), (2), (3), and 4) show that the effect of *CloseVote* on stocks returns is more pronounced for firms with higher *SI*, *Busy* equal to 1, lower *LagReturn* and lower *ROA*, respectively. In terms of the economic magnitude, I find that a one-standard-deviation increase in *SI*, in *LagReturn*, and in *ROA* increase the effect of *CloseVote* on *CR* by 130 basis points (0.059*2205.211), 120 basis points (3256*0.037), and 143 basis points (0.240*596.282), respectively. I also find that the effect of *CloseVote* on *CR* is 189 basis points higher for firms with *Busy* equal to 1 than for firms with *Busy* equal to 0. The results also reveal that stock returns are higher for firms with higher *BM*, suggesting that blockchain recordkeeping of stock ownership may be more beneficial for mature firms, as opposed to growth firms.

I further include all interactions of *CloseVote* and *CVAR* in column (6). The results again confirm that the effect of *CloseVote* on stocks returns are more pronounced for firms with higher *SI*, *Busy* equal to 1, lower *LagReturn* and lower *ROA.* In this column, the coefficient before *CloseVote* × *Size* is significantly positive. The result suggests that accurate voting results are more valuable for larger firms, presumably because larger firms have larger shareholder bases, which lead to a greater likelihood of errors in proxy voting. Overall, the results are consistent with the view that blockchain recordkeeping of stock ownership bring greater benefits to firms with close-call votes when the likelihood of proxy voting errors is higher and when firms experience worse performance.

Table 6: Sensitivity of Proposal Approval or Rejection to Voting Errors and Market Reaction: Cross-Sectional Variation

Panel A: Descriptive Statistics

	CloseVote = 1, No. of Firms = 76			*CloseVote* = 0, No. of Firms = 1,502		
	Mean	Median	Std.	Mean	Median	Std.
SI	0.061	0.036	0.068	0.056	0.037	0.058
Busy	0.776	1.000	0.419	0.770	1.000	0.421
LagReturn	-1,562.775	-1,277.774	3,073.956	-1,833.841	-1,785.574	3,265.379
ROA	0.070**	0.029	0.229	0.015	0.020	0.241
MCAP	16,746.468***	2,694.446**	28,586.394	4,934.402	763.336	14,390.772
BM	0.526	0.408	0.711	0.474	0.380	0.556
InstOwn	0.608*	0.660	0.217	0.565	0.633	0.246

Panel B: Regression Results

Dependent Variable = *CR*	(1)	(2)	(3)	(4)	(5)
CloseVote * *SI*	2205.211**				2302.276**
	(2.06)				(2.15)
CloseVote * *Busy*		189.139*			285.573***
		(1.89)			(2.69)
CloseVote * *LagReturn*			-0.037*		-0.042**
			(-1.87)		(-2.10)
CloseVote * *ROA*				-596.282**	-618.883***
				(-2.46)	(-2.62)
CloseVote * *Size*	0.940	-15.660	-8.284	0.290	48.238**
	(0.14)	(-0.55)	(-0.30)	(0.09)	(2.23)
CloseVote * *BM*	98.347	64.456	36.492	65.740	91.642
	(1.11)	(0.74)	(0.43)	(0.76)	(1.03)
CloseVote * *InstOwn*	-71.483	-20.102	137.577	264.553	-192.210
	(-0.19)	(-0.03)	(0.41)	(0.72)	(-0.59)
CloseVote	21.658	124.266	74.397	16.142	-518.653*
	(0.02)	(0.41)	(0.25)	(0.01)	(-1.75)
SI	-290.757				-311.994
	(-0.33)				(-0.48)
Busy		-4.767			-5.075
		(-0.02)			(-0.10)

Dependent Variable = *CR*	(1)	(2)	(3)	(4)	(5)
LagReturn			-0.002		-0.003
			(-0.74)		(-0.89)
ROA				-36.411	-32.340
				(-0.57)	(-0.45)
Size	7.733	8.567	10.026	9.527	10.312
	(0.08)	(0.11)	(0.47)	(0.20)	(0.49)
BM	135.632**	135.949**	134.575**	136.852**	134.689**
	(2.57)	(2.58)	(2.56)	(2.55)	(2.50)
InstOwn	58.147	35.203	34.194	40.339	65.192
	(0.52)	(0.30)	(0.28)	(0.38)	(0.65)
Intercept	-168.610	-174.030	-190.606	-186.851	-188.848
	(-0.51)	(-0.55)	(-0.92)	(-0.60)	(-1.05)
N	1,578	1,578	1,578	1,578	1,578
Adj. R-squared	0.049	0.045	0.048	0.049	0.058

Note: The table reports descriptive statistics (Panel A) and regression results (Panel B) for the analysis of the cross-sectional variation in the relation between sensitivity of proposal approval or rejection to voting errors and market reactions. Variable definitions are provided in the Appendix A. ***, **, and * in Panel A indicate significance at the 1%, 5%, and 10% levels, respectively, based on a two-sample *t*-test or a nonparametric median test. Panel B reports the coefficient estimates from estimating equation (1). *T*-statistics are reported in parentheses and are calculated from the empirical time-series distribution of coefficients obtained from running the same regression over nonevent windows between April 1, 2015 and March 31, 2016. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, based on two-tailed tests.

5.7 Additional Analyses

5.7.1 Separating Shareholder-Sponsored Proposals From Management-Sponsored Proposals

The literature on shareholder voting often studies shareholder proposals separately from management proposals (e.g. Christofferson et al., 2007; Kalay, Karakas, and Pant, 2014; Aggarwal, Saffi, and Sturgess, 2015) as shareholder proposals are important forms of shareholder activism (Gillan and Starks, 2007; Ferri, 2012; Denes, Karpoff, and McWilliams, 2016). While mostly nonbinding, shareholder proposals have often been implemented in recent years by the company's board when these proposals receive majority support from shareholders (Ertimur, Ferri, and Stubben, 2012) and thereby bring about changes in corporate governance that affect shareholder value (Cuñat, Gine, and Guadalupe, 2012). In contrast, the fact that shareholders massively approve management-sponsored proposals suggests that management-sponsored proposals are typically not regarded as a disciplinary device by the shareholders (Bach and Metzger, 2018). Thus, blockchain recordkeeping of stock ownership is likely to be more beneficial for firms that have shareholder proposals that receive a close vote than for firms that have management proposals that receive a close vote if shareholders tend to use voting on shareholder proposals rather than on management proposals to address agency problems.

To test this prediction, I decompose *CloseVote* into *CloseVote_SHA* and *CloseVote_MGR*, where *CloseVote_SHA* (*CloseVote_MGR*) is defined as a dummy variable indicating whether the firm has at least one close-call vote for a shareholder- (management-) sponsored proposal in the one-year period on or prior to March 31, 2016. I then regress *CR* on *CloseVote_SHA* and *CloseVote_MGR* for Delaware-incorporated firms. In unreported tables, I find that the coefficient estimate on *CloseVote_SHA* is 233 (t = 3.07, significant at the level of 1%) and that on *CloseVote_MGR* is 124 (t = 1.60). The difference in the coefficient estimates is 109 (t = 0.99). This analysis thus provides evidence supporting the notion that blockchain recordkeeping of stock ownership is more beneficial for firms that have shareholder proposals receive close votes than firms that do not have proposals receive close votes. However, the results are inconclusive about whether blockchain recordkeeping of stock ownership is more beneficial for firms that have shareholder proposals receive close votes than for firms that have management proposals receive close votes.

5.7.2 Impact of Corporate Governance

The paper conjectures that one of the possible means through which blockchain recordkeeping of stock ownership improves shareholder value is by reducing errors in proxy voting, which prevent shareholders from efficiently exercising control rights to mitigate agency problems. If firms with weaker corporate governance mechanisms have more severe agency problems, then blockchain recordkeeping of stock ownership would bring in greater benefits for these firms. Accordingly, in this chapter, I explore whether firms with weaker corporate governance mechanisms benefit more from blockchain recordkeeping of stock ownership by regressing *CR* on a governance proxy, along with *CloseVote*, *Busy*, *LagReturn*, *ROA*, *Size*, *BM*, and *InstOwn*, where the governance proxy is board independence, a CEO/board chair indicator, entrenchment index per Bebchuk, Cohen, and Ferrell (2009) or managerial ownership constructed using RiskMetrics or Execucomp.

In unreported tables, I find that while the coefficient estimate on *CloseVote* remains stable at around 180 and significant at the conventional levels, none of the governance proxies is significant in the regression. I augment the regression by including the interaction of the governance proxy and *CloseVote* to allow the effect of governance proxy on *CR* to vary conditional on whether firms obtain a close-vote or not, as these are the cases wherein approval or rejection of proposals is more likely to be affected by voting errors. However, the interaction effects are also statistically insignificant. Thus, the results are inconclusive about whether governance factors affect the shareholder value impact of blockchain recordkeeping of stock ownership. The inconclusive results may be due to the difficulty in measuring corporate governance. It is not clear whether these indicators of corporate governance (e.g., board independence, E-Index) capture the essence of the complex construct of corporate governance. In fact, prior studies such as Larcker, Richardson, and Tuna (2007) find mixed associations between governance indicators and corporate outcomes. As such, the measurement errors may prevent me from finding meaningful results.

5.7.3 Market Reactions to Other Identified Events

To provide additional evidence on the validity of event selection in Chapter 4, I examine average market reaction and the effect of the sensitivity of proposal approval or rejection to errors on market reaction over all candidate event windows.

Table 7 provides the estimation results. Columns (1), (2) and (3) indicate the candidate event number, the event date and the trading day within the event window, respectively. Columns (4), (5) and (6) report the average stock returns of Delaware-incorporated firms for each trading day within the candidate event window to capture the subtle timing of information dissemination. Using various return measures, I fail to find significant market reaction to the news for any trading days in candidate event windows. The results are thus inconclusive about whether blockchain recordkeeping of stock ownership benefits companies. Columns (7), (8), and (9) further show whether firms whose proposal approval or rejection is sensitive to errors benefit more from blockchain recordkeeping of stock ownership. Using various stock returns measures, however, I find that the effects of *CloseVote* on stock returns are insignificant except for Candidate Event #3, consistent with the conclusion from Chapter 4 that it is not likely that other candidate events have information content.

Table 7: Results Based on Other Candidate Events

Candidate Event	Event Date (Time, if available)	Day	Mean Returns: Return	Mean Returns: Size-Adjusted AR	Mean Returns: Industry-Adjusted AR	Coefficient on *CloseVote*: Return	Coefficient on *CloseVote*: Size-Adjusted AR	Coefficient on *CloseVote*: Industry-Adjusted AR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
#1	April 5, 2016 (9:00 am EST)	-1	-37.794	16.072	3.176	-22.087	-29.254	-20.073
			(-0.24)	(0.52)	(0.23)	(-0.47)	(-0.60)	(-0.48)
		0	-90.708	-9.328	-2.997	21.175	25.927	20.800
			(-0.65)	(-0.17)	(0.11)	(0.49)	(0.62)	(0.54)
#2	May 2, 2016 (8:20 am EST)	-1	-85.037	-47.705	-11.337	21.355	22.510	-12.754
			(-0.61)	(-1.22)	(-0.06)	(0.50)	(0.54)	(-0.29)
		0	22.444	-7.383	-35.058	26.523	15.878	33.450
			(0.23)	(-0.12)	(-0.53)	(0.61)	(0.40)	(0.86)
#3	September 29, 2016 (12:30 pm CST)	-1	90.503	5.164	14.638	**103.143**	**111.759**	64.474
			(0.75)	(0.22)	(0.46)	**(2.32)**	**(2.51)**	(1.63)
		0	-107.912	-15.243	-14.710	**95.283**	**92.775**	**92.543**
			(-0.78)	(-0.33)	(-0.13)	**(2.14)**	**(2.09)**	**(2.33)**
#4	March 13, 2017	-1	37.470	3.486	-16.365	-23.229	-15.588	-17.302
			(0.34)	(0.18)	(-0.16)	(-0.49)	(-0.30)	(-0.41)
		0	61.187	0.154	39.102	-7.855	11.996	-16.335
			(0.53)	(0.09)	(0.95)	(-0.15)	(0.31)	(-0.38)
		1	-99.575	-31.502	-41.015	-32.186	-38.407	-26.123
			(-0.72)	(-0.78)	(-0.65)	(-0.69)	(-0.80)	(-0.63)
#5	March 27, 2017	-1	22.518	8.020	20.412	10.861	12.850	7.160
			(0.23)	(0.30)	(0.58)	(0.26)	(0.33)	(0.20)
		0	61.721	30.815	48.613	-20.894	-13.906	-22.218
			(0.53)	(0.92)	(1.14)	(-0.44)	(-0.26)	(-0.53)
		1	55.879	2.651	0.315	32.049	26.884	27.817
			(0.48)	(0.15)	(0.17)	(0.73)	(0.64)	(0.72)
#6	May 5, 2017	-1	-61.577	-12.193	-52.394	20.877	9.272	45.755
			(-0.42)	(-0.25)	(-0.88)	(0.49)	(0.25)	(1.16)
		0	93.234	24.320	29.161	36.860	46.783	26.862
			(0.77)	(0.75)	(0.75)	(0.84)	(1.08)	(0.69)
		1	-31.932	-16.859	-9.923	8.352	5.992	-1.633
			(-0.19)	(-0.38)	(-0.03)	(0.21)	(0.18)	(-0.02)

Candidate Event	Event Date (Time, if available)	Day	Mean Returns			Coefficient on *CloseVote*		
			Return	Size-Adjusted AR	Industry-Adjusted AR	Return	Size-Adjusted AR	Industry-Adjusted AR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
#7	June 6, 2017	-1	-58.208 (-0.40)	-15.914 (-0.35)	-34.768 (-0.53)	15.228 (0.36)	6.031 (0.18)	12.850 (-0.02)
		0	-7.339 (0.00)	6.214 (0.25)	6.936 (0.31)	-2.044 (-0.02)	3.955 (0.13)	-24.872 (-0.60)
		1	-43.789 (-0.29)	-37.112 (-0.93)	-31.694 (-0.47)	-6.447 (-0.12)	-15.363 (-0.29)	1.825 (0.07)
#8	June 14, 2017	-1	63.386 (0.54)	1.857 (0.13)	0.564 (0.18)	6.530 (0.17)	11.860 (0.31)	6.959 (0.20)
		0	-77.247 (-0.54)	-26.799 (-0.65)	-44.025 (-0.71)	-33.296 (-0.72)	-45.076 (-0.95)	-12.816 (-0.30)
		1	-73.552 (-0.52)	-24.604 (-0.59)	-33.179 (-0.50)	31.871 (0.73)	28.876 (0.68)	30.329 (0.78)
#9	June 30, 2017	-1	-57.303 (-0.39)	-4.808 (-0.05)	43.396 (1.04)	29.281 (0.67)	38.858 (0.90)	16.489 (0.43)
		0	5.477 (0.09)	5.204 (0.22)	-20.364 (-0.24)	-17.182 (-0.36)	-17.965 (-0.35)	-13.722 (-0.32)
		1	57.417 (0.50)	1.154 (0.11)	32.753 (0.83)	39.359 (0.90)	47.846 (1.10)	31.894 (0.82)
#10	July 21, 2017	-1	-6.760 (0.00)	-3.856 (-0.02)	-8.626 (0.00)	-26.382 (-0.56)	-31.284 (-0.64)	-32.762 (-0.79)
		0	-48.429 (-0.32)	-25.830 (-0.62)	-37.113 (-0.58)	-51.697 (-1.13)	-57.742 (-1.23)	-43.319 (-1.05)
		1	-8.386 (-0.01)	-17.374 (-0.39)	-7.006 (0.03)	13.591 (0.32)	20.007 (0.49)	10.880 (0.29)
		N	1,676	1,676	1,676	1,525	1,525	1,525

Note: The table reports the mean stock returns (column (3) – column (5)), and the coefficient estimates from regressing stock return measures on *CloseVote* (column (6) – column (8)) for each trading day within the ten candidate event windows. Variable definitions are provided in the Appendix A. *T*-statistics are reported in parentheses and are calculated from the empirical time-series distribution of mean stock returns or coefficients obtained from running the same regression over nonevent trading days between April 1, 2015, and March 31, 2016. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, based on two-tailed tests. Mean stock returns and coefficient estimates on *CloseVote* significant at the 0.1 level (two-tail) appear in boldface.

CHAPTER 6

CONCLUSIONS

This paper examines whether using blockchain technology to maintain stock ownership records can improve shareholder value. I exploit an event associated with a Delaware legislative change that allows companies to maintain shareholder records using blockchain. I find an incrementally more positive market reaction for Delaware-incorporated firms whose proposal approval or rejection is sensitive to proxy voting errors as measured by the existence of a recent close-call vote. Moreover, this effect is more pronounced for firms with a greater likelihood of proxy voting errors and with worse performance. These results are consistent with the notion that blockchain recordkeeping of stock ownership has the potential to reduce errors in proxy voting and they support Delaware Chancery Court Vice Chancellor Laster's view that blockchain is a powerful tool that can be used to improve proxy voting and shareholder welfare (Laster, 2016).

Among the first to provide empirical evidence on shareholder value implication of blockchain, my study adds to the emerging literature in accounting, economics, and finance on the impact of blockchain. My findings also have important implications for regulators, blockchain professionals, and board of directors contemplating the adoption of blockchain for recordkeeping of stock ownership. Future research can examine the impact of blockchain-based stock ledger on proxy voting outcomes, capital market consequences such as liquidity, and firm performance.

APPENDIX

DEFINITIONS OF VARIABLES

Variable	Definition
BM	Ratio of book value of equity to market value of equity as of the most recent fiscal-year end on or prior to March 31, 2016.
Busy	Dummy variable that equals 1 if the firm's most recent annual meeting prior to March 31, 2016 is held in the second calendar quarter of the year and 0 otherwise.
CloseVote	Dummy variable that equals 1 if the firm has at least one close-call vote in the one-year period on or prior to March 31, 2016, where close vote refers to the case in which the difference between vote result and vote requirement is between −5% and 5%.
CR	Cumulative raw returns (in basis point) over the two-day event window.
Delaware	Dummy variable that equals one if the firm is incorporated in Delaware and zero otherwise.
Industry-Adjusted AR	Daily abnormal return (in basis point), where abnormal return is the difference between raw return and value-weighted GIC6 industry portfolio returns.

Variable	Definition
Industry-Adjusted CAR	Cumulative abnormal returns (in basis point) over the two-day event window, where abnormal return is the difference between raw return and value-weighted GIC6 industry portfolio returns.
InstOwn	Percentage of outstanding shares held by institutional investors as of the most recent calendar-quarter end on or prior to March 31, 2016.
LagReturn	One-year buy-hold industry-adjusted stock return (in basis point) ending March 31, 2016, where industry-adjusted stock return is calculated as the difference between raw return and value-weighted GIC6 industry portfolio returns.
MCAP	Market value of equity (in million) measured on March 31, 2016.
Return	Daily raw return (in basis point).
ROA	Industry (SIC4)-adjusted operating income after depreciation divided by lagged total assets as of the most recent fiscal-year-end on or prior to March 31, 2016.
SI	Short-interest ratio measured as the daily open short interest divided by total shares outstanding averaged across one year on and prior to March 31, 2016.
Size	Natural logarithm of *MCAP*.
Size-Adjusted AR	Daily abnormal return (in basis point), where abnormal return is the difference between raw return and CRSP value-weighted decile portfolio returns based on stocks traded on NYSE/AMEX/NASDAQ.

Variable	Definition
Size-Adjusted CAR	Cumulative abnormal returns (in basis point) over the two-day event window, where abnormal return is the difference between raw return and CRSP value-weighted decile portfolio returns based on stocks traded on NYSE/AMEX/NASDAQ.
Total Assets	Total assets (in million) measured as of the most recent fiscal-year-end on or prior to March 31, 2016.

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BIOGRAPHICAL SKETCH

Zhongwen Fan was born in Shanghai, China. After finishing high school coursework at Shixi Middle School at Shanghai, in 2006, he attended Shanghai University of Finance and Economics in Shanghai, China for undergraduate studies. He obtained his Bachelor's degree in Accounting in 2010. After graduation, he worked as a consultant in the transfer pricing department affiliated with the tax group of PwC at Shanghai and left the job in 2012. He joined Carrol School of Management at Boston College in 2012 and obtained his Master of Science in Finance degree in 2014. In August 2014, he started the PhD program in Management Science with concentration in Accounting in the Naveen Jindal School of Management at The University of Texas at Dallas.

CURRICULUM VITAE

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EDUCATION

The University of Texas at Dallas, Richardson, TX — 2019 (Expected)

- Ph.D. in Accounting
- Dissertation Committee: Ashiq Ali (Co-Chair), Ningzhong Li (Co-Chair), William Cready, Umit Gurun, Suresh Radhakrishnan, Yuan Zhang

Boston College, Chestnut Hill, MA — 2014

- M.S. in Finance, Quantitative Track

Shanghai University of Finance and Economics, Shanghai, China — 2010

- B.B.A. in Accounting

RESEARCH INTEREST

Voluntary disclosure, Blockchain recordkeeping, Corporate governance

WORKING PAPERS

[1] "Shareholder Value Implication of Blockchain Recordkeeping of Stock Ownership" (Job Market Paper)

- Dissertation proposal defended on June 12, 2018

[2] "The Role of Capital Expenditure Forecasts in Debt Contracting", with Ashiq Ali and Ningzhong Li

- Based on second-year summer paper
- Under revision for the 2nd round review at *The Accounting Review*
- Best Paper Award, 2017 MIT Asia Conference in Accounting
- Presented at Central University of Finance and Economics (China)*, Columbia University*, Shanghai Advanced Institute of Finance*, the University of Texas at Dallas, 2017 MIT Asia Conference in Accounting, 2018 Lone Star Accounting Research Conference, 2018 Global PhD Colloquium, and 2018 AAA Annual Meeting

[3] "Institutional Cross-Ownership and Corporate Disclosure", with Ashiq Ali and Ningzhong Li

- Based on third-year independent study
- Under revision for the 2nd round review at *The Accounting Review*
- Presented at the University of Texas at Dallas, 2018 AAA Financial Accounting and Reporting Section (FARS) Midyear Meeting, and 2018 EAA Annual Congress*

[4] "Corporate Governance and Earnings Management – Evidence from Shareholder Proposals", with Suresh Radhakrishnan and Yuan Zhang

- Based on first-year summer paper
- Under revision for the 3rd round review at *Contemporary Accounting Research*
- Presented at the University of Texas at Dallas

(* indicates presentation by coauthor)

PRESENTATIONS

2018: Lone Star Accounting Research Conference at Texas Christian University, AAA FARS Midyear Meeting (Austin, TX), the 2nd Global PhD Colloquium at the University of Sydney, AAA Annual Meeting (Washington DC)
2017: The University of Texas at Dallas, MIT Asia Conference in Accounting (Hangzhou, China)
2016: The University of Texas at Dallas
2015: The University of Texas at Dallas

REVIEW ACTIVITIES

2018 AAA Annual Meeting

HONORS AND AWARDS

Best Paper Award, MIT Asia Conference in Accounting, 2017
Nominee for Deloitte Foundation Doctoral Fellowship, the University of Texas at Dallas, 2016
Dean's Scholarship, Boston College, 2012-2013
Outstanding College Graduate, Shanghai Municipal Education Commission, 2010
Excellence in Accounting Scholarship, Australian National Institute of Accountants, 2009
Academic Excellence Award, Shanghai University of Finance and Economics, 2010, 2009 and 2007

TEACHING INTEREST

Financial accounting, Managerial accounting

TEACHING EXPERIENCE

The University of Texas at Dallas
[1] Courses Taught:
Introductory Financial Accounting (Undergraduate)

- Fall 2018 Average Instructor Rating: 4.55/5.00 Class Size: 58
- Fall 2017 Average Instructor Rating: 4.11/5.00 Class Size: 59

[2] Teaching Assistant:
Accounting for Managers (Graduate), Cost Accounting (Graduate), Introduction to Financial Accounting (Graduate), Introduction to Managerial Accounting (Graduate), Fundamentals of Taxation (Undergraduate and Graduate)

Boston College
[1] Teaching Assistant:
International Financial Reporting Standards (Graduate), Statistics (Undergraduate)

PROFESSIONAL EXPERIENCE

PwC, Shanghai, China 2010-2012

- Consultant, Transfer Pricing Service, Tax Department
- Performance rating: "Significantly Exceeds Expectation"

PROFESSIONAL CERTIFICATIONS & MEMBERSHIPS

Certified Public Accountant - China
Member, American Accounting Association
Member, American Finance Association