Does Blockchain Enhance Financial Reporting Quality?

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Abstract

Although blockchain is an innovative and disruptive technology, it has already been adopted in accounting by some firms. However, as the current state of blockchain incorporation into financial reporting systems and its effects on firms' financial reporting quality (FRQ) are still unknown, this gap in the literature is addressed in the current study. The obtained results show that blockchain-adopting firms have a lower incidence of material weaknesses in internal control over financial reporting, as well as issue fewer restatements and are less prone to reporting lags. Furthermore, the benefits generated from blockchain adoption are more pronounced for firms that adopt blockchain with IT expertise in their management teams. Overall, the evidence presented in this work suggests that blockchain adoption has a positive impact on FRQ.

Keywords: blockchain; financial reporting reliability; financial reporting timeliness; financial reporting quality

JEL: M4; M41

1. Introduction

Blockchain is an innovative and disruptive technology with the potential to have a considerable impact on firms' objectives, strategies, operations, and management. In recent years, its application in banking and finance, as well as supply chains, has experienced a boost in several developed countries. The business value of blockchain technology has attracted considerable research interest. However, there is a paucity of empirical studies focusing specifically on the blockchain adoption in accounting and auditing processes (Dai & Vasarhelyi, 2017). This investigation aims to address this gap by providing empirical evidence on the impact of blockchain incorporation into firms' accounting processes on financial reporting quality (FRQ), i.e., the quality of reported earnings. We focus on financial reporting reliability and timeliness as the two highly important dimensions of FRQ.

To examine whether blockchain introduction improves financial reporting reliability, we argue that the consistency of financial data could be enhanced through the blockchain ledger, as it establishes an interlocking shared system for keeping transaction records (O'Leary, 2018, Tan & Low, 2017), which are accessible by multiple parties with a cryptographic key. This design ensures consistency, thereby eliminating the need for traditional internal controls, such as reconciliation and external assurance (Schmitz & Leoni, 2019). Furthermore, due to its chain structure, blockchain technology ensures that financial data is immutable, thereby reducing the probability of accounting errors and financial fraud by preventing the subsequent manipulation of

already stored data. Therefore, blockchain adoption could enhance the effectiveness of accounting systems employed for converting financial performance to reported earnings, making financial information more reliable.

We also investigate whether blockchain adoption enhances financial reporting timeliness, assuming that it facilitates real-time accounting through the use of smart contracts. This approach can greatly improve the intelligence level of accounting information systems (AISs) by automatically generating vouchers and journals without the need for verification, thus saving time by increasing transaction execution speed (Kokina et al., 2017). Moreover, by limiting the risk of unauthorized access and malfunction to a single node instead of the entire system, blockchain technology adoption addresses the technical challenges inherent in traditional information systems, such as network breakdowns and cyberattacks. In light of these arguments, we expect blockchain adoption to enhance the timeliness of the accounting measurement system in converting financial performance into reported earnings.

These hypotheses were tested by analyzing a U.S. sample spanning the period from 2013 to 2022. Our empirical results reveal that firms that have adopted blockchain technology have a higher FRQ in terms of both financial information reliability and reporting timeliness. These results remain valid after alleviating the endogeneity problem using the Entropy Balancing, PSM-DID method, placebo test and IV-2SLS estimation. In addition, the positive relationship between blockchain adoption and FRQ tends to be more significant for blockchain adopters led by a management team with IT

expertise. Lastly, our robustness tests (using alternative measures of FRQ and blockchain adoption, conducting a change analysis, controlling for state effects, considering the effect of exogenous shocks and using the Heckman two-stage procedure) provide consistent results with those yielded by our main models, confirming that blockchain adoption enhances FRQ.

Our study makes several contributions to existing research. First, the obtained findings extend the available literature on blockchain. As proposed by Brennan et al. (2019), although "disruptive technological innovations" (DTIs) have been shown to profoundly affect almost every aspect of corporate governance, their impact on accounting has received limited scholarly attention. To close this gap, we focus on one of the most remarkable DTIs, blockchain technology, which is claimed to have the potential to completely disrupt firms' accounting practices (Coyne & McMickle, 2017) and investigate its effects on FRQ. Moreover, extant research primarily focuses on the concept of blockchain and its practical implications for accounting at a theoretical level (Nowiński & Kozma, 2017, Schmitz & Leoni, 2019, Teppo & Karim, 2018). Thus, our study marks one of the first attempts to empirically demonstrate the implications of blockchain technology implementation for FRQ.

Second, our study extends the FRQ research by providing an overview of the current range of blockchain technology applications in accounting and by delineating their role in FRQ. Thus far, a range of FRQ determinants have been investigated, including corporate governance practice (Demerjian et al., 2013), the accounting

profession (McDaniel et al., 2002), economic factors (Tang et al., 2016), international forces (Jacob & Madu, 2009), non-institutional culture (Garrett et al., 2014), and the processes adopted for the control of financial reporting quality (Doyle et al., 2007). Some authors have also examined the effect of specific information technologies on firms' accounting, such as search-facilitating technology (Hodge et al., 2004), internet-related technology (Moll & Yigitbasioglu, 2019), and enterprise resource planning (ERP) systems (Grabski et al., 2011, Morris, 2011). Although the available data suggest that blockchain has the potential to completely disrupt firms' accounting practices (Coyne & McMickle, 2017), this is based on a few theoretical studies on this topic (Nowiński & Kozma, 2017, Schmitz & Leoni, 2019, Teppo & Karim, 2018). Thus, empirical research on the effects of blockchain on FRQ is limited. Moreover, our study is among the first attempts to empirically demonstrate the implications of blockchain technology for AISs and quantify its effect on firms' FRQ. To achieve these aims, we conduct a rigorous screening process and only consider firms in which blockchain implementation has had a real influence on accounting practices. Not only does this methodological rigor result in a sample that is appropriate for testing our hypotheses, but it also enables us to provide business leaders with timely information on the blockchain application patterns from an accounting practice perspective (i.e., we focus on its business applications that affect FRQ in practice).

Third, we contribute to the literature on FRQ by demonstrating that incorporating blockchain technology into accounting processes can enhance two key aspects of FRQ:

financial reporting reliability and timeliness. We find that the likelihood of material weaknesses in internal controls over financial reporting, financial restatements, and delays in earnings release is lower among blockchain adopters. Our findings are timely and relevant, given that the integral relationship between blockchain technology and financial reporting is continually strengthening owing to the growing dependence on Big Data and digital transformation in firms.

Fourth, because blockchain has been more popularly adopted by firms in the U.S. than in other countries (Cahill et al., 2020), we have been able to collect an adequate sample for our empirical tests and obtain the initial evidence that blockchain adoption has positive effects on FRQ. These positive effects may or may not be applicable to other markets owing to different institutional backgrounds or technological developments. Nevertheless, the U.S. evidence should encourage other companies in the U.S. and companies and financial reporting regulators in other markets to consider blockchain as a valuable means of improving FRQ.

The remainder of this paper is organized into five sections. In Section 2, we present a review of pertinent literature focusing on the development of blockchain adoption. We discuss the implications of blockchain implementation for FRQ and develop our hypotheses in Section 3. We then introduce our data and methodology in Section 4. Section 5 presents empirical results, while Section 6 concludes our work by outlining the key study contributions and their limitations, and provides suggestions for future research in this domain.

2. Background and literature review

2.1 The concept of blockchain

Blockchain is one of the most exciting technologies to emerge in recent years (PricewaterhouseCoopers, 2016). The concept of "blockchain" was first proposed by Nakamoto in 2008, who created a decentralized, publicly available, and cryptographically secure digital currency system based on a series of interlinked blocks. In this context, decentralization indicates that all nodes in the network have access to the entire transaction set (Nakamoto, 2008). Additionally, since every block in the system consists of information and a hash address, any change to the block is disseminated across the entire distributed network. Moreover, all transactions are immutable because data is protected using complex cryptographic keys, making it almost impossible for a single user to modify the transactions executed via the blockchain.

Due to these powerful features and capabilities, blockchain can be used to execute transactions among multiple agents cost-effectively, as the mutual trust required for transactions is based on the system, not on the relationships among parties, with the potential to reshape the social credit system (Swan, 2015). In 2009, blockchain became a central component of the electronic currency Bitcoin. Since then, blockchain design has considerably advanced, expanding its use beyond the cryptocurrency domain (Kaushal & Tyle, 2016). At present, it is considered an ecosystem of emerging technologies that include artificial intelligence, the Internet of Things (IoT), robotics,

and crowdsourcing (Dai & Vasarhelyi, 2017), with diverse applications, such as banking and finance, trading, identity authentication, insurance, and government service (Peters & Panayi, 2016, Yermack, 2017).

This trajectory in blockchain development is also reflected in the research on this innovative technology. Thus, earlier studies mostly focused on the system structure, technical challenges, and application scenarios. For example, Kokina et al. (2017) provide an initial examination of the blockchain and discussed its opportunities and limitations. At the time, permissionless access to the system, high technical expenses, and scalability of adoption were still of concern. In a subsequent review, Yang et al. (2019) summarize additional challenges, as well as trends, in blockchain-based networks. These authors argued that the widespread deployment of their system is contingent upon scalability enhancement, self-organization, functional integration, resource management, and the mitigation of security issues. More recently, Akram et al. (2020) conduct a survey of the state of blockchain applications in the context of Industry 4.0[1] positing that, once the reliability, safety, and scalability issues have been resolved, blockchain adoption will make our society "smarter". In sum, blockchain adoption provides opportunities to companies, but its complex design and inefficient operation restrict its development.

2.2 Blockchain adoption in accounting and financial reporting

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[1] To date, Blockchain 1.0, Blockchain 2.0, and Blockchain 3.0 have been developed. In their work, Akram et al. (2020) focused on the design and implementation of blockchain in Industry 4.0 applications in the near future.

In this study, we focus on identifying patterns of blockchain applications for accounting-related business processes rather than in general business practice. Blockchain has been described as a "game-changer" in accounting (Deloitte, 2016), as it has the potential to fundamentally transform the way we record and process financial data (Dai & Vasarhelyi, 2017, Fanning & Centers, 2016, Peters & Panayi, 2016, Yermack, 2017). As blockchain can be employed in accounting functions such as invoicing, payment processing, contracts, and documentation (Kokina et al., 2017), its adoption can enhance the credibility of accounting data, thereby improving accounting efficiency. Its adoption has also enabled the establishment of blockchain-based accounting practices for business information systems (Demirkan et al., 2020).

Traditionally, financial accounting has been based on a double-entry system, which is now embedded in the widely used Enterprise Resource Planning (ERP) system for processing timely and accurate data (Davenport, 1998, Hitt et al., 2002). Since the emergence of blockchain, this system has been augmented by a third ledger within the blockchain (Cai, 2021). Yermack (2017) defines blockchain as "a sequential database of information that is secured by methods of cryptographic proof" (p. 7), rendering it a suitable alternative to traditional financial ledgers. Grigg (2015) uses the phrase "triple-entry bookkeeping" to refer to blockchain as the third component of the traditional double-entry bookkeeping (Dai & Vasarhelyi, 2017). On the other hand, Schmitz and Leoni (2019) emphasize the role of blockchain as a shared ledger. For example, Distributed Ledger Technology (DLT) is a distributed system that can store, validate,

transmit, and communicate data through its own distributed network without relying on "trust" between involved parties.

Among all the potential benefits of blockchain in accounting, improving financial data processing and enhancing FRQ is widely recognized as perhaps the most prominent one. However, academic research on this topic is limited and primarily focuses on theoretical discussions. For example, Baron (2017) outlines the accounting processes that would benefit from blockchain adoption, such as "authentication of transactions," "tracking ownership of assets," and "registry and inventory systems for assets." In an earlier study, Fanning and Centers (2016) argue that using blockchain maintains data privacy while facilitating comparison across the accounting entries of different transaction participants. Wang and Kogan (2017) concur with this view, adding that blockchain facilitates real-time accounting and fraud detection, as well as continuous monitoring and auditing, which would enhance FRQ. More recently, Fang et al. (2023) obtain evidence that blockchain adoption improves firms' accounting information quality. Their results indicate that blockchain adoption benefits firms' internal corporate governance and synergies with bigger auditors. Rawashdeh (2024) finds the blockchain technology can foster trust in financial reporting through the use of smart contracts.

Nonetheless, just like every innovative and cutting-edge technology, blockchain technology faces some challenges. Dai and Vasarhelyi (2017) examine three aspects that impede the adoption of blockchain at firms: the technological context (the demand

for storage, computational power, and sensitive information protection), the organizational context (threat of traditional business model, collusive avoidance, and heavy overheads), and the environmental context (regulatory guidance and supervision). Using a sample of Chinese listed firms, Chen et al. (2025) reveal a positive associated between blockchain investments and audit fees due to the increase in audit risk and audit effort. These differing views motivated us to conduct a comprehensive and rigorous analysis of the effects of this technology on financial reporting quality. The lack of more recent evidence, along with these differing views, motivated us to conduct an empirical study on the practical effects of blockchain adoption on FRQ.

3. Hypothesis development

3.1 Financial reporting quality

High-quality financial reporting, which is usually reflected in the quality of earnings, is essential because it affects investment decisions and market efficiency (Dechow et al., 2010, Francis, 2005). In the extant literature on reported earnings, various proxies are adopted for earnings quality, including earnings persistence, accruals, earnings smoothness, timely loss recognition, earnings distributions, Earnings Response Coefficients (ERCs), Accounting and Auditing Enforcement Releases (AAERs), restatements, internal control deficiencies, target beating, etc. The reported findings indicate that FRQ is associated with various factors, such as corporate governance practice (Demerjian et al., 2013), economic factors (Tang et al., 2016), non-

institutional culture (Garrett et al., 2014), and the control processes applied to the financial reporting system (Doyle et al., 2007).

To contribute to this body of evidence, we focus on the association between blockchain adoption and FRQ and argue that distributed ledgers (the structure underlying the blockchain technology) can help meet the financial reporting requirements. We explore two critical requirements of FRQ (financial reporting reliability and timeliness) for several reasons. According to the FASB Statement of Financial Accounting Concepts No. 8 (FASB, 2010) and the IASB Conceptual Framework for Financial Reporting (IASB, 2018), faithful representation [2] and timeliness are two important characteristics of high-quality financial reporting. Specifically, for information to be faithfully represented, it must be complete, neutral, and free from errors. Aside from reliability, Statement of Financial Accounting Concepts (SFAC) No. 2 defines timeliness as a qualitative characteristic implying that pertinent information must be available to decision-makers before losing its relevance (FASB, 1980). Accordingly, reliability and timeliness of financial reporting are most strongly related to blockchain adoption (considered an independent variable in our analyses) because the unique features of blockchain technology (transparency, consistency, and immutability) could enhance the financial reporting reliability, while

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[2] "Reliability" has been replaced with "faithful representation" in the most recent conceptual frameworks (FASB, 2010, IASB, 2018). The replacement has, however, attracted some criticism. For example, Erb and Pelger (2015) argue that its aim was to entail fewer limitations on fair value accounting, but not on the basis of academic theories. It seems that the term "reliability" has remained more prevalent in academic research (e.g., Ashraf et al., 2020, Choudhary et al., 2021). However, as it is beyond the scope of this paper to engage in this debate, we will use the two terms interchangeably.

other features, such as real-time processing, could contribute to its timeliness. These two dimensions are also well-documented in extant studies (Dechow et al., 2010).

3.2 Blockchain adoption and financial information reliability

Blockchain provides a novel solution for storing transaction records (Schmitz & Leoni, 2019). Instead of keeping separate records for transacting parties, the blockchain ledger establishes an interlocking shared system (O'Leary, 2018, Tan & Low, 2017). It thus transforms the existing centralized accounting approach to a distributed bookkeeping system involving multiple parties that relies on a synchronous coordination mechanism to ensure data consistency. Blockchain technology can also overcome the limitations of the traditional double-entry system, such as the need for reconciliation and external assurance (Schmitz & Leoni, 2019), particularly when multiple modifications are made simultaneously by several counterparties (Peters & Panayi, 2016). As multiple parties within the blockchain network have access to the same set of shared records (ACCA, 2017), the blockchain ledger ensures the consistency of financial data and enhances the reliability of financial reporting.

Moreover, the blockchain design ensures that financial data is immutable and resistant to fraud, thus improving the reliability of accounting information (Dai & Vasarhelyi, 2017, Kiviat, 2015, Kozlowski, 2018). Further, blockchain generates a hash string for each file, which is timestamped and serves as a digital fingerprint of that file.[3]

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[3] In a blockchain that uses workload proof as a consensus mechanism, 51% of the calculation power is needed to regenerate all chunks to tamper with data (Coyne & McMickle, 2017).

This timestamp technique can also significantly reduce the probability of accounting errors and financial fraud by preventing later users from modifying data that has been stored. This helps prevent earnings manipulation by making it difficult for firms to engage in real earnings management by over-stating (under-stating) expense (revenue). The accounting information asymmetry can therefore be effectively reduced because the financial data generated on the blockchain is less likely to be false (Coyne & McMickle, 2017, O'Leary, 2018). Therefore, blockchain technology prevents unauthorized data manipulation.

In sum, blockchain adoption could help firms to faithfully present the entirety of economic phenomena without material errors or bias. Based on these arguments, we posit that this technology could enhance the effectiveness of converting a firm's financial performance to its reported earnings, increasing their reliability and integrity. Consequently, we hypothesize:

Hypothesis 1: Blockchain adoption enhances the firm's financial reporting reliability.

3.3 Blockchain adoption and financial reporting timeliness

We further investigate whether blockchain adoption influences the timeliness of financial reporting. An ample body of extant literature shows that blockchain could enable the development of a real-time accounting ecosystem (Dai & Vasarhelyi, 2017, Yermack, 2017) because it would facilitate near-instantaneous (daily) updating of accounting information (Byström, 2019). Specifically, AISs based on blockchain

technology can connect to internal and external enterprise record-keeping systems, whereby once transactions occur, the relevant data is automatically passed into the enterprise AISs from the external transaction system (Kiviat, 2015, Peters & Panayi, 2016). The AISs automatically generate vouchers and journals through blockchain in line with the "smart contract" concept. Such a digital contract is "smart" when certain conditions are met; it is executed automatically without the need for manual verification. This approach is based on the so-called "event-driven" set of rules that encapsulate the agreements by the parties involved. As highlighted by Schmitz and Leoni (2019), smart contracts play a crucial role in generating autonomous transaction records that comply with pre-established agreements. Thus, the adoption of blockchain and smart contracts will enable current AISs to generate electronic documents, eliminating duplicate verification of transaction information and significantly reducing the risk of human error, thereby increasing transaction execution speed and saving time (Kokina et al., 2017).

To some extent, blockchain technology also addresses the technical challenges of traditional information systems, such as network breakdowns and cyber-attacks, especially when these systems operate on centralized servers (Jimoh et al., 2019). Therefore, blockchain adoption could help companies improve the efficiency of generating transaction records and preparing financial statements, thereby enhancing the timeliness of their financial reporting.

Given that blockchain could help firms to produce the information required by the decision-makers in real time, we expect that its adoption could enhance the timelines of the accounting measurement system in converting financial performance to reported earnings. Accordingly, we hypothesize:

Hypothesis 2: Blockchain adoption enhances the firm's financial reporting timeliness.

4. Research methods

4.1 Data source and sample selection

In our research, we consider the direct effect of blockchain adoption on FRQ. To generate a reliable dataset for analyses, we conduct a rigorous screening of the scope of blockchain adoption to ensure that we focus only on cases in which implementation has influenced firms' accounts or AISs. Thus, we expand upon the work of Stratopoulos et al. (2022), who subject corporate disclosures to textual analysis to identify evidence of blockchain adoption. Following Stratopoulos et al. (2022), we first collect U.S. listed firm disclosures from the SEC Edgar database.[4] Specifically, we download the four most popular forms, including 8-K, 10-Q, 6-K, and 10-K, as they directly reveal the blockchain-related decisions, plans, or intentions of top executives within firms.

Second, we identify the SEC filings that contain the "blockchain" topic keywords (including Blockchain, Cryptocurrency, Digital Currency, Bitcoin, Litecoin, Dogecoin, and Ethereum). To ensure that we capture firms' real interest in blockchain technology,

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[4] https://www.sec.gov/edgar/search/

we then download and parse all these filings for further analysis using Python. We calculate the word frequencies of blockchain-related words. Since the first use of the term "blockchain" in 2013, until 2022, there were 2,519 firm-years with blockchain disclosures pertaining to 1,143 unique firms.

Next, we analyze the contents of blockchain disclosure by using latent Dirichlet allocation (LDA), an unsupervised Bayesian machine-learning algorithm that identifies the latent topics contained in a large collection of documents (Blei et al., 2003). This analysis enables us to further categorize the contents of blockchain disclosures and assess whether they are accounting-related when the technology is mentioned. By using Python's Gensim library, we model the "financial reporting" topic at the sentence level by providing key terms (including accounting, asset management, digital currency transaction, share issuing, financial reporting, bookkeeping, accounts, reconciliation, ledger, journal, financing, inventory, payment, and internal control) as shown in Appendix B. We extract sentences that contain blockchain-related keywords from SEC filings made over the years, allowing us to identify trends in blockchain adoption by calculating the frequency of blockchain-related and financial-reporting-related keywords that appear in each sentence in individual disclosures. Lastly, we review these SEC filings to ensure that the blockchain was adopted in an accounting-related process. This strategy yields a final sample of 1,326 firm-year observations related to 537 unique firms that have adopted blockchain technology for accounting purposes (the sample LDR process and the utilized keywords are provided in Appendix B).

Panel A of Table 1 summarizes our data, sample selection, and distribution. Based on the disclosures filed by 537 firms that incorporated blockchain technology into their accounting-related processes, we obtain firm-year observations for hypothesis testing and empirical analyses, as described earlier. Although the first disclosure featuring blockchain was filed in 2013, our sampling period commences in 2010 because of the need to run the three-period staggered PSM-DID analysis. We begin with these firm-year observations spanning the 2013−2022 period and retrieve pertinent financial data from Compustat and Audit Analytics database. After removing observations that lack the required information for our study, our final sample for FRQ analysis comprises 27,425 firm-year observations for the pooled regression. Among these, 1,326 firm-year observations are financial-reporting-related blockchain adopters.

4.2 Independent variable: blockchain adoption

To examine the relationship between blockchain adoption and FRQ, we first construct our independent variable, *Blockchain*, which takes the value of one for firms using blockchain related to financial reporting, and zero otherwise. Panel B of Table 1 displays the yearly distribution of blockchain-disclosing firms as well as financial-reporting-related blockchain-disclosing firms. The results presented in these panels indicate that the number of firms adopting blockchain (whether the adoption is financial-reporting-related or not) increased steadily over time, with 370 financial-reporting-related cases noted in 2022.

[Insert Table 1 about here]

4.3 Dependent variables: reliability and timeliness

To test Hypothesis 1, we examine the effect of blockchain application on the likelihood of financial restatements and material weaknesses in internal controls over financial reporting. We thus incorporate two categories of independent variables—internal control weaknesses and financial restatements—which are linked but are fundamentally different (Garrett et al., 2014).

Our first measure is *Material_weakness*, which equals one if the auditors of the firm disclose in SOX 404 a material weakness in the internal control over financial reporting in a given year, and zero otherwise. In line with the Auditing Standard No. 5 from the Public Company Accounting Oversight Board (PCAOB), a material weakness in internal controls is defined as "a significant deficiency, or combination of significant deficiencies, that results in more than a remote likelihood that a material misstatement of the annual or interim financial statements will not be prevented or detected" (p. 10). Although control weaknesses do not necessarily result in financial misstatements, they still indicate a limited capability to prevent, detect, and correct errors, which is associated with lower quality financial reporting (Dechow et al., 2010, Ge & McVay, 2005).

Our second measure of FRQ is financial restatements, as it is a salient measure frequently used in pertinent literature to proxy for unreliable financial reporting (Dechow et al., 2010, Francis & Michas, 2013). We denote it as *Restatement*, which equals one if the firm revised its financial statement in a given year, and zero otherwise.

We obtain this information from Audit Analytics, as it provides the actual incidence of misstatements (Garrett et al., 2014), thus serving as an appropriate measure of FRQ (Dechow et al., 2010, Garrett et al., 2014). A negative association between *Blockchain* and *Material_weakness*/*Restatement* would provide support for Hypothesis 1.

To test Hypothesis 2, we examine the effect of blockchain applications on financial reporting timeliness. Our third measure of FRQ is *Earnings_lag*, which equals the number of days lagged after the financial statement day. A higher value of *Earnings_lag* indicates less timeliness. If financial reporting is not timely, then its usefulness to stakeholders is diminished (Ashraf et al., 2020). A negative association between *Blockchain* and *Earnings_lag* would provide support for Hypothesis 2.

4.4 Control variables

In line with the prior research, we include the following variables in our model: *Roa*, the ratio of net profit to year-beginning total assets; *Size*, measured as the natural logarithm of total assets; *Leverage*, leverage ratio calculated as total liabilities divided by total assets; *Inventory*, the ratio of inventories to total assets at the year-end; *Loss*, a dummy variable that equals one for firms with negative net income, and zero otherwise; *Receivables*, the ratio of net account receivables to total assets at the year-end; *Bm*, book-to-market ratio, calculated as the book value of equity divided by market value of equity; *Cash*, cash ratio, calculated as cash scaled by total assets; *Quick_ratio*, the current assets less inventory, all scaled by current liabilities; *Dec*, set to one if the fiscal year for the firm ends in December, and zero otherwise; *Age*, the number of years the

firm has had Compustat data; *M&A*, a dummy variable that equals one if the firm

engaged in a merger or acquisition during the year, and zero otherwise; *Restructuring*,

set to one if firm accrued non-zero restructuring costs during the year, and zero

otherwise; *Foreign*, a dummy variable that equals one if the firm reported non-zero pre-

tax foreign income, and zero otherwise; *Accrual*, based on discretionary accruals

estimated by performance-matched modified Jones model (Kothari et al., 2005);

Going_concern, set to one if the external auditor issued a going concern opinion for the

firm in the year, and zero otherwise; *Board_independence*, the total number of

independent board members scaled by the total number of board members for the firm

during the year; *Board_size*, the number of directors on the board for the firm during

the year; and *CEO_is_chiarman*, set to one if the CEO is also the chairman of the firm's

board during the year, and zero otherwise. We present the variable definitions and

measures in Appendix A.

4.5 Regression models

To test the influence of blockchain adoption on the studied firms' FRQ, we apply

the following baseline regression models:

$$Reliability\ (Material\_weakness/Restatement)$$

$$= \alpha + \beta_1\ Blockchain + \gamma Control_i + Year_t + Industry_k$$

$$+ \varepsilon \tag{1}$$

$$Timeliness\ (Earnings\_lag)$$

$$= \alpha + \beta_1\ Blockchain + \gamma Control_i + Year_t + Industry_k$$

$$+ \varepsilon \qquad\qquad\qquad (2)$$

where *Reliability* represents *Material_weakness* or *Restatement*, *Timeliness* represents *Earnings_lag*, *Blockchain* denotes blockchain-adopting firms, and *Controls* captures a set of control variables. Given that, in the U.S., the quality of financial reporting may vary across industries and years, we also control for year ($Year_t$) and industry ($Industry_k$) fixed effects in the regression. To minimize the effects of outliers, we winsorize all continuous variables at the 1st and 99th percentiles. We summarize our data, along with the sample selection and distribution in Table 1 and report the summary statistics in Table 2.

5. Empirical results

5.1 Summary statistics

Table 2 displays the descriptive statistics of the study variables. The mean value of *Blockchain* is 0.028, implying that about 2.8% of firms have adopted blockchain technology that influences their FRQ. Consistent with the values reported in prior FRQ studies (Ashraf et al., 2020, Garrett et al., 2014), *Material_weakness* is identified in 4.2% of the cases, and there is a 4.8% incidence of *Restatement* with an average of 64 days between the firm's fiscal year-end date and firm's earnings announcement date (*Earnings_lag*). The control variables are generally consistent with prior findings from

FRQ studies (Cao et al., 2012, Demerjian et al., 2013, Doyle et al., 2007, Graham et al., 2005).

[Insert Table 2 about here]

5.2 Blockchain adoption and financial reporting reliability

We report the results of Hypothesis 1 tests in Table 3. Since blockchain adoption could be persistent in a firm over time, the standard errors are clustered at the firm level in our regression. Column (1) of Table 3 shows the effects of blockchain adoption on *Material_weakness*. We regress *Material_weakness* on *Blockchain* by applying a logit regression model to our pooled sample. After controlling for firm and board characteristics, industry fixed effect, and year fixed effect, the coefficient of *Blockchain* is -0.381 (z-stat = -6.854), which is negative and statistically significant at the 1% level. This evidence is consistent with Hypothesis 1 and suggests that blockchain adoption is associated with a lower likelihood of having material weaknesses in internal controls. Regarding the economic significance of this result, blockchain-adopting firms are 31.7% less likely to experience a material weakness (odds ratio = 0.683). Thus, the impact of blockchain adoption on the reliability of financial reporting is also economically significant, rendering the magnitude economically significant.

Column (2) of Table 3 presents an alternative measure of financial reporting reliability, i.e., *Restatement.* The coefficient of *Blockchain* is -0.219 (z-stat = -5.037) for the multivariate regression model, which is negative and statistically significant at the 1% level. This shows that blockchain adoption is negatively and significantly

associated with the likelihood of a restatement issuance. Specifically, blockchain-adopting firms have a 19.7% lower chance of issuing a financial restatement (odds ratio = 0.803). Thus, the impact of blockchain adoption on the reliability of financial reporting is also economically significant. Overall, our evidence indicates that blockchain adoption increases the reliability of financial reporting, which is consistent with Hypothesis 1.

[Insert Table 3 about here]

5.3 Blockchain adoption and financial reporting timeliness

In this section, we analyze the link between blockchain adoption and timeliness, as another important characteristic of FRQ. Table 4 reports the results of testing Hypothesis 2, which posits that blockchain adoption can enhance financial reporting timeliness (*Earnings_lag*). We regress *Earnings_lag* on *Blockchain* based on the multivariate regression sample. The coefficient of *Blockchain* in Column (1) is significantly negative (-8.219, t-stat = -3.564). These results suggest that, by adopting blockchain, firms could reduce the time it takes to announce their earnings, thereby providing support for Hypothesis 2. The value-increasing effect of blockchain adoption consequently enhances the timeliness of financial reporting. In terms of economic significance, blockchain adopters report earnings on average 8 days earlier, or approximately 12% sooner than the sample mean. The magnitude of the coefficient is also economically significant.

Taken together, the results presented in Tables 3 and 4 provide evidence in support of Hypothesis 1 and Hypothesis 2, as they suggest that more reliable and timelier financial reporting is associated with blockchain adoption.

[Insert Table 4 about here]

5.4 Moderating effects

Tables 3 and 4 report the baseline regression results, indicating that FRQ improves with blockchain adoption. In this section, we further conduct cross-sectional tests to examine the moderating effects of blockchain adoption proximity. Specifically, we examine the effect of blockchain adoption on FRQ, conditional on the IT expertise of firms' management teams, given that IT knowledge and experience aid in understanding the impact of different technologies on financial reporting. Many policies and procedures that support internal control over financial reporting rely on IT platforms. Consequently, having IT experts in the management team provides a comparative advantage in preventing internal control deficiencies and risks to financial reporting (Dechow et al., 2010, Rice & Weber, 2012). Moreover, they can assist in efficiently resolving IT-related matters, which will lead to timelier financial reporting (Ashraf et al., 2020).

To explore the aforementioned moderating effect, we begin by considering whether the CEO has an IT background. We define a dummy variable, *IT_CEO*, which equals one if the firm's CEO has IT expertise and zero otherwise. In Columns (1), (3), and (5) of Table 8, the interaction terms of *Blockchain*IT_CEO* are negative and

statistically significant across the FRQ models. Similarly, we consider whether having managers with an IT background influences the effect of blockchain adoption on FRQ. We thus introduce *IT_Manager*, which equals one if the firm has at least one senior manager (excluding the chief information officer) with IT expertise, and zero otherwise. In Columns (2), (4), and (6) of Table 8, the interaction terms of *Blockchain*IT_Manager* are negative and statistically significant across the FRQ models. These results reveal that blockchain adopters that have IT expertise in their management teams have a higher FRQ because this management structure provides them with a comparative advantage in preventing internal control weaknesses and restatements and assists in timelier financial reporting, thereby enhancing the positive link between blockchain adoption and FRQ.

[Insert Table 5 about here]

5.5 Entropy balancing method

To supplement our main results, we subject an entropy balanced sample to our regression models and report the results in Table 5. By reweighting covariates from the treatment and the control groups, the entropy balancing method helps to address functional form misspecification and self-selection bias due to observable characteristics (Hainmueller, 2012). Accordingly, the mean, variance, and skewness of all covariates used in our analyses are balanced across the treatment group (*Blockchain* = 1) and control group (*Blockchain* = 0) after entropy balancing. We rerun our main analyses using entropy balanced samples and find that our results are consistent. The

coefficients of *Blockchain* across the three dependent variables presented in Columns (1)−(3) are negative and statistically significant at the 1% level, which supports the findings reported in Tables 3 and 4. Our main results are thus robust, ruling out the possibility that they are influenced by confounding firm characteristics.

[Insert Table 6 about here]

5.6 PSM-DID and time-varying trends

In the main regression tests presented in Tables 3 and 4, we follow extant empirical accounting research by controlling for characteristics of the sample firms. However, the multivariate regression analysis imposes assumptions about the linear relationships between these covariates (firm characteristics) and FRQ. The selection bias may lead to an endogeneity problem, as the firms adopting blockchain are fundamentally different from firms that do not. As the entropy balancing method used in the above analyses does not account for a propensity score of outcomes, we also employ the PSM-DID method to provide further evidence that our results are robust. First, we perform a 1:1 nearest-neighbor matching to pair each firm from the treated group (*Blockchain* = 1) with a firm from the control group (*Blockchain* = 0) with as close as possible propensity score (with replacement). This procedure generates 1,243 pairs of firms. Most of the differences in covariates between the two groups are insignificant after PSM matching (untabulated), indicating that our matched sample is balanced across the treatment and control groups. Then, we conduct staggered DID analysis based on the 2,486 matched samples. For this purpose, we introduce a series

of DID dummy variables. *Current* is coded as one for the year when the treatment group adopts blockchain, and zero otherwise. Pre_{t-2}, Pre_{t-1}, $Post_{t+1}$, $Post_{t+2}$ are coded as one when the treatment group adopted blockchain in the year before (after), and zero otherwise. Table 7 shows the results from the staggered DID regression. The results indicate that pre-adoption coefficients (Pre_{t-1} and Pre_{t-2}) of the three FRQ measures are insignificant, whereas the coefficients of $Post_{t+1}$ and $Post_{t+2}$ are negative and statistically significant at the 1% level. Similarly, Figures 1-3 display the time-varying trends of the coefficients for these DID dummy variables, indicating that the difference between the treated and control groups is slight in magnitude before blockchain adoption and becomes negative and significant after the adoption, thereby verifying the "parallel pre-trends" assumption and validating our DID approach.

Taken together, these findings reveal the dynamic impacts of blockchain adoption, indicating that it begins to take effect on FRQ after firms adopt blockchain technology. The results obtained using the PSM-DID method provide important support for our two hypotheses and confirm the findings presented in Tables 3 and 4.

[Insert Table 7 and Figures 1-3 about here]

5.7 Placebo test

The matching method presented above controlled for the observed firm characteristics that exhibited temporal variations. However, certain unobservable factors that change over time and affect FRQ can be a source of endogeneity even if the parallel trend test has been passed. Thus, we conduct the placebo test to ensure that our

empirical results are not driven by unobserved factors (Chen & Wang, 2022). This approach necessitates that we randomly select the treated time or treated group for re-estimation. First, we randomly select blockchain disclosing firms as the treated group and randomly select the year in which blockchain implementation started. Second, we perform a DID regression on this fictitious sample, expecting that any omitted factors should still reside in the testing framework and may drive the relationship between blockchain adoption and FRQ. Accordingly, their p-values should be lower than 0.1. Third, we repeat the random assignment in the first and the second step 500 times and run our baseline regression model. Finally, we obtain 500 estimated coefficients and standard errors, which are used to calculate the p-values. As can be seen from Figures 4-6, the estimated coefficients are centrally distributed around zero and roughly follow a normal distribution for the three FRQ measures (*Material_weakness*, *Restatement*, and *Earnings_lag*). [5] These figures further show that the p-values of most of the sampled estimated coefficients are above 0.1 and the coefficients are not significantly different from 0. Thus, we believe that blockchain adoption (rather than some unobserved factors) is the driver behind the FRQ-related results, which further supports the conclusions stated above.

[Insert Figures 4-6 about here]

5.8 IV-2SLS estimation

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[5] The solid lines represent the kernel density distribution of the estimated coefficients. The open circle scatters represent P-values.

To address the possible problems of reverse causality (e.g., a firm with higher audit quality is more likely to implement blockchain technology), we adopt an instrument variable (IV) two-stage least squares (2SLS) estimation. We construct an instrument variable (*IV_blockchain*) by considering an exogenous regulatory event. On April 3, 2019, the SEC released a "*Framework for 'Investment Contract' Analysis of Digital Assets*," aiming to "assist those seeking to comply with the U.S. federal securities laws." This framework illustrates that the SEC is willing to exempt certain blockchain-based digital assets from being treated as securities.[6] Our instrument variable (*IV_blockchain*) equals one if the firm complies with the SEC framework regarding the classification of blockchain-based digital assets in the particular year, and zero otherwise.[7] Our instrumental variable (IV) fulfils the relevance condition because the likelihood of classification of blockchain-based digital assets is correlated to blockchain adoption by firms in a particular year. In addition, our IV fulfils the exclusion condition because it does not directly influence our outcome variables. Table 8 displays the results yielded by the 2SLS regressions. In the first stage (untabulated), we regress the independent variable (*Blockchain*) to the instrument variable (*IV_blockchain*) and controls. Second, we regress our dependent variables (*Material_weakness*, *Restatement*, and *Earnings_lag*) on our predicted value of

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[6] Although it may not be an adequate substitute for clear legislation and judicial rulings, the guidance represents an improvement in the regulation of blockchain-based digital assets.

[7] We check whether firms comply with the SEC framework by searching for keywords in their annual reports, including the appendices.

blockchain (*Fitted_blockchain*) generated from the first regression. The results of the second-stage regressions across the FRQ measures are presented in Columns (1)−(3). The relationship between instrumented *Blockchain* and FRQ continues to exhibit negative and statistically significant coefficients, indicating that the results reported in Tables 4 and 5 remain valid. Besides, Wald F-statistics further suggest that our IV fulfills the relevance condition. Likewise, the p-values for the test of endogeneity are lower than 0.01, indicating that our IV fulfills the exclusion condition. The IV-2SLS results could thus mitigate the concern of reverse causality.

[Insert Table 8 about here]

5.9 Robustness tests

In this section, we conduct several robustness checks to strengthen our hypothesis testing. First, we use alternative measures of financial reporting reliability, namely *Material_weakness_counts* and *Restatement_counts*, which represent the number of material weaknesses and restatement items reported in a given year, respectively. The coefficients presented in Columns (1) and (2) of Panel A, Table 9 are negative and statistically significant, consistent with our main results. In Column (3), we investigate the relationship between blockchain applications and earnings management. The results are consistent with our expectation that blockchain adopters have a lower level of earnings management.

Second, we replace our test variable *Blockchain* with *Blockchain_word*, reflecting the number of occurrences of terms relating to "blockchain" in firms'

disclosures. The coefficients of *Blockchain_word* across Columns (1)−(3) in Panel B of Table 9 are negative and statistically significant across all models, indicating that our baseline results are still valid and are unaffected by the use of an alternative proxy for the independent variable.

Third, we consider another measure of financial timeliness, *Forecast Timeliness,* as sell-side analysts provide early forecasts of firms' earnings.[8] Guttman (2010) argued that the timing of analysts' forecasts is based on both privately and publicly available information about forthcoming earnings. We expect that blockchain-adopting firms can generate more precise information and release financial information sooner (which is indicative of a higher FRQ), thereby allowing analysts to issue their forecasts earlier. The results shown in Panel C of Table 9 reveal that the coefficients of *Blockchain* in Columns (1)−(3) are negative and statistically significant across all models, indicating that firms that have adopted blockchain technology are more likely to receive early analysts' forecasts, thus lending support for our main results pertaining to Hypothesis 2.

Fourth, as noted previously, one limitation of propensity score matching and entropy balancing is that these strategies only control for observable characteristics (Balsam et al., 2014). Although we have controlled for a variety of firm characteristics in prior analyses, it is possible that our outcomes are driven by some unobservable or

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[8] It can be argued that "management forecast" might be a more appropriate alternative measure of financial reporting timeliness. However, our sample firms generally did not disclose the management forecast information. Therefore, we use analyst forecast data as an alternative measure for this purpose.

difficult-to-measure factors. To address this concern, we conduct a change analysis, which enables us to account for unobservable firm characteristics. To conduct the change analysis, we modify Equation (1) and replace all variables with their differences between year *t*−1 and *t*, denoted by adding a prefix Δ. We construc*t* Δ*Blockchain* to capture the year-to-year change in blockchain adoption. We also calculate changes in the controls. As shown in Panel D of Table 9, the coefficients of Δ*Blockchain* in the *Material_weakness*, *Restatement*, and *Earnings_lag* models remain negative, which is consistent with our main findings.

Fifth, to supplement our main analyses, considering that FRQ may vary across the U.S. states due to geographical characteristics and economic growth (Isidro et al., 2020), we further control for state fixed effects in our main regression tests. In Panel E of Table 9, the coefficients of *Blockchain* are statistically significant and negative across *Material_weakness*, *Restatement*, and *Earnings_lag* models. This evidence suggests that our main findings are robust after considering the state fixed effects.

Sixth, to ensure the relationship between blockchain and FRQ is not caused by an exogenous shock such as the SEC's regulation of blockchain-based digital assets, we partition the sample into subsamples before 2019 and after 2019. As seen in Panel F of Table 9, the coefficients of *Blockchain* in both subsamples are statistically significant, confirming that our main findings are robust to such exogenous shocks.

Lastly, we use a Heckman two-stage approach as a supplement to the PSM method to check whether our observations are subject to self-selection bias. The results

of the Heckman procedure are reported in Panel G of Table 9. The coefficients of the inverse mill ratio (imr) are insignificant across all FRQ models, indicating that selection bias does not seem to play a substantial role in our research.

[Insert Table 9 about here]

6. Conclusion

Although the (potential) benefits of introducing blockchain technology into firms' accounting practices have attracted considerable attention in both academia and industry due to its decentralization, transparency, and immutability (Coyne & McMickle, 2017, Yermack, 2017), extant research in this domain has mostly focused on whether blockchain adoption influences FRQ at a theoretical (Schmitz & Leoni, 2019) or conceptual level (Nowiński & Kozma, 2017, Teppo & Karim, 2018). Yet, there is a considerable gap between conceptual blockchain applications and their practical effects, and scholars are still struggling to specify the real impact of blockchain technology on FRQ. To the best of our knowledge, our study is among the first of this kind.

Based on a U.S. sample of firms that incorporated the blockchain technology in their accounting processes in the 2013−2022 period, we provide empirical evidence that blockchain adoption has improved both financial reporting reliability and timeliness by lowering the adopting firms' incidence of material weaknesses in internal controls over financial reporting, restatements, and reporting lags. Our results are robust to the use of multiple methodologies, including multivariate regression, entropy balancing, PSM-

DID and placebo test. In addition, we find that the aforementioned benefits tend to be more significant when the blockchain-adopting firms are led by management teams with IT expertise. Our results are also robust to alternative measures of FRQ and blockchain adoption, change analysis, a state fixed effects model, a test for exogenous shocks and the Heckman two-stage procedure.

The results yielded by these investigations provide important contributions to accounting research and practice in several ways. First, we contribute by constructing measures of blockchain applications related to financial reporting and empirically testing their impact on FRQ. The evidence of positive effects of blockchain adoption we provided will likely boost the confidence of additional firms to adopt this technology. Moreover, our findings should also be of interest to corporate boards considering blockchain adoption when developing future strategies for improving FRQ. Similarly, stock exchanges and financial reporting regulators may consider our findings when evaluating how IT experts should be involved in financial reporting. In light of our findings, auditors should assess the challenges, risks, and benefits stemming from clients' blockchain adoption and consider using this technology in the audit process.

However, when interpreting the findings reported here, it is important to recognize the challenge of measuring blockchain adoption in AISs. We have thus restricted our measurement of blockchain adoption to the characteristics strongly indicative of such adoption in AISs that may influence FRQ. In doing so, we have maintained the validity of the proxy for blockchain adoption with respect to our

research question. However, it is likely that we have been unable to identify some blockchain adopters. Although we have performed sufficient tests to mitigate the endogeneity concern, we have to recognize that endogeneity cannot be entirely eliminated because the implementation of blockchain is ultimately a "self-selection" issue. This shortcoming could be overcome in future research by developing more precise measures of blockchain adoption tailored to the specific research setting and question. Another study limitation stems from the fact that blockchain adoption in accounting is still in relatively early stages. Accordingly, it would be beneficial to track the dynamic progress of this technology's application and its impact on FRQ. Lastly, we call for academic researchers to evaluate other dimensions of FRQ that may be affected by blockchain adoption, such as information usefulness, earnings management, and earnings response. Also, we call for more empirical research on the effects of blockchain on financial reporting and strategies to overcome adoption barriers in other international settings and markets.

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Table 1 Sample Selection and Distribution

Panel A Sample Selection

Sample	N
Blockchain disclosing firms:	
Number of firms disclosing blockchain	1,143
Number of firms disclosing blockchain (financial-reporting related)	537
Firm-year observations：	
Firm-year observations disclosing blockchain	2,519
Firm-year observations disclosing blockchain (financial-reporting related)	1,326
Firm-year observations for baseline regressions	27,425

Panel B Distribution of Blockchain Disclosing Firms

Year	No. of firms disclosing blockchain	No. of firms disclosing blockchain (financial-reporting related)
2013	1	1
2014	6	2
2015	14	5
2016	47	34
2017	179	87
2018	347	172
2019	336	170
2020	350	186
2021	596	299
2022	643	370
Total	2,519	1,326

Notes: This table summarizes our data and sample selection and distribution. Panel A lays out the number of different sample sets. Panel B displays the distribution of blockchain disclosing firms.

Table 2 Descriptive Statistics

Variable	N	mean	sd	p25	p50	p75
Dependent variable						
Material_weakness	27,425	0.041	0.158	0.000	0.000	0.000
Restatement	27,425	0.048	0.214	0.000	0.000	0.000
Earnings_lag	27,425	64.243	33.562	59.000	59.000	61.000
Independent variable						
Blockchain	27,425	0.028	0.083	0.000	0.000	0.000
Control variable						
Roa	27,425	0.006	0.184	0.022	0.030	0.090
Size	27,425	7.186	2.340	5.652	7.303	8.771
Leverage	27,425	0.169	0.223	0.000	0.118	0.301
Inventory	27,425	0.197	0.228	0.000	0.124	0.338
Loss	27,425	0.257	0.437	0.000	0.000	1.000
Receivables	27,425	0.311	0.189	0.105	0.306	0.398
Bm	27,425	0.581	0.682	0.214	0.407	0.740
Cash	27,425	0.147	0.165	0.026	0.083	0.208
Quick_ratio	27,425	2.744	4.226	0.945	1.764	2.650
Dec	27,425	0.734	0.440	0.000	1.000	1.000
Age	27,425	24.654	6.142	23.751	24.183	26.000
M&A	27,425	0.123	0.246	0.000	0.000	1.000
Restructuring	27,425	0.191	0.461	0.000	0.000	1.000
Foreign	27,425	0.278	0.327	0.000	0.000	1.000
Accrual	27,425	-0.063	0.509	-0.082	-0.039	-0.006
Going_concern	27,425	0.021	0.152	0.000	0.000	1.000
Board_independence	27,425	0.679	0.132	0.579	0.653	0.792
Board_size	27,425	8.947	2.291	7.973	8.307	10.000
CEO_is_chairman	27,425	0.398	0.482	0.000	0.000	1.000

Notes: This table presents summary statistics for the variables of our equations. All continuous variables are winsorized at the bottom and top 1% to avoid the effects of outliers. Variable definitions are presented in Appendix A.

Table 3 Blockchain Adoption and Financial Reporting Reliability

	(1) Material_weakness	(2) Restatement
Blockchain	-0.381***	-0.219***
	(-6.854)	(-5.037)
Roa	-0.426***	0.008*
	(-3.978)	(1.854)
Size	0.016***	0.002***
	(5.931)	(9.268)
Leverage	-0.000**	0.000
	(-2.574)	(0.379)
Inventory	-0.035**	-0.001
	(-2.217)	(-0.135)
Loss	0.066***	-0.003**
	(3.159)	(-2.292)
Receivables	-0.213***	-0.002
	(-4.316)	(-0.440)
Bm	-0.001	-0.001
	(-1.480)	(-0.601)
Cash	0.003	0.004
	(0.020)	(0.338)
Quick_ratio	0.003	0.001
	(1.587)	(0.239)
Dec	0.010***	-0.001
	(3.158)	(-0.091)
Age	-0.000	0.000
	(-0.508)	(0.612)
M&A	0.000	-0.000
	(0.069)	(-0.174)
Restructuring	0.008**	0.001
	(2.262)	(0.424)
Foreign	-0.049***	-0.007***
	(-10.647)	(-4.416)
Accrual	0.021***	0.002
	(4.701)	(1.199)
Going_concern	0.016***	-0.001
	(4.400)	(-1.415)
Board_independence	-0.284***	-0.020***
	(-2.865)	(-5.081)
Board_size	-0.015***	-0.001***
	(-2.593)	(-4.525)
CEO_is_chairman	0.052***	0.007***
	(5.151)	(3.826)
_cons	0.034**	-0.014***
	(2.305)	(-2.743)
Industry fixed effect	Y	Y
Year fixed effect	Y	Y
pseudo R^2	0.364	0.334
N	27,425	27,425

Notes: This table reports the regression results of Equation (1), regarding the effect of blockchain adoption on financial reporting reliability (*Material_weakness* in Column (1) and *Restatement* in Column (2)). Industry and year fixed effects are included in all regressions. The numbers in parentheses are z-statistics and computed using robust standard errors, clustered by client firm. ***, ** and * indicate two-tailed statistical significance at the 1%, 5% and 10% levels, respectively.

Table 4 Blockchain Adoption and Financial Reporting Timeliness

	(1) Earnings_lag
Blockchain	-8.219***
	(-3.564)
Roa	3.901***
	(3.218)
Size	-1.651***
	(-5.702)
Leverage	3.175***
	(3.614)
Inventory	-2.899
	(-1.585)
Loss	0.177
	(0.411)
Receivables	2.719***
	(2.617)
Bm	0.108***
	(13.822)
Cash	-0.004
	(-0.718)
Quick_ratio	-0.001
	(-0.723)
Dec	-0.206
	(-0.523)
Age	-0.381***
	(-5.123)
M&A	0.015
	(0.043)
Restructuring	0.238
	(0.661)
Foreign	1.309***
	(2.912)
Accrual	-0.955***
	(-2.817)
Going_concern	0.755***
	(5.772)
Board_independence	-15.587***
	(-3.030)
Board_size	0.324***
	(3.797)
CEO_is_chairman	0.294
	(0.582)
_cons	89.490***
	(55.310)
Industry fixed effect	Y
Year fixed effect	Y
adj. R^2	0.462
N	27,425

Notes: This table reports the regression results of Equation (2), regarding the effect of blockchain adoption on financial reporting timeliness (*Earnings_lag*). Industry and year fixed effects are included in all regressions. The numbers in parentheses are t-statistics. Robust standard errors are clustered at the client firm level. ***, ** and * indicate two-tailed statistical significance at 1%, 5% and 10% levels, respectively.

Table 5 Moderating Effects

	(1)	(2)	(3)	(4)	(5)	(6)
	Material weakness		Restatement		Earnings lag	
Blockchain	-0.381***	-0.380***	-0.250***	-0.250***	-8.116***	-8.379***
	(-6.903)	(-6.897)	(-5.586)	(-5.575)	(-3.185)	(-3.117)
IT_CEO	-0.007		-0.036***		1.512	
	(-0.718)		(4.238)		(1.490)	
Blockchain*IT_CEO	-0.092**		-0.085***		-4.326***	
	(-2.344)		(-3.828)		(-2.891)	
IT_Managers		0.006		0.087		0.238
		(1.627)		(0.223)		(0.878)
Blockchain*IT_Managers		-0.026**		-0.188***		-0.456***
		(-2.304)		(-2.708)		(-3.723)
Controls	Y	Y	Y	Y	Y	Y
Industry fixed effect	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y
adj. R^2/pseudo R^2	0.369	0.369	0.032	0.032	0.424	0.424
N	27,425	27,425	27,425	27,425	27,425	27,425

Notes: This table shows the effects of blockchain adoption on FRQ conditional on the CEO's IT background and the managers' IT background. Industry and year fixed effects are included in all regressions. The numbers in parentheses are z-statistics for *Material_weakness* and *Restatement* and t-statistics for *Earnings_lag*. Robust standard errors are clustered at the client firm level. ***, ** and * indicate two-tailed statistical significance at 1%, 5% and 10% levels, respectively.

Table 6 Entropy Matching Method

	(1) Material_weakness	(2) Restatement	(3) Earnings_lag
Blockchain	-0.370***	-0.220***	-8.011***
	(-7.186)	(-8.749)	(-6.433)
Roa	-0.154***	-0.016***	2.135*
	(-3.218)	(-4.143)	(1.702)
Size	0.005***	0.001***	-1.642***
	(10.376)	(5.862)	(-7.344)
Leverage	-0.000***	-0.000	5.394***
	(-3.870)	(-0.084)	(17.232)
Inventory	0.059***	-0.003	-3.306
	(3.216)	(-0.435)	(-1.350)
Loss	0.036***	-0.001	1.339***
	(3.043)	(-1.352)	(3.033)
Receivables	-0.124***	-0.009**	5.081***
	(-3.992)	(-2.535)	(5.114)
Bm	-0.001	-0.001	0.134***
	(-1.308)	(-0.599)	(30.634)
Cash	0.003	0.004	-0.004
	(0.483)	(0.347)	(-0.462)
Quick_ratio	-0.003	0.001	-0.002
	(-0.748)	(0.001)	(-0.587)
Dec	-0.005	-0.001	-0.185
	(-1.503)	(-1.021)	(-0.440)
Age	0.001***	0.000	-0.397***
	(6.614)	(0.942)	(-14.218)
M&A	-0.005*	-0.000	0.300
	(-1.836)	(-0.144)	(0.934)
Restructuring	0.011***	0.002**	0.310
	(3.669)	(2.038)	(0.874)
Foreign	-0.063***	-0.010***	1.830***
	(-15.346)	(-7.150)	(3.976)
Accrual	0.015***	0.002*	-0.951***
	(4.416)	(1.760)	(-3.243)
Going_concern	0.015***	-0.001**	0.693***
	(5.963)	(-2.415)	(5.756)
Board_independence	-0.171***	-0.007**	-16.095***
	(-5.368)	(-2.338)	(-3.557)
Board_size	-0.011***	-0.001***	0.265***
	(-5.084)	(-5.163)	(3.464)
CEO_is_chairman	0.038***	0.002	-0.383
	(8.284)	(0.966)	(-0.755)
_cons	0.225***	0.013***	87.223***
	(17.891)	(2.967)	(54.159)
Industry fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y
adj. R^2/pseudo R^2	0.367	0.030	0.421
N	27,425	27,425	27,425

Notes: This table displays the results from using the entropy matching method. Industry and year fixed effects are included in all regressions. The numbers in parentheses are z-statistics for *Material_weakness* and *Restatement* and t-statistics for *Earnings_lag*. Robust standard errors are clustered at the client firm level. ***, ** and * indicate two-tailed statistical significance at 1%, 5% and 10% levels, respectively.

Table 7 PSM-DID Method

Panel A Five-year staggered DID

	(1) Material_weakness	(2) Restatement	(3) Earnings_lag
Pre_{t-2}	-0.101	-0.187*	-4.605**
	(-0.959)	(-1.732)	(-2.288)
Pre_{t-1}	-0.106	-0.125	-4.418**
	(-0.545)	(-1.308)	(-2.261)
Current	-0.150***	-0.130***	-13.465***
	(-3.873)	(-2.854)	(-6.872)
$Post_{t+1}$	-0.160***	-0.130***	-10.287***
	(-3.882)	(-3.025)	(-5.283)
$Post_{t+2}$	-0.133***	-0.094***	-8.902***
	(-5.583)	(-5.795)	(-12.469)
Controls	Y	Y	Y
Industry fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y
adj. R^2/pseudo R^2	0.368	0.031	0.422
N	2,486	2,486	2,486

Notes: This table presents the results from adopting the staggered PSM-DID. The numbers in parentheses are z-statistics for *Material_weakness* and *Restatement* and t-statistics for *Earnings_lag*. Robust standard errors are clustered at the client firm level. ***, ** and * indicate two-tailed statistical significance at 1%, 5% and 10% levels, respectively.
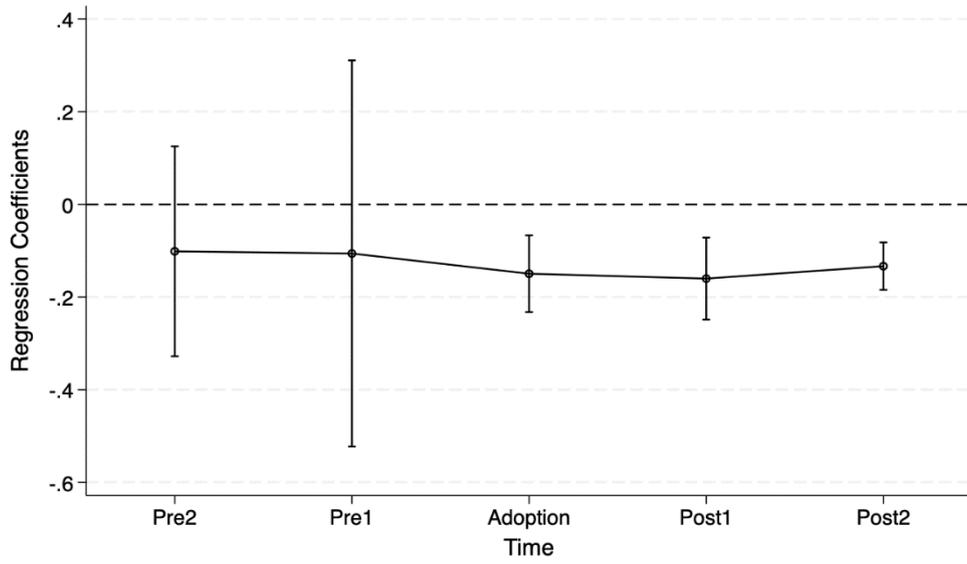
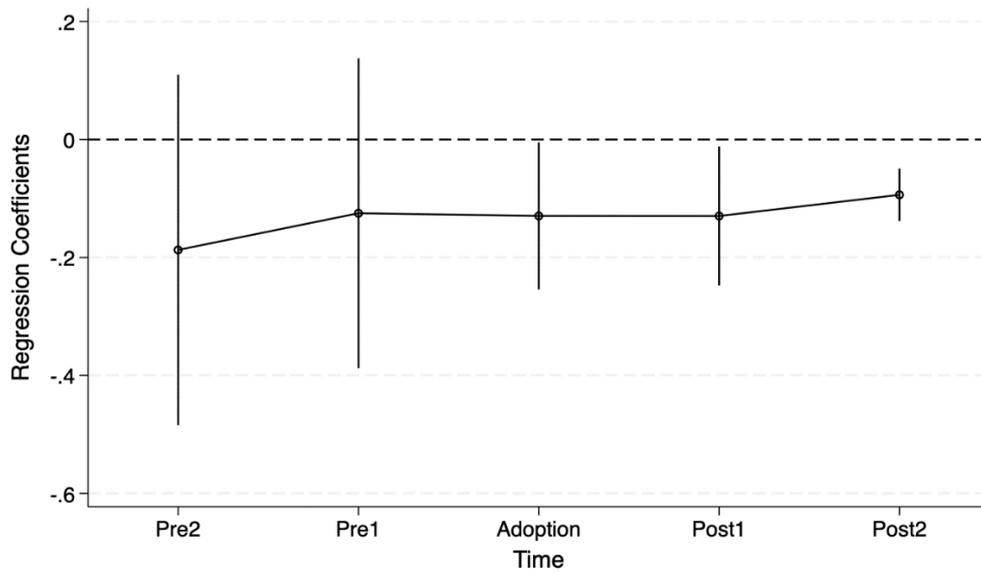Figure 1 Time-varying trend for *Material_weakness*

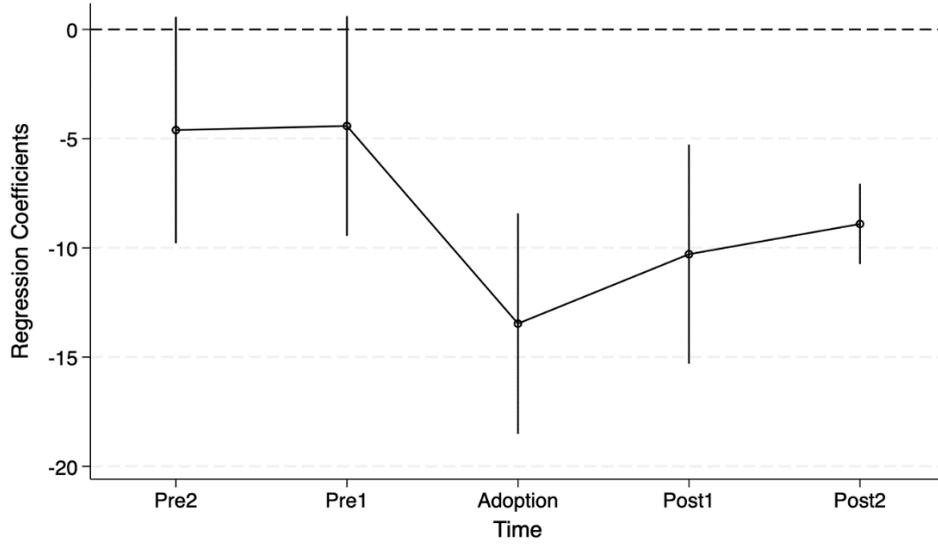Figure 2 Time-varying trend for *Restatement*
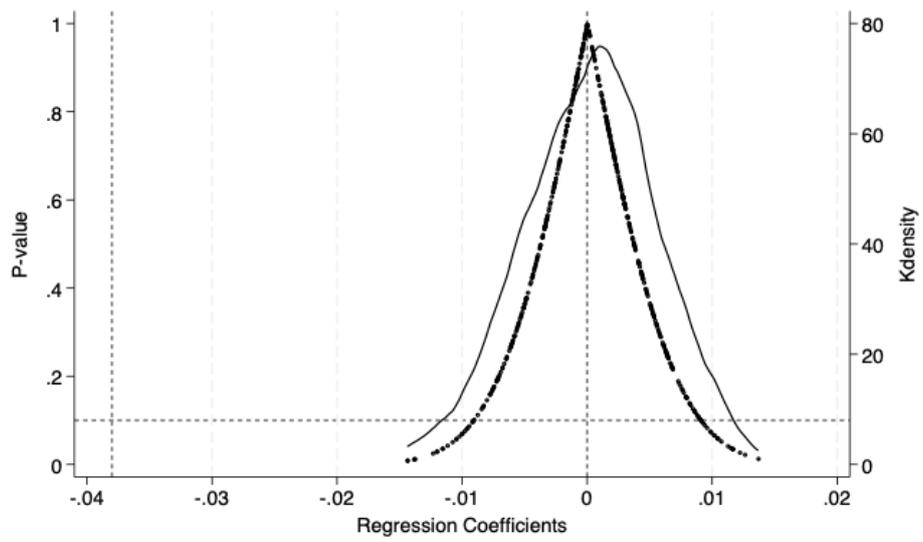
Figure 3 Time-varying trend for *Earnings_lag*
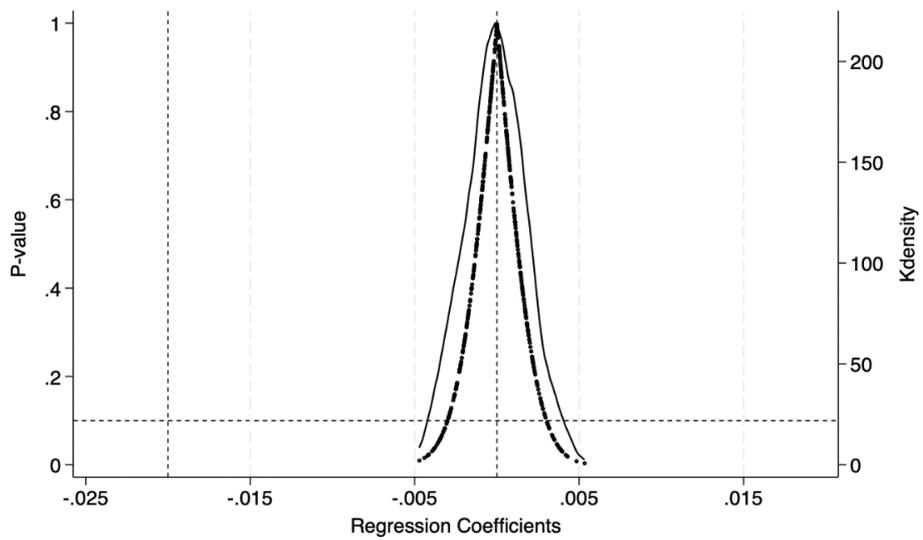
Figure 4 Placebo Test for *Material_weakness*
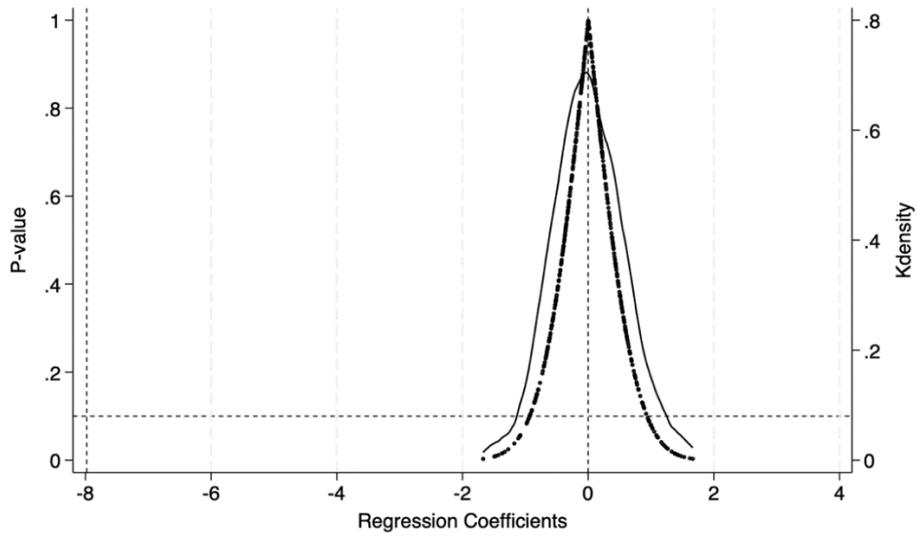

Figure 5 Placebo Test for *Restatement*

Figure 6 Placebo Test for *Earnings_lag*

Table 8 IV-2SLS estimation

	(1) Material_weakness	(2) Restatement	(3) Earnings_lag
Fitted_blockchain	-0.380***	-0.215***	-8.250***
	(-4.250)	(-2.647)	(-4.731)
Roa	-0.274***	0.005	3.679***
	(-9.144)	(1.085)	(3.198)
Size	0.016***	0.002***	-2.008***
	(24.494)	(10.433)	(-6.259)
Leverage	-0.000	0.000	2.343***
	(-1.015)	(0.560)	(3.150)
Inventory	-0.242***	0.018***	5.342***
	(-17.290)	(4.413)	(3.287)
Loss	0.037***	-0.002*	0.976*
	(8.962)	(-1.755)	(1.779)
Receivables	-0.201***	0.011***	-3.911***
	(-5.678)	(3.009)	(-3.582)
Bm	-0.001**	-0.001	0.110***
	(-2.570)	(-0.664)	(10.449)
Cash	-0.003	0.002	-0.009
	(-0.654)	(0.028)	(-1.119)
Quick_ratio	0.001***	-0.002	-0.001
	(3.021)	(-0.448)	(-0.386)
Dec	0.058***	0.003***	0.530
	(6.416)	(2.634)	(1.154)
Age	0.002***	0.001	-0.401***
	(7.895)	(0.812)	(-2.654)
M&A	-0.073***	-0.005***	1.829***
	(-7.181)	(-3.924)	(4.094)
Restructuring	0.079***	-0.004***	2.113***
	(2.881)	(-3.415)	(4.775)
Foreign	-0.101***	-0.010***	2.825***
	(-8.530)	(-6.439)	(4.829)
Accrual	-0.014***	0.001	-2.349***
	(-2.702)	(0.390)	(-5.181)
Going_concern	0.012***	0.000	1.621***
	(4.247)	(0.834)	(6.875)
Board_independence	-0.078**	-0.003	-13.985***
	(-2.189)	(-0.846)	(-4.389)
Board_size	-0.008***	0.001***	0.443***
	(-2.557)	(3.404)	(4.081)
CEO_is_chairman	0.068***	0.010***	-0.584
	(7.242)	(5.377)	(-0.898)
_cons	0.246***	0.002	86.761***
	(15.098)	(0.468)	(45.690)
idstat	10,367.505	10,367.505	4,496.157
widstat	11,706.114	11,706.114	5,055.060
Industry fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y

adj. R^2/pseudo R^2	0.368	0.031	0.422
N	27,425	27,425	27,425

Notes: This table presents 2SLS regression results on the impact of blockchain adoption on FRQ. Industry and year fixed effects are included in all regressions. The numbers in parentheses are z-statistics for *Material_weakness* and *Restatement* and t-statistics for *Earnings_lag*. Robust standard errors are clustered at the client firm level. ***, ** and * indicate two-tailed statistical significance at 1%, 5% and 10% levels, respectively.

Table 9 Alternative Explanation and Robustness Tests

Panel A. Alternative Measures for Financial Reporting Reliability

	(1)	(2)	(3)
	Material_weakness_counts	Restatement_counts	Accrual
Blockchain	-0.113***	-0.038***	-0.004**
	(-7.649)	(-12.713)	(-2.017)
Controls	Y	Y	Y
Industry fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y
adj. R^2	0.128	0.064	0.023
N	21,127	21,026	27,425

Panel B. Alternative Measures for Blockchain

	(1)	(2)	(3)
	Material_weakness	Restatement	Earnings_lag
Blockchain_word	-0.001***	-0.004***	-0.052**
	(-7.606)	(-4.504)	(-2.317)
Controls	Y	Y	Y
Industry fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y
adj. R^2/pseudo R^2	0.368	0.031	0.422
N	27,425	27,425	27,425

Panel C. Analyst Forecast Timeliness

	(1)
	Forecast_timeliness
Blockchain	-0.121***
	(-10.327)
Controls	Y
Industry fixed effect	Y
Year fixed effect	Y
adj. R^2	0.017
N	25,312

Panel D. Change Analysis

	(1)	(2)	(3)
	ΔMaterial_weakness	ΔRestatement	Δ Earnings_lag
ΔBlockchain	-0.203***	-0.064***	-2.562*
	(-15.923)	(-3.253)	(-1.719)
ΔControls	Y	Y	Y
adj. R^2/pseudo R^2	0.023	0.019	0.013
N	27,425	27,425	27,425

Panel E. Control for State Fixed Effect

	(1)	(2)	(3)
	Material_weakness	Restatement	Earnings_lag
Blockchain	-0.319**	-0.186**	-1.746***

	(-2.497)		(-2.194)		(-4.396)	
Controls	Y		Y		Y	
Industry fixed effect	Y		Y		Y	
Year fixed effect	Y		Y		Y	
State fixed effect	Y		Y		Y	
adj. R^2/pseudo R^2	0.370		0.035		0.427	
N	27,425		27,425		27,425	

Panel F. Exogeneity Shock: SEC Regulation

	(1)	(2)	(3)	(4)	(5)	(6)
	Material_weakness		Restatement		Earnings Lag	
	Before 2019	After 2019	Before 2019	After 2019	Before 2019	After 2019
Blockchain	-0.314***	-0.402***	-0.224***	-0.229***	-8.261***	-7.305***
	(-5.121)	(-7.202)	(-5.047)	(-5.972)	(-4.284)	(-3.749)
Controls	Y	Y	Y	Y	Y	Y
Industry fixed effect	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y
adj. R^2/pseudo R^2	0.323	0.420	0.336	0.337	0.401	0.454
N	20,546	6,878	20,546	6,878	20,546	6,878

Panel G. Heckman Two-Stage Procedure

	(1)	(2)	(3)
	Material_weakness	Restatement	Earnings_lag
Blockchain	-0.384***	-0.019***	-8.278***
	(-69.203)	(-9.908)	(-13.653)
imr	-0.178	0.719	-0.364
	(-0.757)	(0.560)	(-1.035)
Controls	Y	Y	Y
Industry fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y
adj. R^2/pseudo R^2	0.368	0.031	0.422
N	27,425	27,425	27,425

Notes: This table presents the results of robustness checks. Panel A uses alternative proxies for financial reporting reliability. Panel B shows an alternative measure of blockchain adoption. Panel C reports the results for using an alternative measure of financial reporting timeliness. Panel D shows the results of a change analysis. Panel E displays the results after controlling for state effect. Panel F displays the results by considering an exogenous shock. Panel G provides the results of the Heckman two-stage procedure. Industry and year fixed effects are included in all regressions, except for Panel D. The numbers in parentheses are z-statistics for *Material_weakness* and *Restatement* and t-statistics for *Earnings_lag*. Robust standard errors are clustered at the client firm level. ***, ** and * indicate two-tailed statistical significance at 1%, 5% and 10% levels, respectively.

Appendix A. Definition of variables

Variable name	Definitions
Independent variables	
Material_weakness	A dummy variable which equals one if the auditors of firm *i* disclose a material weakness in SOX 404 related to controls over financial reporting in year *t*, and zero otherwise
Restatement	A dummy variable which equals one if the firm *i* issues a restatement in year *t*, and zero otherwise
Earnings_lag	The number of lag days after the financial statement day
Dependent variables	
Blockchain	A dummy variable that takes the value of one for firms using blockchain related to financial reporting, and zero otherwise
Control variables	
Roa	ROA ratio, calculated as net profit divided by year-beginning total assets
Size	Natural logarithm of total assets
Leverage	Leverage ratio calculated as total liabilities divided by total assets
Inventory	The ratio of inventories to total assets at the year-end
Loss	A dummy variable that equals one for firms with negative net income
Receivables	The ratio of net accounts receivables to total assets at the year-end
Bm	Book-to-market ratio, calculated as the book value of equity divided by the market value of equity
Cash	Cash ratio, calculated as cash scaled by total assets
Quick_ratio	The current assets less inventory, all scaled by current liabilities
Dec	Equals one if the fiscal year for firm ends in December, and zero otherwise
Age	The number of years for which the firm has Compustat data
M&A	A dummy variable that equals one if the firm engaged in a merger or acquisition during the year, and zero otherwise
Restructuring	Equals one if the firm exhibited non-zero restructuring costs during the year, and zero otherwise
Foreign	A dummy variable that equals one if the firm exhibits non-zero pre-tax foreign income, and zero otherwise
Accrual	Discretionary accruals estimated by performance-matched modified Jones model (Kothari et al., 2005)
Going_concern	A dummy variable that equals one if the external auditor issued a going concern opinion for the firm in the year, and zero otherwise
Board_independence	The total number of independent board members scaled by the total number of board members for the firm during the year
Board_size	The number of directors on the firm's board during the year
CEO_is_chairman	A dummy variable that equals one if the CEO is also the chairman of the firm's board during the year, and zero otherwise
Variables used in additional tests	
IT_CEO	A dummy variable that equals one if the CEO of the firm has IT expertise, and zero otherwise

IT_Manager	A dummy variable that equals one if the firm has at least one senior manager (excluding the chief information officer) with IT expertise, and zero otherwise
Material_weakness_counts	The number of material weaknesses reported in the year
Restatement_counts	The number of restatement items reported in the year
Blockchain_word	The number of occurrences of terms relating to "blockchain" in firms' disclosure
Forecast_timeliness	The number of days by which the forecast precedes the financial statement day

Appendix B. Latent Dirichlet Allocation (LDA) process and keywords

LDA Process	Step 1: Tokenize each file into sentences and extract the sentences that contain the "blockchain" topic keywords (case insensitive and including its plural form). Step 2: Tokenize each sentence into tokens, and remove numbers, punctuation, and stop words. Step 3: Lemmatize each word to its dictionary form. This process converts a word to its base dictionary form, for example, "technologies" to "technology" and "adopting" to "adopt." Step 4: Input each of the cleaned sentences into the LDA model of the Python Gensim library and calculate the frequency of the blockchain-related keywords and financial-reporting-related keywords in each sentence. Step 5: Review the disclosures pertaining to the blockchain adoption that are related to financial reporting in the SEC filings manually to ensure that the blockchain technology is incorporated into accounting-related processes. Step 6: Assign observations to the treatment group (firms disclosing blockchain that is related to financial reporting).
Blockchain Key Words	blockchain, cryptocurrency, digital currency, Bitcoin, Litecoin, Dogecoin, and Ethereum
Financial Reporting Key Words	accounting, asset management, digital currency transaction, share issuing, financial reporting, financial statement, bookkeeping, accounts, reconciliation, ledger, journal, financing, inventory, payment, internal control