# Fintech in Financial Reporting and Audit for Fraud Prevention and Safeguarding Equity Investments

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## Abstract

**Purpose** – The aim of this paper is to explore the audit-related causes of financial scandals and advise how emerging technologies can provide solutions thereto. Specifically, this study seeks to look at the facilitators of financial statement fraud and explain specific fintech advancements that contribute to financial information reliability for equity investments.

**Design/methodology/approach** – The study uses the case studies of Enron and Arthur Andersen to document the evidence of audit-related issues in historical financial scandals. Then, a comprehensive and interdisciplinary literature review at the intersection of business, accounting, and engineering, provides a foundation to propose technology advancements that can solve identified problems in accounting and auditing.

**Findings** – The findings show that blockchain, internet of things, smart contracts and artificial intelligence solutions have different functionality and can effectively solve various financial reporting and audit-related problems. Jointly, they have a strong potential to enhance the reliability of the information in financial statements and generally change how companies operate.

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**Practical implications** – The proposed and explained technology advancements should be of interest to all publicly listed companies and investors, as they can help safeguard equity investments, thus build investors' trust towards the company.

**Social implications** – Aside from implications for capital markets participants, the study findings can materially benefit various stakeholder groups, the broader company environment, and the economy.

**Originality/value** – This is the first paper that seeks solutions to financial fraud and audit-related financial scandals in technology, and not in implementing yet another regulation. Given the recent technology advancements, the study findings provide insights into how the role of an external auditor might evolve in the future.

**Key words:** audit, blockchain, equity investment, financial reporting, fintech, internet of things, machine learning, smart contracts

**JEL codes:** G10, G15, M42

## 1. Introduction

"Gatekeepers in financial markets have the power to provide the institutional stability, fortitude, and direction necessary for the development and the smooth functioning of capital markets." (Roychowdhury and Srinivasan, 2019) A capital market is a marketplace where the supply and the demand meet, and where the asset price is discovered within the valuation process. Since asset valuation is based on public information, the main role of gatekeepers is to ensure that the information available to investors is correct.

Gatekeeper institutions range from auditors, financial analysts, regulators, stock exchanges, rating agencies, lenders, tax authorities to media and watchdogs. Their common feature is that they all bear fiduciary responsibilities towards capital market participants, even if they are hired (and paid) by the companies. In this paper, we narrow down the discussion to only one type of gatekeeping institution: the auditors, and we investigate their role in safeguarding equity investments in capital markets.[1] The information investors use in valuation models comes primarily from financial statements. Given the possibility of accidental errors or purposeful manipulation, public companies must have their financial reports audited by entities external to the organization, independent of the company's management. The purpose of an independent auditor is to apply professional judgment to identify and assess risks of material misstatement and discover potential frauds in a company's financial statements. Specifically, an auditor is to provide "an opinion as to whether the financial statements present fairly, in all material respects, an entity's financial position, results of operations, and cash flows in conformity with generally accepted accounting principles" (*Auditing Standard 2815: The Meaning of "Present Fairly in Conformity with Generally Accepted Accounting Principles"*, 2017). Despite consecutive law amendments targeted at more transparent and better-quality financial reporting, the reliability thereof is still problematic. According to the Report to the Nations of Occupational Fraud and Abuse, the total loss caused by fraud events only in 2016 exceeded $6.3 billion, most of which was related to financial statements fraud (*Report to the Nations on Occupational Fraud and Abuse*, 2016).

There are separate streams of academic literature dedicated to auditor's role in different settings of equity investments. For instance, Weber and Willenborg (2003) argue that when a private company goes public, the presence of outside experts (the auditor) can convey critical information to investors. This is particularly important for small non-venture capital backed companies with a lot of retail investors and information asymmetry (Brav and Gompers, 1997), and with a less prestigious underwriter (Carter et al., 1998). Similarly, having an auditor that

knows well both parties of a transaction helps assess risk, assure the precision of valuation and earn higher returns in the mergers and acquisitions process (e.g., Cai et al., 2016; Dhaliwal et al., 2016). A separate trajectory of thought looks at auditor's role in determining troubled companies that, from the shareholders' perspective, are of great concern because they are likely to go bankrupt in the subsequent period(s). To this point, academics investigate the so-called auditor's going concern opinion (Krishnagopal and Williams, 2010; Read and Yezegel, 2018; Wu et al., 2016). Separately, a lot of discourse in academia and in business practice relates to what endures the quality of auditor's service (report) in any of these situations.

This paper investigates whether fintech—the fusion of finance and technology (Goldstein et al., 2019)—can help overcome or mitigate the shortcomings of financial reporting and auditing that historically lead to some of the biggest financial scandals. Hereto, two examples of such scandals are particularly interesting: the Enron Corporation (hereafter, 'Enron') and its long-time auditor Arthur Andersen (hereafter, 'AA'). The choice is deliberate. These cases present a comprehensive picture of the typical audit-related problems that oftentimes result in financial statements fraud and substantial stakeholder losses. In the Enron case, when it went bankrupt, equity investors lost billions of dollars as the stock price fell from $90 to $1 within one year (Healy and Palepu, 2003; Schwartz and Oppel Jr, 2001). Arthur Andersen was not a publicly listed company but a partnership, so it was its partners—the people who managed the company—who lost their wealth. However, due to the reputation loss, also the shareholders of other AA's clients (other publicly listed companies) incurred negative market returns following the Enron scandal (Chaney and Philipich, 2002). Furthermore, the damage ascribed to audit failures needs to be extended to other stakeholder groups, i.e. to all parties affected by the fraudulent company and an inefficient auditor (about 20,000 employees of Enron and 85,000 of AA lost their jobs, even more, contemporaneous and former employees lost their pensions, business partners lost contracts, etc.). To safeguard equity investments better in the future, multiple measures have been introduced, mostly in form of new, stricter regulation, e.g. Sarbanes-Oxley Act and Dodd-Franc Act in the U.S., European Parliament and Council Regulations and Directives in Europe (Ganuza and Gomez, 2007), amendments to accounting and auditing standards (Unerman and O'Dwyer, 2004). Despite intense debate and several reforms, problems with the reliability of financial statements and with the quality of auditor reports seem far from over.

In this paper, we do not attempt to propose yet another regulatory or managerial improvement. Rather, we analyse how contemporary technologies can mitigate or eliminate auditor's failures.

Specifically, we look at how blockchain, smart contracts, internet of things and machine learning can help safeguard equity investments in capital markets by improving the reliability of financial statements and increasing the quality of audit process and its outcomes.[2] We relate each technology solution to the analysed cases and evaluate how they can contribute to overcoming the audit-related problems with information reliability and accounting fraud. Noteworthy, in our analysis, we are adapting the shareholders perspective, as it enables us to look at the implementation of new technologies from the cost-benefit perspective. An independent audit of financial statements based on emerging technologies can further improve the trust that is crucial for the successful equity investments in public companies and effective functioning of the capital markets. As "any erosion of this trust may damage an entity's reputation, stock price and shareholder value, and can result in fines, penalties or loss of assets" (CPA Canada et al., 2017), implementing fintech solutions should become of interest not only to the company's management but also to its shareholders.

The contribution of this paper is four-fold. First, we add to the academic debate on the role of audit in safeguarding equity investments in capital markets. Second, this is the first paper that seeks solutions to the audit-related financial scandals in technology, not in implementing yet another regulation. Third, as discussed in academic literature, equity investors' losses are even more severe in situations when the accumulated bad news reaches a certain tipping point, it is suddenly released to the market at once because then it results in an abrupt decline in stock price (i.e., a crash). Despite some early red flags and concerns, this was a situation of Enron, but it is also a common problem in today's stock markets. Kim and Zhang (2014) argue for increased transparency in transactions as they find that accrual management, the presence of financial statement restatements, and auditor-attested internal control weakness are all positively and significantly associated with the level of perceived crash risk. Our results support the argument that improving financial reporting transparency and audit process with emerging fintech solutions can be an important mechanism for companies and investors to reduce tails risk and stabilize the stock market as a whole. Fourth, given the recent technology advancements, our findings and conclusions provide insights into how the role of an external auditor might evolve in the future.

The rest of the paper is organised as follows. Section 2 explains how the trust in the space of equity investments has been reduced or even broken because of the auditor's failures in the Enron and Arthur Andersen cases. Section 3 presents fintech solutions to the previously-identified problems and explains how trust in the space of equity investments can be improved

using emerging technologies. Section 4 concludes and provides insights into how the role and function of an external financial auditor might be redefined given technology advancements.

## 2. Audit-Related Problems in Safeguarding Equity Investments: Mistakes from the Past

External audit function has been of importance to investors of publicly listed companies for a long time. Yet, disruptive audit failures needed to happen to start a serious discussion on how to regulate and improve the space, and how to structure the relationship between an auditor and a client. Historically, the most notorious cases of fraudulent financial reporting and auditor's failure to prevent it are the Enron and Arthur Andersen scandals. These cases have already been well described in the academic literature therefore only a brief description has been provided in the Appendix. In the following paragraphs, we present the key problems in the space of financial reporting and auditing that were the main causes of the Enron and AA scandals and the subsequent equity investors' losses.

### *2.1. Falsification of Records and Information Mutability*

There are a few points related to the financial information that is being published to the investor's community. First, there is a question about how a company interprets and incorporates financial reporting regulation when preparing their financial statements. The problem arises particularly when there are loopholes in the law that ultimately "allow" for misrepresenting the actual financial standing in the accounting records. Enron under the Jeffrey Skilling's presidency was launching ever newer dubious mechanisms to boost sales, income and accelerate growth. One of these was *mark-to-market accounting*, which enabled recognizing the present value of future cash inflows as revenues and expensing present value of expected costs. This mechanism was legal with respect to short-term contracts, but Enron used it for much longer periods (e.g. 20 years). Another gimmick was how they recognized revenues from the trading activities: as an intermediary, instead of using the 'agent model' and reporting revenues in the amount of the fee-only, Enron was reporting the entire value of each trade as revenue. Then, Andrew Fastow introduced the so-called "Special Purpose Entities" (SPEs). These were funded by theoretically independent equity investors and lenders and were used to hedge investment gains and deleverage the balance sheet. The situation became critical and excessively risky when Enron indirectly controlled over 3,000 of those "partnerships" but was still not obliged to consolidate their performance due to the loophole in the financial regulations. In consequence of the described "creative accounting" techniques and falsification of other account records, there was a substantive discrepancy between Enron's financial

situation presented in its balance sheet and the actual financial standing. Thus, it was impossible to estimate the company's actual profits and market value.

Then, the company provides an auditor with financial statements for their verification. If an auditor discovers errors or fraud, the company should restate its financial statements before publishing them to investors' community. Enron managers used loopholes in accounting and illegal gimmicks to hide bad debt in its balance sheet and to inflate the company's earnings. Yet, instead of Enron managers correcting the statements after auditor's recommendations, it was Enron's auditor who was changing audit reports to hide or validate Enron's fraudulent results. Quite often lower-level AA auditors were made by Enron managers to produce false statements (with the consent of senior auditors). Collins reports about situations when Enron employees were "locking an Andersen auditor in a room until he produced a letter supporting a $270 million tax credit" (2019). Importantly, in some cases, even a thorough auditor's investigation is not enough to discover the company's fraudulent actions. If a company like Enron provides proofs for entry information that are falsified, detecting fraud might be difficult at best.

Finally, by law, all audit documents are to be stored as proof of an independent and objective report. In the US, SEC requires auditors to "retain certain records relevant to that audit or review. These records include work papers and other documents that form the basis of the audit or review, and memoranda, correspondence, communications, other documents, and records (including electronic records), which are created, sent or received in connection with the audit or review, and contain conclusions, opinions, analyses, or financial data related to the audit or review." (*Final Rule: Retention of Records Relevant to Audits and Reviews*, 2003) In October 2001, Enron disclosed that the SEC was launching an investigation into the company, and the scope of the inquiry included the actions of the company's auditor. In December 2001, Enron filed for Chapter 11 bankruptcy protection, whereas AA's managers instructed its employees to destroy a large number of Enron-related documents.

### *2.2. Diffusion of Responsibility*

A person or an entity is responsible when it satisfies certain objective conditions for being a subject for blame or praise, and we indeed blame or approve. Card (2005) notes that due to the agentic shift, hierarchical entities (corporations) suffer from erosion of agency that makes it difficult to identify the action ownership. When not explicitly assigned, *diffusion of responsibility* arises, particularly within big groups (Leary and Forsyth, 1987). Darley and

Latane (1968) explain it as a sociopsychological phenomenon whereby a person is less likely to take responsibility for action or inaction when others are present.

In the Enron scandal, there were thousands of employees that actively participated in wrongdoing. It was the CFO who elaborated creative accounting strategies, accountants who directly falsified the accounting entries and who put other creative ideas into play, but also many more individuals (the CEO, internal controls) that passively participated in misconduct by accepting the actions or failing to stop the fraud internally. At the same time, there were gatekeepers that either neglected their responsibilities or committed intentional omission: the auditor (Arthur Andersen), lawyers, etc. All corporate actions were the result of aggregated actions of many individuals linked and working together but also those who were in the formal structures of fraud but unaware of the final outcome. Thus, once the scandal burst, it was difficult to precisely ascribe responsibility for the fraud. From the equity investors' perspective, this is a significant problem because it becomes when there is no direct assignment of responsibilities to individuals, it is difficult to hold them responsible for fraud and financial losses.

Responsibility imposes active moral deliberation, which was not present in most of the activities of Enron employees. Similarly, there was no moral deliberation of the orders from the client in the AA case. Robinson suggests that such an attitude was missing when one of the AA executives asked his colleagues to check for any smoking guns: "The significant point is that none of his colleagues questioned what he meant or its moral significance. It was not seen as their responsibility, and responsibility, or its lack, is tied intimately to awareness of the other." (Robinson, 2009, p. 18)

### *2.3. Auditor's Revenue Priority over Intrinsic Audit Objectives*

Companies are brought to life to make profits, and even though business and academics agree that the purpose of any company cannot be narrowed down to only Friedman's shareholder's value maximization (1970), in practice profits most often take priority over other corporate outcomes. In most cases, revenues priority is accepted by the company's environment, even if it is harmful to some stakeholder's groups. It differs for firms that provide audit services. They have a legal responsibility towards "the society" to provide objective and reliable audit report aside from being for-profit organizations. Yet, they paid by the audited company. As they do not want to do anything to jeopardize their income (Dunn, 1996), they are naturally inclined to make the client happy. When a company acts fraudulently, an auditor has financial incentives

to participate in the client's misbehaviours, and a persistent conflict-of-interest situation occurs (Sezer et al., 2015).

Enron was one of the greatest success stories of the 'New Economy' boom, thus an attractive client to be associated with and a significant source of revenue in auditing and consulting. For AA, having it as a client was "like these very bright geeks at Andersen suddenly got invited to this really cool, macho frat party" (McRoberts, 2002). Andersen's fees from auditing Enron were more than satisfactory ($25 million only in 2000), along with sound revenues from consulting services (another $27 million). Enron was a high-risk client, but the auditing industry was so competitive that Andersen partners were under pressure to keep it at all costs. AA accountants repeatedly raised doubts about unreasonable risks being taken by Enron (Salter, 2008). Yet, to retain the profitable client, none of those concerns has ever reached Enron's management or audit committee (Collins, 2019). With the rapid growth of Enron, the two companies became very close not only through contractual terms but also because of the personal relationships between companies' leaders.

Nevertheless, the collapse of AA was foreseeable even sometime before the Enron scandal. Barbara Toffler, AA's partner in charge of Ethics and Responsible Business Practices, suggested that along with the rapid growth, the management team's focus was shifted from professional integrity and fairness to revenues at all costs, from a good career at a place with a good name, to get rich hand over fist. The cornerstone values of company's identity became 'three pebbles and a boulder': the boulder was financial performance, whereas the rest seemed like a joke (Toffler and Reingold, 2003). For many years AA worked hard to develop a positive reputation and the aim was to serve the client but stand up to it when necessary. Then for the sake of revenues from consulting and auditing services, keeping the clients happy became the purpose of the firm.

### *2.4. Auditor's Dependence*

Probably the biggest challenge when it comes to auditor's role in safeguarding equity investments is ensuring its independence (Bazerman and Gino, 2012), especially when in a long-term, close relationship with a client. As defined by law, "the auditor has a responsibility to plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement, whether caused by error or fraud" (*Auditing Standard 1001: Responsibilities and Functions of the Independent Auditor*, 2017, para. 2). Thus, external auditors have the capability to discover and make public any misstatement done by the company's managers that could harm investors. In practice, when too dependent on a

client, this capability fades away, and the quality of service decreases. Indeed, ICAEW clearly states that "a critical element is the quality of the audit, and auditor independence is one of a number of important blocks on which that quality is built" (ICAEW, 2020). This applies also to the internal audit, as its role is to verify management's actions and decisions even prior to external examination.

Just like at any other publicly listed company, Enron's top executives formally needed an internal and external validation for each of their major business decision. In reality, both internal and external audit was subject to Skilling's supervision, therefore any form of concern about the company's accounting improprieties or violations was met with rejection. Regarding internal control, there was a theoretically independent group of analysts, accountants, and lawyers to evaluate every project with respect to its risks. In practice, the group's recommendations did not have any power to direct corporate actions because the group was reporting directly to Skilling. External control—Vinson & Elkins (attorney) and Arthur Andersen (long-term auditor)—also proved inefficient. Auditor's independence requires that in cases when she spots an error or a fraud, she is obliged to take a position that a client would dislike (DeAngelo, 1981). Yet, Enron's accounting manoeuvres were each time legitimated by its auditor, who gave an informal consent to its dependence in exchange for long term material benefits. Inefficient internal and external controls, together with the accounting framework full of loopholes and limitations, yielded room for Enron's managers to undertake even riskier accounting practices (Fox, 2003), that ultimately led to gigantic investors' losses.

The list of financial reporting- and audit-related failures that affect the riskiness and returns of equity investments is far from finished. Our goal here was, however, to point to the main reasons for fraud in the analysed cases in order to have a deeper understanding of the problems in practice. In the next section, we propose how particular emerging technologies can help fight financial fraud and prevent subsequent losses incurred by equity investors.

## 3. Safeguarding Equity Investments: Fintech Solutions of the Future

### *3.1 Blockchain for Information Reliability*

The promise of blockchain technology in financial reporting and auditing is to fix current challenges (Simon et al., 2017) and overcome a number of issues that historically led to serious financial scandals. Blockchain has the potential to materially improve information reliability in financial statements. The contemporary accounting system is based on duplicate entries, periodical controls and multiple verification techniques that are to make the system

incorruptible (Deloitte, 2016). It is quite labour-intensive as still many tasks are done manually.[3] Blockchain technology can be applied to recordkeeping processes, including the way transactions are initiated, processed, authorized, recorded, reported, and how data is stored (CPA Canada et al., 2017).

Accounting involves processing and analysing a large amount of information, which yields inefficiencies, errors, and room for manipulation. Efficiency can be improved when information is stored in a structured way, with full interoperability. Blockchain technology is a "distributed database that is organized as a list of ordered blocks, where the committed blocks are immutable" (Casino et al., 2019). Arguably, blockchain is an accountancy-based technology that treats data flows as transactions. In comparison to traditional accounting software, blockchain allows for keeping all data well structured, stored and easily accessible in almost no time. Such a solution can boost productivity, accuracy, speed and interoperability in routine accounting processes (Paine, 2018) and provide a great platform for subsequent use, e.g., by external auditors.

The benefits, accounting and auditing can derive from implementing blockchain,[4] stem directly from the technology design and its characteristics. Blockchain brings decentralization, strong authentication, and tamper-resistant ledger of all historical transactions. There is a claim that blockchain permits 'triple-entry bookkeeping', where a transaction leads to not two but three entries: debit, credit and a cryptographic signature to verify a transaction's validity (Wiatt, 2019). Data is encrypted and validated by participants before being added to the ledger. The new entry is verified via a predetermined mechanism: a consensus protocol (Casino et al., 2019), i.e. 51% of the members of the chain need to agree to it. Upon transaction acceptance, the entire ledger is updated. Multiple entries, which represent transactions, are put together into a 'block', which is added to the ledger (Welker, 2018). This way, each block contains information that can be traced back to previous blocks, as they are all connected on a chain with a secure hash that is generated using a cryptographic private key, difficult to break (decipher). Enron created a whole system of off-balance-sheet operations hiding large scale losses and liabilities. This was not visible to external shareholders, as the company used SPEs that were not consolidated in Enron's accounting system. Notably, in Enron's time, firms were legally allowed to use these SPEs for off-balance-sheet uses. The mounting problem at Enron was using this tool on such a big scale, while investors (and other stakeholders) not realizing how massively it was used for hiding bad debt.If all transactions had been recorded on the blockchain instead, they would have been linked to Enron and so investors could have realized

sooner that company's results have been boosted in an artificial way. Then, once in the ledger, records are immutable, that is unchangeable and irreversible, and no member can delete them. Blockchain technology makes it impossible to reverse any transactions that have already been verified, which is in line with the argument that non-reversibility can improve transparency in accounting processing. Any suggested change would only occur if it were approved by the majority of participants, not just by a single individual. This makes changes highly infeasible and reduces data altering possibilities, for legitimate or illegitimate reasons. From the auditor's perspective, because transactions are pre-verified and immutable, they do not need to be audited in a forensic manner through sampling; rather an auditor should focus on the whole population of transactions, their nature and legal basis to provide a higher level assurance (Moll and Yigitbasioglu, 2019). This means AA should have investigated more thoroughly the whole idea or mark-to-market accounting, revenue recognition model and non-consolidation of SPEs' books, rather than verifying whether an individual transaction's revenues had been backed by the actual value of trade. At the same time, entering the initial transaction should be done carefully to avoid making corrections in the future. If information is only added, and never deleted or lost, then blockchain's digital ledger captures and stores all the data that members of the blockchain network feed thereinto, for instance, a full disclosure of asset's history and ownership. If blockchain was used at Enron, its managers would not have been able to change the entries without leaving a trace. Also, any change to financial statements suggested by an auditor would have been visible in the history of Enron's ledger.

In the existing accounting systems, changes made to the records can be traced back only if the audit trail has been implemented into the software. Otherwise, no history of the balances exists, and it is impossible to verify who altered the data. Conversely, blockchain technology has a built-in "auditing functionality." Blocks that store information, are linked to each and are immutable, therefore blockchain ledger provides not only balances but the whole history of transactions. This enables the trackability of individual transactions (changes). Blockchain can also securely store or link documentation supporting transactions (contracts, agreements, purchase orders, invoices) in an encrypted way (CPA Canada et al., 2017). In the Enron case, this would have proved extremely helpful, as any fraudulent change the financial results suggested by Fastow or Skilling, yet implemented by a lower-level accountant, would have been written in the ledger history, and each change (transaction) would have had its 'owner' written in the block. This could help mitigate the diffusion of responsibility problem at Enron as each outcome would have been trackable to the agent originating or approving it. Also,

Enron managers never allowed for any unfavourable audit report to reach investors' community. Krishnagopal and Williams (2010) report negative excess returns when an auditor discloses the 'going concern audit report.' In pursuit of stock price increase, Enron executives often made auditors change their official opinion. Blockchain immutability could prevent companies from forcing auditors to change their audit findings as the evidence thereof would still remain in the ledger.

On the Arthur Andersen side, they physically destroyed a lot of audit documentation when Enron filed for bankruptcy. Supposedly, among those documents, there were proofs of AA acquiescence to Enron's financial data manipulation and other forms of auditor's wrongdoing. Blockchain technology offers another feature that would have prevented such an information loss: decentralization, i.e. the same set of data is replicated and stored in each node (a computer in the chain). Hence, any change, or rather any addition to the ledger is automatically visible to all network members. Most of the existing accounting solutions are centralized databases with data being replicated in a back-up database server. Storing data in one place makes it prone to manipulation and loss, and historically contributed to the multitude of financial frauds (Welker, 2018). In the blockchain, all the participants retain duplicate copies of the entire ledger as proof that specific transactions took place (Simon et al., 2017).

Another dimension of data security is its susceptibility to external alteration and other forms of hacking. Current accounting systems are normally protected by the server and database login details, at times with a two-step verification. Anyone who has the login details can access the database, and potentially change or destroy records (data is mutable) [5]. In the blockchain-based accounting system, once information is written to the chain (a block is added), it becomes practically immutable. This system design leaves no room for external tampering, hacking, or fraud unless again the majority of participants agree to the change.

Blockchain ledger characteristics (continuity, irrevocability, irreversibility) can successfully prevent management from cooking the books (creating fictitious transactions, changing records, backdating options, etc). The transparency of blockchain-based accounting system could benefit external auditors by providing already verified, correct data (Deloitte, 2016) and make it easy for forensic accountants to access and examine the material related-party transactions (Dai and Vasarhelyi, 2017). Therefore, blockchain not only increases the chance of detecting fraud (even without an external auditor in place), but also prevents management to reduce earnings manipulation. This robust architectural design assures financial data reliability more than contemporary accounting systems This is important for equity investors

because they work with information verified already at its entry, and not only by the external auditor. On the company's end, it builds up a reputation because with blockchain technology it can create a more reliable and accurate picture of its financial standing.

### *3.2 Internet of Things for Entry Automation*

Recent improvements in business processes often target automation because tasks performed manually are costly and erroneous. Internet of things (hereafter, 'IoT') can reinforce blockchain technology in conjunction with accounting entry automation. IoT system consists of sensors and actuators embedded in physical objects that are "linked through wired and wireless networks, often using the same Internet Protocol (IP) that connects the Internet" (Chui et al., 2010). The idea is that if many different 'things' can be connected to the internet, so they can be connected to each other (O'Leary, 2013). As sensors send data to the cloud, information is collected, and software can process it for the purpose of performing an action.

IoT is already transforming manufacturing, supply chain and other industries. It can also enhance the accounting systems. Existing Enterprise Resource Planning (hereafter, 'ERP') solutions already offer an increasing level of automation and resultant efficiencies (Spraakman et al., 2018). In a supply chain, cooperating companies can integrate their systems to automate and streamline operations. For instance, a buyer can check the vendor's reported stock levels and prices and place a purchase order. There is no need for the human element to input data or communicate, as both companies' systems are connected to each other enough to enable automated transactions. When, additionally, IoT sensors are in place, the information from operations automatically ends up in the accounting ledgers, hence no need for manual entry. Sensors can update financial records regarding any physical asset in real-time: inventory, production levels, equipment usage (e.g., mileage records for company cars) and its wear and tear. Automating these entries in the accounting system presents a few benefits: real-time-data, lower labour costs for the company, fewer errors but also fewer possibilities for manipulating records. IoT, similar to blockchain, can help companies free up resources to concentrate on planning and valuation, rather than recordkeeping (ICAEW IT Faculty, 2018). Then, data from IoT sensors can be shared directly with business partners or even integrated with the system of a financial provider. Resultantly, the real-time levels of inventories can be linked to a credit line account at lender's and used to instantaneously adjust credit limit.

Auditors (Arthur Andersen), rather than checking the correctness of information in the financial statements, will be able to put more emphasis on detecting fraudulent behaviour of the company's management (Enron). The application of IoT sensors will decrease or even

eliminate the need for confirming ledger balances with the real-life external sources (e.g. inventory balance with items in the warehouse). Rather, auditors will be obliged to double-check if the information sent by sensors have not been anyhow distorted (e.g., physical inference into sensor technology to alter the transmitted data).

Integrating IoT with blockchain in the accounting system creates a more comprehensive solution: IoT sensors provide automatic entries regarding physical assets, while transactions recorded on blockchain complement the automation with data about other, mainly financial positions. IoT combined with Blockchain is also known as the Internet of Trusted Things (hereafter, 'IoTT') as blockchain technology provides trust (verification) to IoT outcomes. IoT is still not an inter-connected network (within or across industries), therefore it is expensive to establish the identity of transacting parties, trust among them and exchange data in a trusted way (Patil, 2018). Despite challenges in sending sensor data from the IoT devices to the blockchain securely (Makhdoom et al., 2019), IoTT could facilitate a trust model that "secures machine-to-machine communications and assess whether the actions of these devices are normal or expected" (Epps, 2017).

In the analysed cases, the IoT-enabled accounting entry automation (inventory and other assets' tracking in particular) could have provided a comprehensive and undisturbed record keeping, could have reduced or even eliminated the necessity for reconciliations and would have made it more challenging to conceal a fraud. It could have also helped AA focus on actions that added more value to the audit process. For instance, the auditor could have verified more complex transactions and the big picture of accounting scheme (inducing Enron's SPEs to hide bad debt) or its internal control mechanisms, rather than counting individual items of inventory in the warehouse.

Notably, IoT may also enhance fair value accounting and disclosure, thus contributing to more proper valuations. IoT provides a multitude of data about various assets. It can track not only the amount of inventory but also its quality. Similarly, sensors, video cameras or chips embedded in property or machinery can provide a more accurate record of a fixed asset. While sensory data measuring the health of an asset may be utilized by operations to decide about its maintenance, replacement etc., accounting can use this data to select a more appropriate depreciation method, and investors can use this new information in their valuation models. Given that valuation was one of the biggest challenges for Enron investors, and they needed to rely only on what the company's management was reporting, IoT could have benefited them by shedding more light on what the health and value of all those company's assets was. Aside

of its trading activities, Enron owned and operated a variety of assets across the globe that included gas pipelines, electricity plants, pulp and paper plants, water plants and broadband services (Healy and Palepu, 2003). New big data derived from IoT sensors may have enhanced investors' ability to understand the Enron's assets, features and conditions, which, building on Warren et al. (2015) could support fair value accounting, and in our case, decrease the risk of unreliable inputs to the valuation models.

### *3.3 Smart Contracts for Improving Financial Statements and Ascribing Responsibility*

Smart contracts are "user-defined programs that specify rules-governing transactions" (Delmolino et al., 2016) that can be integrated into the blockchain. Blockchain users program their own rules (in practice, 'if-then' propositions) into a smart contract. These rules are encoded to execute specific tasks automatically, upon certain conditions being met. A simple application of an 'if-then' smart contract proposition in accounting is an automatic payment of accrued, unused vacation on termination of employment: if an employee contract terminates and she had not used paid vacation days, an appropriate amount would be automatically added to her last salary payment. Similarly, management can incorporate different company-specific rules into smart contracts to execute controls (Dai and Vasarhelyi, 2017), two separate entities can use smart contracts to carry out various agreements, etc. Many IFRS, US GAAP or national accounting standards could be written into a smart contract, in order to homologate bookkeeping concepts and financial analysis. The current limitation of smart contracts is that rules must be unequivocal. However, practitioners are pointing to the possibility of applying ML to smart contracts, which leads to an 'intelligent contract' that can learn from the past experiences and be applicable to the new situations and circumstances (Sukkar, 2019).

There are quite a lot of potential smart contracts applications in the analysed cases. At Enron, one of the problems was revenues overstatement. Blockchain technology together with smart contracts can provide evidence of any potential irregularities in revenue recognition (Wang and Kogan, 2017). Relevant 'if-then' propositions can assure that all necessary conditions are met before sales revenue is recognized. The automation and enforcement of contractual terms with less human intervention add to the process efficiency and limits inherent risks (CPA Canada et al., 2017). Once data is on the blockchain, smart contracts perform accounting functions automatically, thereby reducing human error or purposeful manipulation of ledger records like in the Enron case. Another benefit is that any party, internal or external, can verify whether transactions are in compliance with encoded rules (Dai et al., 2017). This can prevent companies like Enron from hiding from their auditors that certain balances are inconsistent

with the general practices or accounting standards. Similarly, investors can oversee both the records in financial statements and general governance in the company that is transcribed into the blockchain via smart contracts.

Finally, smart contracts could help overcome the diffusion of responsibility problem. Processes and actions, and respective responsibility, can be precisely assigned to individuals or teams. Such an 'autopilot' implementation leaves no room for doubts, who originated and carried out an action because this decision would have been made already at the smart contract design (encoding) phase. At Enron, many top executives denied wrongdoing claiming they did not know about the fraud (Kenneth Lay) or that they were not directly responsible. With smart contracts, when all decisions have their 'owners', the responsibility of particular individuals for Enron creative accounting would have been evident and unambiguous. This solution enables also clear separation of the company's and the auditor's responsibility for fraud. If smart contracts had been applied, it would not have been that easy for AA to accept and validate Enron's financial statements.

Blockchain together with IoT and smart contracts can in the near future enable what some practitioners call fully automated audits (Deloitte, 2016). Some level of automatic execution is already achievable with existing software, but smart contracts give the possibility to bring it to a whole new level. Especially, if we start implementing Ricardian contracts that work like smart contracts, but are also legally binding (Al Khalil et al., 2017). This is especially important in companies with complex related-party transactions and product diversification (like Enron) because increasing complexity of financial information reduces transparency and raises information asymmetry between managers and auditors, resulting in higher audit risk (Hung and Cheng, 2018).

### *3.4 Emerging Technologies for Real-Time Data and Faster Publication of Financial Results*

Timing is particularly important in preparing and auditing financial statements, as it has direct consequences for investment decisions. Few points are noteworthy here. First, there is an issue of assigning the company's performance to the appropriate accounting period. Manual data entry yields an opportunity for results manipulation related to shifting revenues and costs between periods. In the blockchain, transactions (entries) are verified, settled, and recorded in the ledger almost in real-time. Therefore, it is impossible for any member of the network to advance or delay a transaction. Using IoT, data can be automatically sent from the sensor to

the accounting system. As such, a company like Enron would no longer be able to smoothen earning or ascribe transactions to periods other than they belong to.

Second, with the use of blockchain, IoT and smart contracts, there is a possibility to deliver verified real-time information also to external stakeholders. Many organizations already benefit from providing their employees with access to real-time information with the use of the existing software. For instance, the existing ERP applications already report the company's results instantaneously but only to internal stakeholders because the numbers are still unaudited. With blockchain, the real-time data is already pre-verified by network participants, IoT provides unbiased information about the assets, while smart contracts prevent management from manipulating income statement positions, e.g., revenues. If information about the company's performance becomes immediately be available to a broader public, external stakeholders could gain ground-breaking insights for their decisions. Real-time data can be very helpful: lenders adjust the company's credit to its current needs; investors take more time-relevant trading decisions. Arguably, the latter would be at the expense of increased stock price volatility, which is desired neither by the company nor long-term investors. Hereto, a private blockchain (with granted access) or a minimal disclosure model (discussed in the next subsection) can be a solution. Conversely, a private blockchain no longer provides ground-breaking benefits; in fact, it closely resembles the modern accounting system (cloud- or edge-based private data centre), and its only extra benefit is the security assured by the use of cryptography (Ray, 2018). In the Enron case, real-time reliable data could have saved equity investors from losing at least some of their money. Kenneth Lay, the Chairman of Enron, who had constant access to company's results, was presenting the contemporaneous financial standing of the company as very good during some meetings with investors, while himself selling off his shares in the company. If the investor community had access to the real-time information just like he did, there would have not been a situation of unfair insider trading. This topic is further discussed in Section 3.5.

Third, technology can deliver faster audit report publication. Current accounting software solutions already enable having yearly or quarterly financial results ready the same day as the period ends. In business practice, however, there is an audit report lag (hereafter, 'ARL') defined as the period between a company's fiscal year-end and the audit report date (Lee et al., 2009). The length of ARL is sample-dependant, it varies for different countries, times, and company types. Habib et al. (2019) report that for the U.S. public companies the ARL is 60 days and more (again various sub-samples provide different results). There have been already

quite a few real-time computer-aided auditing solutions used for data extraction and analysis in auditing to make the process more time-efficient. Proprietary tools like IDEA (a product of CaseWare) and ACL (a product of ACL Services Ltd) facilitate retrieving data from one or more applications and performing analytical procedures on this data (Harding, 2007). These solutions already help professional auditors scan and profile records, summarize and compare financial and business transactions to identify and reduce risk. Importantly, they provide a more efficient approach for identifying questionable records for the examination process that is no longer sample-based (statistical sampling practiced by traditional auditors) but exception-based (Appelbaum et al., 2018). The possibility of modifying the default join property makes it easier to spot irregularities and warning signs of fraud (Lehman, 2008) while setting up continuous controls monitoring enables detecting fraud in real-time. This seems like already a good level of improvement; however, emerging technologies can shorten the ARL even more. Auditing function is quite standardized, but the audit process is client-specific because the financial information is very idiosyncratic. Before an audit process begins, auditors receive all the data and only then schedule the scope of work and its timing, which adds to the ARL. If blockchain was implemented, an auditor could have (read-only) immediate access to all the data in a consistent, recurring format (CPA Canada et al., 2017), and plan the audit process in advance or even conduct audit continuously, in near real-time. In doing so, AA could have identified high-risk positions in Enron financial statements faster than at the end of the financial year.

Fourth, there is a problem of companies releasing financial results to the investors' community before an audit report is ready. This issue has not been evidenced in the Enron scandal, but it is widespread among contemporary companies. Historically, it used to be a good, common practice that first an audit was performed, and only then the investors learned about the company's (externally validated) financial results. Before 2002, three in four companies published its yearly earnings announcements after the audit report was done (Marshall et al., 2019). After 2003, fewer and fewer companies wait until the audit report date. Recent evidence suggests that around 70% of annual earnings announcements happen 16 days before the audit report is released (Marshall et al., 2019), mostly because reporting financial results prior to the audit report makes the auditor more willing (pressured) to follow management's goals, and accordingly reduces the probability of audit-adjustment recommendations (Bhaskar et al., 2019). This yields room for abuse and fraudulent reporting, which affects the valuation process and investor's trading decisions. The availability of pre-verified real-time data in the

blockchain-based accounting system can shorten the ARL and eliminate the danger of releasing unaudited results. Additionally, smart contracts could be employed to restrict managers from publishing periodic results before they are audited or even to automate the financial statements publication process: *if* the audit report is ready, *then* company results are published.

### *3.5 Minimal Disclosure Models for Tailored Information Access*

Financial reporting is intended to provide timely and reliable financial information for various company's stakeholders: investors, banks, customers, suppliers, regulators, etc. Current accounting systems can supply internal users with detailed and near real-time information, but companies are only required to report quarterly balances to external users. No obligation to disclose information about intermediate transactions is advantageous for companies, especially for those that to a great extent use other party's resources, mainly money (customers' and suppliers funds, investors', and lenders' capital, etc.). Under the current system, they can use those resources as per their individual convenience and benefit; without anybody's knowledge, verification, or approval. If the accounting ledger of all transactions was public, visible to anyone, like in the Bitcoin's blockchain, it could deprive companies form the flexibility of using these resources but also it could harm company's competitive advantage and cause other short-term disruptions like stock price volatility. Conversely, it would work to the advantage of multiple stakeholders. As previously argued, investor's access to real-time, detailed financial data about company's performance could help safeguard their equity investments because they could learn more about its performance on a more granular level and they might react sooner to potential problems. Hence the scepticism, whether privacy and transparency can indeed co-exist.

In the contemporary world, where because of technology a lot of data is being created, shared with, and exchanged by multiple parties, creates points of vulnerability. Importantly, often individuals and companies repeatedly share unnecessary information, beyond what is actually needed. Minimal disclosure models can be a solution here as they enable creating "systems in which relevant data is disclosed to querying parties, while non-relevant data is kept private, greatly reducing the transmission of and number of parties storing sensitive identifying information" (Humenansky, 2019). Such systems already exist, for instance, for individuals who verify their identity only once with a certain entity, which later shares with various financial providers only the personally identifiable information that is absolutely needed by the provider to make a funding decision. When it comes to sharing the company's financial results, not every user needs access to the same type and profundity of company data. Through a

minimal disclosure model, depending on their relationship to the company, financial statement users may be granted a different level of access to the accounting ledgers. In capital markets, by law all investors must have the same access to company's information; otherwise, it is categorized as insider information. Hereto, all users categorized as an investor must be given equal permissions to data. However, access can be differentiated for the company's auditor, regulator, bank, or investors in the public market. In an example of a loan application and approval process, which typically requires verifying income, performance, borrower's outstanding debt or credit rating, proof of collateral ownership and other financial and legal records, a bank should be given access to all these. If, however, it was public debt instrument in question, bond investors would only see part of this data.

Blockchain technology enables facilitating minimal disclosure models (Humenansky, 2019). A minimal disclosure model built on blockchain enables unique access privileges for different members. Following the principle of data minimization—using the least amount of data to accomplish a transaction—this system discloses the relevant data to the querying party, while keeping private the non-relevant data, thereby reducing unnecessary data transmission and the number of parties that store sensitive information. Importantly, unlike financial statements, blockchain allows so-called 'transactional reporting' where aggregation and presentation choices are left to the users of financial information (Vasarhelyi, 2012). In consequence, those who can access the blockchain, can retrieve disaggregated and very detailed information about the company's operations, and use it according to their idiosyncratic needs. But if a minimal disclosure model were built onto the blockchain, access to blocks containing different accounting information could be granted at different levels, i.e., full access to regulatory bodies or partial access to investors. This could not only provide a compromise between privacy and transparency but also address the inadequacy of accounting standards that force one model of information format which fails to meet information needs of various stakeholders (Vasarhelyi, 2012).

As suggested in the previous section, had Enron's investors had access to transactional, real-time data about its operations, they could have avoided tremendous losses. However, no company would agree to publish all the information to a broader public. Therefore, a minimal disclosure model could be of help here. Implementing a minimal disclosure model to Enron's accounting ledgers would have made it possible for AA to gained more intertemporal data to examine more thoroughly the identified red flags and to react sooner to client's fraudulent activity. Full disclosure could have been granted to regulatory bodies (capital market

surveillance: the SEC) to learn the details about Enron's accounting gimmicks (hiding bad debts off-balance-sheet, using mark-to-market accounting against its purpose for long-term contracts) and react before it was too late. At the same time, this data could have been secured and only accessible to authorized members, unlike competition or the broader public. Also, by granting the audit oversight bodies access to all detailed documents of AA could expose its cooperation in the client's wrongdoing, while not revealing sensitive information to other parties.

Finding a solution is more complicated when it comes to sharing information with investors. More real-time information would have benefited Enron shareholders who, instead of having lost billions of dollars, could have taken measures to prevent it. Noteworthy, institutional investors use valuation models they base their trading/investment decisions upon. As noted by Wahlen et al., market practitioners "often spend enormous amounts of time and effort building forecasts of firms' upcoming quarterly and annual earnings" as "accounting earnings provide a basis for valuation" (2010, p. 1006). Indeed, earnings constitute the core of investment (security) analysis and are the key variable when evaluating a company's growth potential (Gu and Lev, 2017). In order to get a perfect earnings prediction model, investors (or their analysts) not only use the information published in financial statements but actively seek more current and detailed guidance from company executives participating in earnings calls, attending industry conferences, investor days and approaching company representatives directly to obtain background information. In companies that already grow rapidly, like Enron back in the days, earnings estimation becomes a baseline for investment. A minimal disclosure model could provide them with all necessary information, without it being too excessive, and could contribute to less information advantage of the company's insiders. To this point, when Enron's problems started becoming evident, Kenneth Lay still remained positive in public announcements: "there are no accounting issues, no trading issues, no reserve issues [..] I can honestly say that the company is probably in the strongest and best shape [..] that it's probably ever been in" (Salter, 2008, p. 92). At the same time, he was cashing in his $100 million share options. Afterwards, he claimed not knowing about fraudulent activities and untruthful financial statements, but his trading activities prove the opposite. Naturally, insiders always know more than external investors. Providing all investors with the same information is currently impossible; the law would probably need to change first. However, future developments regarding minimal disclosure models on the blockchain could facilitate equality in capital markets.

### *3.6 Machine Learning for Fraud Detection*

Artificial intelligence (hereafter, 'AI') is a broad space that is best described as "that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment" (Nilsson, 2010, p. 13). AI software helps business take decisions. In accounting and auditing, AI can facilitate decisions that are related to financial data.

AI ranges from very simple methods and applications to quite significant systems. Actually, AI techniques have been in use since the 1950s. In auditing, one of the first applications that noticeably improved the audit process were expert systems that were problem-solving tools "in a specific decision area in order to provide a specific recommendation to a set of problems" (Arnold et al., 2004). They were able to achieve good performance in a specialized problem they processed the knowledge of experts in that specific field and were designed to "mimic their thinking, skill, and intuition" (Ford, 1985). Omoteso (2012) summarizes various processes in auditing that expert systems support: audit planning, compliance testing, substantive testing, opinion formulation, reporting and audit client engagement decisions, and He specifically analyses how they help classify collectable debts vs. bad debts or evaluate internal control risks. Despite numerous benefits of expert systems, their usefulness is limited because they are based on a simple rule-based logic and are performing well only where data is structured, and the level of unknown and/or variance is low. With the rapid increase of data being generated, in general, and in accounting, and with ever newer methods of management committing a fraud, expert systems become insufficient. Big data and open-ended problems motivated creating more sophisticated decision support systems for auditors. Thus, in the 1990s, in finance, practitioners started replacing expert systems with machine learning-based solutions (Buchanan, 2019).

Machine learning (hereafter, 'ML')—a more advanced form of AI—automates analytical model building by learning from data that was fed into the system, identifying patterns, and making decisions with minimal human intervention. Even further, neural networks (where algorithms process signals via interconnected nodes) and deep learning (systems with a multi-stage learning process) solve problems without being explicitly programmed (Samuel, 1959). Such solutions utilize data and models to solve unstructured or semi-structured problems and make predictions based on large databases of past events and trends, hence they are recently viewed as truly disruptive and helpful in auditing. ML uses a probabilistic framework to come up with a model that best explains (fits) observed data (Ghahramani, 2015). First, a model

needs to be developed and trained on human auditor experience (historical audit data). Then, the model automatically detects red flags in the new data inputs. This means less human labour, less cost, and more accuracy, while their users (auditors) can focus on supervising models outcomes, that is they investigate further the meaning of identified irregularities (fraud). Blockchain brings on efficiency related to storing transactional data that is verified upon entry and limits the possibility of its manipulation. ML complements blockchain in improving data analysis and decision making. Specifically, decisions are based on bigger datasets, are faster, more accurate and engage fewer resources. ML can also reduce the lag time between the information request and its delivery, mainly because it is capable of extracting specified information from big datasets almost in real-time, what takes days if a human was employed instead (Smith, 2017).

Machine learning, neural networks already detect various human diseases better than doctors (Grady, 2019; Knight, 2019), so naturally, they have the potential to outperform some decisions of accountants, finance managers and auditors. In accounting, ML has already proved itself in the inhouse revision making process. Once trained on big data, neural network models reach high success rates in identifying patterns, discrepancies, and irregularities in financial records. At Enron, this could have helped the internal audit, other executives and the Board sooner uncover that not all numbers related to the company's results produced by the finance team have been describing the true performance. From the equity investors' perspective, applying new technologies in the auditing process to help detect errors, irregularities, and management fraud in financial statements is even more important. Several academic studies investigated the primacy of neural networks in verifying financial information that is key for investment decisions. For instance, neural network-based models are more efficient in predicting the going concern status of the audited company (Koh and Tan, 1999), the accuracy of inventory valuations (Liang et al., 1992), future earnings from the tone of forward-looking-statements in the Management Discussion and Analysis section of 10-K and 10-Q filings (Li, 2010), and directly in detecting management fraud (see e.g., Cerullo and Cerullo, 1999; Fanning et al., 1995). When auditing Enron, such solutions could be used for instance to estimate the real magnitude of the company's debt (as most of it was kept off-balance-sheet). Another application would be to use ML tools to conduct a deep search of the market (the Internet) with the purpose of improving valuations of hard-to-value assets (Warren et al., 2015). There are several accounting regulations that require managers to make substantial estimates, for instance: accounting rules that mandate marking to market of both assets and liabilities, even

those without market values or rules that govern the writing off of impaired assets and goodwill (Gu and Lev, 2017). Such estimates are often unreliable and sometimes—as in the Enron's case—manipulated, and significantly affect equity investors capability to forecast short- and long-term earnings.

What is paramount in the above-described solutions is that using ML to conduct an audit of financial statements instead of entrusting only one or a group of auditors, we rely on the technical expertise that have been trained on the aggregated experience of thousands of historical audits. The audit process involves extensive use of subjective judgement. If performed by people not trained or experienced enough to know various possibilities of errors and purposeful misstatements, an audit may result in a report full of accounts that are not necessarily accurate. Another issue is what Giddens calls reflexivity: a tendency for knowledge and understanding of various aspects of life to be strongly influenced by prior experiences (Giddens, 1990). An auditor who came across specific errors and misstatements is naturally inclined to look for those in subsequent audits, while might omit other irregularities. ML better approximates human intelligence because it evolves with more 'experiences' being added to the model (neural networks learn with the new data being provided) and captures tacit knowledge that is inherently difficult to program (Brynjolfsson and Mcafee, 2017). 'Judgement' and 'opinion' produced by a neural network can be more relevant and comprehensive, the improvement stemming from eliminating human erroneous and less experienced element. This, in turn, helps investors make more accurate decisions and increase shareholders value. Enron investors could have avoided losses related to the company bankruptcy had a neural network-based model been used to estimate Enron's going concern status, its future earnings and bad debt. If additionally, all audit outcomes information had been recorded in the blockchain immutable ledger, there would have been no chance to destroy the evidence of the ML-detected red flags and of all accounting gimmicks and frauds committed or even attempted by Enron's management. This joint implementation of ML and blockchain would be particularly useful in the analysed cases, as the two companies cooperated in wrongdoing.

Furthermore, ML tools give a possibility of deploying automatic, near real-time alerts for relevant interested parties about unusual company's activities. Tax authorities can be immediately notified if there is an event of tax evasion, investors—if the company is misusing its resources, banks—if the company is using borrowed funds not in accordance with the loan agreement. This could be possible through joint implementation of machine learning and

blockchain technology in the company's accounting system (CPA Canada et al., 2017). At Enron, this could have helped monitor company's contemporaneous use of debt that has not been properly consolidated in its financial statements. Even if using SPEs was legal, tax authorities and investors could have been real-time informed about debt in Enron-related SPEs reaching higher and higher levels. If ML tools can be implemented to continuously monitor and audit certain positions in company's accounting systems and predict whether they are endangering company's solvency and going concern, the problem of bad debt (so important from the equity investment perspective) could be completely eliminated in the future.

Notably, because machine learning, neural networks use big, often non-financial data, this poses an additional challenge on auditors, their judgements, and decisions. Auditors are familiar with computer-based tools to analyse structured data. To estimate the probability of misstatement, traditional audit process uses mostly text-mining methods that help analyse company disclosures (Humpherys et al., 2011), and sometimes conference call transcripts (Larcker and Zakolyukina, 2012). With ever more data being created and available, also from non-typical sources, auditor's investigation could expand accordingly, increasing the chances to discover potential errors and fraud in financial reports. For instance, data derived from the IoT sensors, and chips can be used to verify inventory, while data from news, forums, social networks and other internet sources may be helpful to verify the sales data (Vasarhelyi et al., 2015). At the same time, auditors' skills are often inadequate for more advanced techniques, especially to analyse non-financial data. Hereto, using an expert system would not be enough. Conversely, a neural network can self-learn to detect ever newer forms of management fraud analysing data of multiple types and sources. Nascent information overload could be overpassed by designing decision support systems (Brown-Liburd et al., 2015) that, learning from new data inputs through the application of neural networks, help auditors make a sound judgement about the reliability of company's financial reporting. Enron case was not really one of those cases where an auditor was incapable of detecting management fraud; quite the contrary—AA consultants were actively devising how to exploit loopholes in accounting standards to boost growth and hid bad debts in the client's books. But in many other cases, management resorts to ever newer methods of fraud that are initially not known to auditors. In such cases, deep learning models could learn to detect novel types of misstatements using both financial disclosures and no-financial data. And further, given that advanced ML algorithms already can predict construction accidents before they happen (Knight, 2019), their application in auditing could potentially predict fraud before it is committed.

In practice, ML-based tools are already in use ranging from specific tools (e.g., to detect fraudulent invoices, to assist with tax returns), up to complex audit solutions. Several software providers offer a broad spectrum of ever more diligent and accurate solutions that are enhancing the quality of audit outcomes. All Big Four auditing companies currently have ML tools to increase the efficiency of their auditing services. Some of these ML-based fraud detection systems reach 97% accuracy (Zhou, 2017), which makes the audit process more efficient while using less time and other resources.

### *3.7 Emerging Technologies for Auditor Independence*

An audit function is an extremely sensitive one because auditors have a certain conflict of interests. They are being paid by the company (the client), but they primarily serve the needs of and have the responsibility towards the company's investors, tax authorities, other stakeholders, and the general public. They are obliged to report on any illegal or non-accepted practice that the company is engaged in and on the potential risk of its bankruptcy. Since their salaries come from the audited company, there is a natural tendency to work toward its advantage in order to maintain a source of income. Therefore, recent regulatory changes encompassed initiatives making auditors less dependent on the client, e.g., prohibiting auditors from providing certain non-audit services, rotating not only audit partners but also audit firms (in force in the E.U. but not in the U.S.). Other regulations, like the Sarbanes-Oxley Act, additionally increased auditor's liability. These reforms have somewhat decreased audit failures (Deng et al., 2012), but it did not ultimately prevent companies' from committing financial statement fraud. In general, Quick and Schmidt (2018) fail to identify a positive impact of the regulatory measures on investors' perceptions of auditor independence and audit quality.

As auditor independence is critical for audit quality, regulators point to the main threats thereto. According to ICAEW, independence can be compromised by "self-interest, self-review, being in an advocacy position, over-familiarity, or intimidation" (ICAEW, 2020). We argue that Arthur Andersen's independence was subject to at least (i) the self-interest threat, (ii) the familiarity threat, and (iii) the intimidation threat.

The self-interest threat arises either when an auditor has a financial interest in the client company or when it depends on the client for a major fee. In the analysed case, it was the latter situation. Taking an example of the year before Enron's bankruptcy, AA fees from auditing this client's accounts amounted to $25 million, which made Enron one of the most important clients. On top of this, AA generated even more fees from selling consulting services to Enron

($27 million), thereby exposing it to accusations of conflicts of interest. Indeed, later investigations revealed that AA not only had not conducted auditing services properly but also had played an active and central role in consulting the aggressive earnings management techniques employed by Enron. Long before these scandals, scholars and practitioners were arguing that fees for consulting services provided by the same entity that conducts an audit of client's financial statements threatened the independence of auditor's opinion (see e.g., Simunic, 1984). We argue that employing fintech solutions can considerably automate the auditing process, which decreases audit fees, thereby contributing to auditor's independence. Current accounting systems are often based on manual entries and allow for data modification, hence the need for auditors and other gatekeepers to ensure the reliability of financial statements. Blockchain and IoT automate entries that become transparent, immutable and contain fewer errors, and there is no longer a need for a third-party to verify the credibility of most accounting data. The innate traceability incorporated into blockchain ledgers makes auditing process faster and easier. Self-execution enabled by smart contracts additionally eliminates the need for many tasks currently conducted within an audit process, leading to further reduction of audit time. In result, audit service includes fewer components and is more focused on the big picture of the company's activities and financial results. This reduces the amount of various resources needed for conducting an audit (Ray, 2018) as there are fewer activities to be billed for on the auditor's timesheet, and, in consequence, can also decrease the cost of the audit to the client company (Welker, 2018). Further, it is possible that smaller fees make the competition in the audit sector even more cut-throat as more contracts will be needed to maintain the current level of business. Several auditor firms may even go out of business, but those that remain will be less dependent on a few big clients, thus the inclination to provide a client-friendly rather than an objective report will be lower.

Reduced auditor fees due to automation of the auditing process can have a broader effect on the audit industry. First, the described technologies yield the possibility of a near real-time audit. If so, an audit would no longer be a one-time event but could become a continuous process. Audit fees could then become subscription-based, just like the current offerings of blockchain services ('Blockchain-as-a-service'). This could imply that companies will be in long relationships with one auditor as the service is ongoing, but subscription systems are also known for relatively low switching costs. Therefore, the outcome thereof is *ex-ante* unclear. Importantly, due to the increased automation and standardization of the audit process imposed by blockchain and other technologies, services offered by different auditors might become

more homogenous—the use of ML-based systems for conducting an audit not only has a benefit of increasing its efficiency but also consistency (Murphy and Brown, 1990). Therefore, client companies may switch easier and more often between auditing firms.

The familiarity threat exists when an auditor is too personally close to or familiar with employees, officers, or directors of the client company. In the analysed cases, there were close personal relationships between the Enron and AA leaders, which intensified the auditor's willingness to ratify the client's wrongdoing. These relationships were built over time (long-term contractual bonds), and the closer they were becoming, the less inclination to break up the successful cooperation between Enron and AA there was. Hereto, Ball et al. (2015) find evidence of a negative association between audit quality and the length of tenure between the lead audit partner and client firm management. This means that close person-to-person relationships between the auditor and client undermine auditor independence and resultant financial information reliability (Krishnan and Zhang, 2019). Conversely, Ball et al. (2015) find that conditional on audit partner rotation, audit quality increases the longer the auditor's tenure because auditor develops expertise. That was also one of the official claims, why Enron kept AA as its auditor throughout all the years. Machine learning, blockchain technology and smart contracts can replace this expertise, making the audit process more objective, thus encouraging companies to change auditors more frequently and contributing to the greater independence of their opinions. Another potential benefit that stems from applying the described technologies, particularly storing all data on the blockchain, and having physical assets reported to the system automatically by IoT sensors and chips, is that it enables real-time access to accounting records from any device. Such data-sharing abilities and mobility enable auditors to analyse and verify the client's records and performance without the need to be physically present at the client's or even contacting the client during the audit process. On one end, this would yield fewer possibilities for personal contact and establishing personal relationships between auditors and company's managers, just as it happened in AA and Enron, thus contributing to auditor's independence. On the other end, no need for spending hours at the clients could save a lot of time and money for both the auditor and the audited company. With all these technologies in use, long-term, personal relationship with an auditor will not have as much value as it has today.

Finally, the intimidation threat arises when an auditor is intimidated by management or its directors to the point that they are deterred from producing an objective opinion. Investigation of the two companies conducted in the scandal aftermath revealed multiple proofs of Enron

managers making AA auditors produce documents, opinions and reports that would sanction and ratify Enron's accounting gimmicks and fraud, even if it meant physically locking them in the room and making them do it against their will. Whenever AA auditors "objected to anything, Enron managers would push them on trying to find ways to do it." (McRoberts, 2002) If the client accounting system were based on the blockchain, IoT and smart contracts, there would be less temptation (or even possibility) for auditors to engage and approve fraudulent results. In blockchain, any change in the financial statements in favour of the client would be recorded and kept with public access thereto, which, in turn, can cause serious damage to auditor's reputation. AA entanglement in Enron scandal—its quiet consent to Enron's fraudulent financial reporting—made it lose all its clients the minute the scandal was revealed (Nelson et al., 2008). With emerging technologies, financial reporting and audit can become more transparent at its origination, thus the auditor report can be more objective and independent.

### *3.8 Discussion: Functionalities and Limitations of the State-of-the-art Technology Solutions*

The analysis of Enron and Arthur Anderson cases enabled us to distinguish four major financial reporting and audit-related issues that lead to both companies' collapses. In the following paragraphs, we provide a succinct comparison of the functionalities of each technology and its contribution to solving the identified problem areas.

*1. Falsification of Records and Information Mutability.* The paramount improvement in this space comes from blockchain technology that makes all the information in the reporting system already pre-verified and impossible to be changed or deleted. IoT and smart contracts automate various types of entries (e.g., inventories, revenue recognition) recording them in the accounting system without the need for human (often biased or erroneous) intervention. Together, they deliver correct, real-time data, available for continuous auditing.

*2. Diffusion of Responsibility.* Emerging technologies have the potential to prevent further abuses in the corporate world by ascribing all actions to their 'owners'. Hereto, blockchain enables tracking back each transaction up to its origination. Smart contracts can be used to programme entries or transactions but also to encode who is responsible for each process. On the audit side, solutions based on ML, neural nets, have the potential to help an auditor connect the reporting outcome with its originator to either eliminate an error or uncover and report a fraudulent behaviour.

*3. Auditor's Revenue Priority over Intrinsic Audit Objectives.* Entry automation (IoT, smart contracts) and information pre-verification and immutability (blockchain) lead to less time dedicated to a high-quality audit process. ML-based solutions further enhance the audit process by efficient identification of red flags in reported numbers that are not in line with the accounting standards and practice. This way the service becomes cheaper and more objective, which eliminates many incentives to adjust audit outcomes to the client's expectations for the sake of maintaining revenue. Blockchain and smart contracts applied in the auditing and forensic accounting processes, further objectives the auditor report.

*4. Auditor's Dependence.* Blockchain, IoT, and smart contracts make most of the accounting data impossible to manipulate by the company and difficult to 'cover' with a favourable auditor's report. ML-based audit tools can be programmed to objectively spot and report red flags. Minimal disclosure models implemented on top of the blockchain give specific permissions to look into the company's data: auditors (not only the contracted one!) and forensic accountants can have full access, while the broader financial community can have limited access to company's records to protect its competitive advantage.

Arguing for the advantages of emerging technologies, one needs to mention limitations thereof. First, there are quite a few 'technical' issues with the described technologies. To start with, blockchain is currently a concept, a framework, an architecture, a solution, but not a ready-to-use product. It requires continuous improvements driven by changing organizational goals and process, industry demands. It is also an emerging solution so should be handled with great care when applied in accounting and auditing. Moreover, blockchain technology, just like all other software systems, can be maliciously hacked. Then, it is not clear if permissionless or permissioned, centralized, or decentralized blockchain would be more suitable for applications in accounting and auditing. This, however, remains out of the scope of the current paper.

Second, there are quite serious 'barriers of entry' that encompass the cost of developing and implementing technology solutions (an accounting system in blockchain, smart contracts, IoT, machine learning models) and costs related to the daily functioning of these solutions. For instance, blockchain and ML algorithms are known for high energy consumption and blockchain has a serious scalability problem (the number of transactions processed per second by a blockchain system). As stated in the introduction, in this paper we adopt the shareholders perspective, which enables us to look at the implementation of new technologies from the cost-benefit perspective. Some business reports suggest that currently, implementation costs exceed the benefits (revenues) of emerging technologies form the immediate financial value

perspective (Ransbotham et al., 2019). However, the perspective we propose should look at the long-term benefits of safeguarding equity investments because the risk related to equity investments is known to have fat tails. Not mentioning that the befits might be even higher for other company's stakeholders, and the society.

Third, blockchain, IoT, smart contract and machine learning's benefits may be overstated if technologies are implemented only in a single entity and are not integrated into the whole value chain or across business-lined entities. The emerging technology solutions could definitely assist with mitigating risks of fraud but, as of today, their implementation depends solely on the willingness of the entity to do so. When only a single company employs these technologies, then many of the solutions lose their sheen in terms of functionality, transparency, trackability and fraud prevention. The benefits of mass-implementation could either be achieved through appropriate regulations requiring firms to adopt certain solutions or through the industry self-regulation (i.e. the industry voluntarily moves into that direction). But then we are back again to the point where we actually need some new regulatory initiatives to embrace the full potential of the new technology solutions.

Fourth, there are new problems arising from more information being available to the financial community. Emerging technologies can materially decrease some of the proprietary costs, such as preparation of the information to be disclosed to the financial market, while increasing other proprietary costs, such as competitive costs. Hereto, a solution could be found in even more technology implementation, forest ML, neural nets. Moreover, very detailed and timely disclosure might put retail investors at a disadvantage due to higher information processing costs. Finally, real-time financial data might also force the manager to even more short-termism. Notwithstanding, the change is coming and both businesses and auditing professionals need to be ready for it.

## 4. Conclusion

Companies commit frauds, but that does not happen in a vacuum. Roszkowska and Mele (2020) observe that in each financial scandal, a fraudulent company remained in a network of interrelations with several external entities (e.g., Enron with Arthur Andersen). They suggest that company's actions can be strongly affected by what they call *external influences*: institutions or individuals that jointly constitute firm's immediate environment, who have their own intentions and goals, and because companies constantly interact with them, they affect firm managers' behaviour. Hereto, Boatright (2004) emphasizes the importance of gatekeeper

institutions, as they play a pivotal role in preventing corporate fraud, safeguarding equity investments and interests of the society. Indeed, in addition to accounting irregularities, a failure of the auditor appears to be among the main causes of corporate frauds studied by Soltani (2014). Against this backdrop, to fight financial fraud, improvements should be implemented both at the company and at the auditor side.

Steps towards entry validation, enhanced efficiency of processes and resultant decrease of data corruption possibilities have been so far taken mainly *via* increased regulation. Given Enron, Arthur Andersen, and many other financial scandals, one realizes that the subsequent law amendments did not solve the problem. There is even some evidence that excess governance reforms may negatively affect the organization's accountability and disclosure transparency (Haraldsson, 2016). Hence the need for a different, more effective solution. In this paper, we argue that fintech offers solutions to many of the identified issues.

We find that blockchain, smart contracts and IoT can improve the reliability and integrity of financial information already at the entry-level. Blockchain-based accounting system makes all entries "electronically distributed and cryptographically sealed, similar to transactions verified by a notary," therefore "falsifying or destroying them to conceal activity is practically impossible" (Deloitte, 2016). Hereto accountants, as they are specialists in applying accounting standards, business logic and complex rules to the record-keeping, will be key in consulting for blockchain solutions design (ICAEW IT Faculty, 2018), especially since each company setup is idiosyncratic. A one-size-fits-all approach and resultant expertise will not be enough here. It is highly likely that many accounting activities (bookkeeping, budgeting, reconciliation, etc.) will be reduced or eliminated due to automation. There will still be a need for more value-adding activities like verifying the accuracy of blockchain transactions with the external sources. Companies are already spending big money on technology to improve the quality of the information in their financial statements, and to demonstrate it has not been manipulated or otherwise corrupted. Auditing is the last instance of information validation, and it also needs a revision once companies adopt blockchain, smart contracts and advanced AI solutions. Importantly, it is a combination of technology implementation on the company and auditor's side, regulation and market watch that more comprehensively assures data reliability. Nonetheless, the practical aim of this paper is to make equity investors aware of the technology solutions that can help safeguard their investments.

Fintech has the potential to revolutionize the way, how companies function, how investors make decisions in capital markets, but also how auditors perform their responsibilities. With

blockchain and other solutions, bookkeeping and reconciliation, but also some auditing functions become redundant. The external financial audit will not be eliminated, but technological evolution will transform the purpose and role of an auditor. The regulation would never be capable of driving such transformation, but, importantly, accounting and auditing standards will need to be revised and updated to regulate new ways of information handling and transfer and various privacy issues related to fintech solutions in place (Yoon et al., 2015).

Brown-Liburd et al. (2015) point to technology choice and auditor skill development as primary considerations regarding how auditor judgement and decision making will be done going forward. The audit process needs to be adjusted to the new technologies offered in auditing but also to new fintech solutions used by audited companies. While client's accounting entries will be for the most part automated and their correctness verified, auditors will still have to apply professional judgment to analyse financial outcomes and statements made by management in the descriptive part of financial statements. There will still be the need to test the client's internal controls over the data integrity with all sources of incoming information (CPA Canada et al., 2017). When a combination of blockchain and other solutions are in place, auditor's expertise and skills can be better used for addressing 'higher-level' problems. For instance, reviewing the underlying of transactions that led to final outcomes or investigating their impact on financial positions require deeper insights into the business. Such analyses are rarely done and even if so, more than often they remain unavailable to the external users of financial statements. With blockchain technology, an auditor could dedicate much time to these activities (ICAEW IT Faculty, 2018). Eventually, new technologies and accordingly adjusted audit process have the potential of providing better quality and more timely information for equity investors, allowing them to make more informed analysis, and take timely trading decisions. Notably, in pursuit of accommodating to the new industry needs, some audit companies (e.g., the Big Four auditing firms) are already trying to identify new applications of emerging technologies and are already offering new auditing services for blockchain projects and start-ups (Vetter, 2018).

Given the uncertainty about the ultimate technology advancements and applications, it is difficult to precisely advise on the desired skills and competencies of future auditors. What seems certain though is that there will be ever more use of technology in auditing, so auditors need to get used to working closely with engineers. They themselves do not need to develop audit software solutions, but they need at least a basic understanding of how technologies work (Paine, 2018) to help design software functionality, ongoingly provide inputs to software

solutions like entering contracts into the blocks (Arnold, 2018), and ultimately derive benefits thereof. They also need to understand which companies are likely to implement which solutions and for what purpose (Patil, 2018) to adjust the audit process to the client's resources. Eventually, it is always those who understand the nature of change and evolution of technology that best adapts to new situation and succeeds.

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## Notes

[1] The described technologies help safeguard debt investments too, however, we see this as less risky given debt seniority over equity in investors' claims against the company's cash flows and assets.

[2] There are other technologies that are used in the contemporary financial reporting and auditing that we do not discuss in this paper (e.g. cloud). They contribute to the accounting and auditing process, but they do not directly affect the information reliability. For instance, the only innovation of cloud data storage is that the data (bigger datasets) is stored on the external servers rather than internally in the company, which can lower the cost of hardware and potential loss of accounting information.

[3] Nowadays, many big companies already make journal entries into company ledgers digitally, using software that automates the process, thereby minimising errors. Existing software for business record keeping encompasses e.g., ERP (Enterprise Resource Planning), SCM (Supply Chain Management), HFM (Hyperion Financial Management), HRM (Human Resource Management), and CRM (Customer Relationship Management). Other accounting functions are mostly manual.

[4] In this paper, it is a conscious choice not to distinguish between permissionless and permissioned blockchain, and we discuss blockchain characteristic in more generic terms. We are, however, aware that Bitcoin's blockchain and permissioned blockchain provide different advantages and disadvantaged for accounting and auditing. For instance, system security can be strengthened when a permissioned blockchain is in place, rather than the original permissionless one, but then one still relies on the middleman.

[5] In accounting systems, two solutions have been used so far for data storage: Cloud or local (Edge). The company that stores data locally takes responsibility for its protection against cyber threats, data recovery in case of storage loss and data server availability. Conversely, cloud technology moves liabilities such as storage safety, uptime, cybersecurity to a third party (cloud provider). Aside of monetary benefits to the client (pay-as-you-go subscription system), the existing cloud environments (e.g., AWS, Google, IBM, Microsoft, Oracle) deploy substantial resources to protect the system from cyber-attacks and data losses. Noteworthy, it is still only one provider that a client company entrusts its account data to unless the client decides for a multi-cloud deployment strategy, which optimizes on performance, costs, and security. A blockchain distributed ledger mitigates the risk of data loss or corruption as information is stored on all the nodes (computers) in the network.

# Appendix

*A brief introduction to the Enron Corporation case*

Enron Corporation was created in 1985 as a traditional pipeline company distributing natural gas. During the next fifteen years, it became an unquestionable leader within the energy sector, and the seventh-largest company in the U.S. It was founded and for many years led by Kenneth Lay—a PhD in economics who had formerly held notable positions in governmental agencies and in the private sector. The man behind Enron's spectacular financial success was, however, its CFO: Jeffrey Skilling. He advised on how to benefit from gas deregulation and was the key propagator of growing the company through expanding trading activities as opposed to investing in traditional power generation. When Skilling was further promoted for the President and the COO, together with Andrew Fastow—the new brainy CFO who was named "the most creative financial officer of the year" in the U.S. ("The Finest in Finance", 1999)—he pursued an *asset-light* strategy. In the beginning, the portfolio of Enron's financial instruments consisted of rather simple oil and gas futures or long-term supply and hedge contracts, but it soon extended to more exotic and complex financial products. In 1999, the company introduced EnronOnline—the first electronic trading platform for oil, gas, and other products. In doing so, Enron was not only a typical company, but also served as a marketplace.

In time shareholder pressure on Enron to maintain earnings growth intensified, so top executives needed to look for ever-new ways of increasing profits. Between 1996 and 2000, the company's consolidated net income grew from $580 to $970 million, mostly due to the expansion of trading activities. However, part of the profits was only on paper, as the management was fabricating results by ever more exploiting loopholes in the financial reporting regulation. In 2000, investors community started raising concerns regarding Enron's earnings quality and the increasing share sales being done by the company's senior executives. In 2001, Enron announced accounting 'adjustments' leading to a substantial loss for its third quarter that amounted to $618 million, followed by shareholder equity reduction from its peak of $60 to $1.2 billion. When the true situation of the company's activities and financial standing came to light, it immediately lost its customers, its share price plummeted, banks stopped providing loans. Finally, unable to meet the debt obligations, on December 2, 2001, it filed for the largest Chapter 11 bankruptcy in history. As revealed later, Enron's reported financial condition was sustained substantially by an institutionalized, systematic, and creatively planned accounting fraud carried out with the quiet acquiescence of the auditor, Arthur Andersen.

*A brief introduction to the Arthur Andersen case*

Arthur Andersen was founded by Arthur E. Andersen, who displayed a propensity for mathematics, and who at the age of 23 became the youngest certified public accountant in Illinois. Equipped with solid experience from other accounting services firms, in 1913, he established his own company, attracting serious clients like International Telephone & Telegraph, Colgate-Palmolive, Parker Pen, etc. Andersen was a true leader. He drove strategic development but was also personally involved in nearly every detail of the enterprise and was gifted in hiring truly talented accountants. He built an empire with a certain corporate culture and core values: integrity, stewardship, public responsibility. The company has been ruled based on Andersen's original vision illustrated in the following quote "There is not enough money in the city of Chicago to induce me to change the report" (Squires et al., 2003, p. 32). Leonard Spacek, who took over the company after Andersen's death in 1947, followed founder's management but also grew the company internationally, increasing revenues from $6.5 million to $51 million.

Until the 1950s, there were no formal procedures or generally applicable principles for the auditor's profession. Spacek initiated the standardization movement of the whole sector. Believing in Andersen's idea that the company should serve the public role of an industry policeman, he launched a campaign aiming at improving accounting methods and practice by implementing uniform principles that ensured 'fairness' not only with respect to the customer but also to the employees, investors, management and broad society.

In the 1970s and 1980s, following the trend among other auditing companies, AA became involved in large-scale consulting services. For many years consulting activities were controlled by the auditors, and in 1988 they amounted to 40% of AA's revenues. It was then that the company faced its first massive lawsuits, being accused of failing to realize and inform the public of its clients' financial struggles. In time, an open conflict between consultants and auditors was mounting up due to the disparity in the growth rates, revenue inputs, salaries and the desire of independence on the consulting side. In 1989, the company was split into two financially separate entities: Arthur Andersen & Company, an auditing and tax firm, and a consulting firm Andersen Consulting. Finally, the consultants could report to their managers, and not to auditors. After the restructuring, AA's revenues skyrocketed reaching almost $5.6 billion in 1992. At the same time, the increasing rancour between the consultants and accountants was approaching a dramatic culmination, foremost because of the disparity in revenue growth: 90% year on year in consulting, while only 38% in auditing and tax services.

Eventually, in 2000 Andersen Consulting was granted complete independence, was re-named Accenture and began to build its brand-name recognition from scratch. The auditing firm, which in time became one of the world's Big Five accounting companies, was highly appreciated for its high professional standards until it was accused of obstructing justice in relation to the Securities and Exchange Commission (hereafter, 'SEC') investigation of Enron. In June 2002, the jury announced a guilty verdict, forbidding AA from operating as an accountant and an auditor. The company almost immediately lost all its clients, shrank from 85,000 employees worldwide to 200, and faced massive civil lawsuits in relation to the Enron scandal.

A broad literature available on the Enron scandal (Ackman, 2002; Coffee Jr., 2002; *Enron Special Committee Report*, 2002; Ferrell and Ferrell, 2010; Fox, 2003; Hamilton and Micklethwait, 2006; Healy and Palepu, 2003; Labaton, 2002; McLean, 2001; Schwartz and Oppel Jr, 2001; Sims and Brinkman, 2002; Thomas, 2002; Windsor, 2018) and Arthur Andersen demise (Bahle, 2002; *Bloomberg Businessweek*, 2002; Linthicum et al., 2010; McRoberts, 2002; Melé, 2009; Niiece and Trompeter, 2004; O'Connell, 2004; Randall, 2003; Toffler and Reingold, 2003) enables the reader to easily extend their understanding through other publications if needed.