

CEO overconfidence and financial reporting complexity: evidence from textual analysis

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Abstract

Purpose – This study investigates the relationship between the Chief Executive Officer's (CEO) overconfidence and financial reporting complexity in Iran, a context characterized by weak corporate governance and heightened managerial discretion.

Design/methodology/approach – The sample consists of 1,445 firm-year observations from 2010 to 2021. CEO overconfidence (*CEOOC*) is evaluated using an investment-based index, specifically capital expenditures. Financial reporting complexity (*Complexity*) is measured through textual features, particularly three readability measures (Fog, SMOG and ARI) extracted from annual financial statements. The ordinary least squares (OLS) regression is employed to test the research hypothesis.

Findings – Results suggest that *CEOOC* is positively related to *Complexity*, leading to reduced readability. Additionally, robustness analyses demonstrate that the relationship between *CEOOC* and *Complexity* is more distinct and significant for firms with lower profitability than those with higher profitability. This implies that overconfident CEOs in underperforming firms tend to increase complexity. Also, firms with better financial performance present a more positive tone in their annual financial statements, reflecting their superior performance. The findings remain robust to alternative measures of *CEOOC* and *Complexity* and are consistent after accounting for endogeneity issues using firm fixed-effects, propensity score matching (PSM), entropy balancing approach and instrumental variables method.

Research limitations/implications – This study adds to the literature by delving into the effect of CEOs' overconfidence on financial reporting complexity, a facet not thoroughly investigated in prior studies. The paper pioneers the use of textual analysis techniques on Persian texts, marking a unique approach in financial reporting and a first for the Persian language. However, due to the inherent challenges of text mining and feature extraction, the results should be approached with caution.

Practical implications – The insights from this study can guide investors in understanding the potential repercussions of *CEOOC* on financial reporting complexity. This will assist them in making informed investment decisions and monitoring the financial reporting practices of their invested companies. Policymakers and regulators can also reference this research when formulating policies to enhance financial reporting quality and ensure capital market transparency. The innovative application of textual analysis in this study might spur further research in other languages and contexts.

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Originality/value – This research stands as the inaugural study to explore the relationship between CEOs' overconfidence and financial reporting complexity in both developed and developing capital markets. It thereby broadens the extant literature to include diverse capital market environments.

Keywords CEO overconfidence, Financial reporting complexity, Readability, Firm performance, Textual analysis

Paper type Original article

1. Introduction

The pivotal role of Chief Executive Officers (CEOs) in shaping organizational trajectories has attracted significant research attention over the past decade. CEOs, through their strategic and influential leadership capacities, not only drive the company's direction but also shape its social capital and legitimacy (Bamford *et al.*, 2006). Furthermore, various facets of CEOs' backgrounds and demographics, encompassing their life, firm and functional experiences, furnish stakeholders with insights into the firm's potential value. These facets influence strategic decision-making processes in myriad ways (Hambrick and Mason, 1984; Rajagopalan and Datta, 1996; Zajac and Westphal, 1996; Zimmerman, 2008). Focusing on a specific trait, overconfidence, underscores its significant bearing on corporate strategies. CEOs, as pivotal decision-makers exerting substantial sway over company strategies, occasionally display overconfidence. Such overestimation of their capabilities can make them believe they can control outcomes and lead them to downplay risks (Finkelstein *et al.*, 2009; March and Shapira, 1987; Galariotis *et al.*, 2023). This overinflated self-view might inadvertently guide CEOs toward less than optimal investment choices, potentially resulting in obscuring their investment inefficiencies and mediocre firm performance through complex disclosures (Chen *et al.*, 2015; Malmendier and Tate, 2005, 2008; Li, 2008; Lo *et al.*, 2017).

Tracing the intricate linkage between CEO overconfidence (CEOOC) and financial reporting complexity, this study anchors its foundation in the diverse frameworks of agency and signaling theories, augmented by the obfuscation and incomplete revelation hypotheses. Agency theory highlights potential misalignments between CEOs and shareholders, particularly with overconfident CEOs prone to overinvestment and misallocation of resources (Healy and Palepu, 2001; Ahmed and Duellman, 2013). Such behavior, potentially camouflaged by complex financial reporting – as suggested by the obfuscation hypothesis – obscures information, potentially swaying market reactions (Li, 2008). Conversely, signaling theory posits that firms might employ complex reporting as signaling mechanism to showcase their superior attributes without exposing proprietary information (Leland and Pyle, 1977; Trueman, 1986). This complexity might be perceived differently by overconfident CEOs and stakeholders, introducing a perplexing element of transparency versus perceptual complexity (Bloomfield, 2008). Aligning this with the incomplete revelation hypothesis, overconfident CEOs might unintentionally engender market ambiguity by underestimating stakeholders' cognitive burden in processing complex information, subsequently impacting trading inclinations and price efficiency (Kim and Verrecchia, 1991; Guay *et al.*, 2016). Hence, this study ventures deeper into understanding the mechanisms through which CEOOC could potentially influence financial reporting complexity.

From an empirical standpoint, the relationship between CEOOC and a range of corporate behaviors and decision-making processes has been thoroughly scrutinized in existing literature. Overconfident CEOs, characterized by their inclination for excessive investment and participation in value-diminishing mergers (Malmendier and Tate, 2005, 2008), often view their firms as undervalued and perceive external financing as excessively costly (Malmendier *et al.*, 2010). Their influence extends to realms like corporate innovation (Hirshleifer *et al.*, 2012), dividend policies (Deshmukh *et al.*, 2013), debt maturity structures (Huang *et al.*, 2016) and even the tone of press releases (Gong, 2023). Moreover, such CEOs exhibit propensities to postpone loss recognition and embrace less conservative accounting strategies (Ahmed and Duellman, 2013), collectively pointing to the significant overlap

between overconfidence and financial reporting. However, a gap in existing research persists, one that specifically explores the impact of CEOOC on financial reporting complexity in a context such as Iran, thereby providing a novel trajectory for this study, which seeks to investigate these unexplored dimensions.

Iran, with its unique set of characteristics, offers an ideal backdrop for investigating corporate governance and CEO behavior. In 2004, the Tehran Stock Exchange (TSE) rolled out the inaugural Iranian Code of Corporate Governance, subsequently revised in 2005. This code spans five chapters and 38 clauses, covering pivotal areas like board qualifications and mandatory disclosures. Chapter 2, a vital segment of the code, provides directives on board qualifications. It also outlines the demarcation of duties between directors and administrative managers, emphasizing the majority presence of non-executive directors as a measure to curb excessive CEO influence. Although the adoption of this code is optional, a significant number of firms have embraced its guidelines (Mashayekhi and Bazaz, 2008). This decision becomes especially salient in light of Iran's delicate corporate governance framework and the amplified discretion afforded to managers, a scenario underscored by Oradi and Izadi (2020). The potential consequences of CEOOC in such a context, where CEOs might wield disproportionate authority, warrant careful scrutiny. Given adherence to the stipulations of the Code of Corporate Governance, there exists a possibility that overconfident CEOs might exploit their position, fostering complex financial reporting practices. This could, in turn, compromise the clarity and comprehensibility of financial statements.

Furthermore, the process of selecting top executives and board members in Iranian companies is more influenced by trust and adherence to traditional Islamic customs than by emphasis on specialization or educational qualifications, as commonly observed in many other countries. Iranian civil law, which amalgamates elements from both French and Belgian civil laws, provides only limited legal safeguards for shareholders and creditors. This environment cultivates dispersed ownership, heightened corruption and, subsequently, reduced transparency in financial statements (Porta *et al.*, 1998; Mashayekhi and Bazaz, 2008). The insufficient protection for minority shareholders' interests and the vague delineation of organizational roles often result in individual interests taking precedence over collective corporate ones. Contrary to countries like China (Zhang *et al.*, 2018), Iran's nascent corporate governance structure and fragile internal controls, which significantly influence the execution of these controls (Bagherpour *et al.*, 2014; Oradi and Izadi, 2020), place top managers in a prominent role. These managers, particularly in Iran, have a wider operational scope compared to their counterparts in nations with robust corporate systems and well-developed managerial labor markets. Such leeway empowers them to significantly influence firm performance based on their individual characteristics and inclinations (Mashayekhi and Bazaz, 2008). In essence, given Iran's dominant traditional Islamic customs, its weak civil law and frail corporate governance, as well as the limited protection afforded to shareholders and the extensive freedom provided to top executives, especially CEOs, the country presents a fitting backdrop for examining the relationship between CEOOC and financial reporting complexity, promising significant practical insights.

In this study, 1,445 firm-year observations from 2010 to 2021 are utilized. CEO overconfidence (CEOOC) is determined based on annual capital expenditures, consistent with prior studies (Hasas Yeganeh *et al.*, 2015; Sarlak *et al.*, 2018; Ahmed and Duellman, 2013). To evaluate firm complexity (*Complexity*), three widely accepted readability metrics – the Fog index, Simple Measure of Gobbledygook (SMOG) and automated readability index (ARI) – are employed. These metrics align with prior research in Iran (Hesarzadeh and Rajabalizadeh, 2019, 2020; Hesarzadeh *et al.*, 2020) and on an international scale (Guay *et al.*, 2016; Bozanic *et al.*, 2019; Chychyla *et al.*, 2019). The OLS regression analysis results suggest that overconfident CEOs contribute to an increase in financial reporting complexity, leading to a decrease in readability. These findings resonate with the obfuscation hypothesis (Bloomfield, 2008; Li, 2008; Kothari *et al.*, 2009). Evidently, overconfident CEOs tend to heighten financial reporting complexity, which can potentially

obscure firm performance. Such behavior seems to align with the expectations of agency theory, suggesting that CEOs, especially those who are overconfident, might partake in activities that are not fully aligned with the interests of shareholders. This includes the potential for overinvestment and the misallocation of resources (Healy and Palepu, 2001; Ahmed and Duellman, 2013). Moreover, a nuanced interpretation of results relative to the incomplete revelation hypothesis and signaling theory suggests a dual-layered impact. While overconfident CEOs might not intentionally aim to introduce market uncertainty or influence price efficiency (Kim and Verrecchia, 1991; Guay *et al.*, 2016), the complexity of financial reporting, which could be seen as a signaling tool based on signaling theory (Leland and Pyle, 1977; Trueman, 1986), might unintentionally lead to such outcomes. This complexity can serve as a mechanism for CEOs to emphasize positive attributes without disclosing proprietary information, thereby influencing market reactions in light of the aforementioned hypothesis.

In the robustness tests, results highlight that firms with lower profitability exhibit a stronger and more significant positive relationship between CEOOC and financial reporting complexity compared to their more profitable counterparts. This insinuates that overconfident CEOs in underperforming firms have a greater propensity to amplify financial reporting complexity than those leading better-performing entities. Moreover, companies with superior financial performance tend to adopt a more optimistic tone in their financial statements, signaling their commendable performance. The robustness of these findings is confirmed through alternative measures of CEOOC and complexity. The results maintain their consistency even after addressing potential endogeneity concerns by implementing firm fixed effects, the PSM method, entropy balancing approach and instrumental variables.

This research seeks to elucidate the nuanced influence of overconfident CEOs on financial reporting complexity, particularly the observed reduction in readability in annual financial statements. In doing so, it contributes to the academic discourse surrounding the interplay between managerial traits and financial reporting complexity. The study offers a detailed examination of overconfidence, a prominent behavioral bias (Moore and Healy, 2008), and its ramifications on the generation of increasingly complex financial statements, thereby expanding the existing body of literature on this subject. Overconfidence plays a pivotal role in molding managers' information processing, expectation formulation and strategic decision-making (Chen *et al.*, 2015; Schumacher *et al.*, 2020; Hribar and Yang, 2016). Furthermore, this research accentuates the behavioral theory that intertwines psychological facets, such as CEOOC, with corporate strategic decision-making. Recognizing that CEOOC can be empirically identified (Goel and Thakor, 2008), the study draws a correlation between a firm's reporting complexity and the behavioral inclinations of its CEO. This suggests that a company steered by an overconfident CEO might present heightened complexity in its financial disclosures. Additionally, this research stands out by leveraging advanced textual analysis techniques tailored to the Persian language and applied to Iranian annual financial statements – a pioneering approach in this specific context. In doing so, it bolsters existing studies on readability within the Iranian market (Hesarzadeh and Rajabalizadeh, 2019, 2020; Hesarzadeh *et al.*, 2020) and complements international explorations that investigate the interplay between managerial traits and financial statement readability (Hasan, 2020; Sun *et al.*, 2022; Xu *et al.*, 2018; E-Vahdati *et al.*, 2022). While prior research has predominantly focused on facets such as board gender diversity (Ginesti *et al.*, 2018; Nadeem, 2021) and the presence of women in senior executive positions (E-Vahdati *et al.*, 2022) to gauge their impact on 10-K report readability, this study offers a fresh perspective. It delves deeper into assessing the influence of the CEO's intangible attributes on financial reporting complexity.

The remainder of the paper is structured as follows. In Section 2, theories and hypothesis development are discussed. Section 3 outlines the research design. The results are presented in Section 4, while robustness analyses are covered in Section 5. Finally, the conclusion and remarks are provided in Section 6.

2. Theoretical framework, literature review and hypothesis development

2.1 Theories

In this research, the association between CEOOC [1] and financial reporting complexity is examined through the multifaceted lenses of agency and signaling theories, complemented by the obfuscation and incomplete revelation hypotheses. CEOOC emerges as a central theme, weaving these theoretical perspectives together to provide a comprehensive framework for analysis.

Agency theory, as articulated by [Jensen and Meckling \(1976\)](#), paints a picture of the inherent tension between shareholders (principals) and managers (agents). It posits that informational gaps and divergent incentives can thwart efficient resource distribution within the economic ecosystem. In this context, CEOOC, characterized by [Ahmed and Duellman \(2013\)](#), could amplify agency-related issues. Such overconfidence might fortify a CEO's conviction in the potential returns of their investment endeavors, inadvertently fostering overinvestment and potential resource misallocation. Crucially, this heightened confidence may not always align with shareholder preferences. The nuanced interplay between overconfidence and financial reporting complexity can be viewed as an instrument to veil these possibly suboptimal investment choices. In alignment with [Li \(2008\)](#), it is suggested that managers might deliberately employ complex linguistic constructs in their financial statements. The aim? To raise the informational processing toll, potentially stalling or skewing market responses to the information embedded in these disclosures. Furthermore, [Bens et al. \(2011\)](#) and [Graham et al. \(2005\)](#) emphasize that factors like proprietary costs, career progression and external reputational considerations play a pivotal role in shaping managers' voluntary disclosure choices. These factors could induce a calculated complexity in reporting, potentially to camouflage inherent inefficiencies or errors in judgment.

On the flip side, signaling theory seeks to elucidate why firms might choose to disclose information in the face of prevalent informational asymmetries ([Leland and Pyle, 1977](#)). This theory suggests that top-tier firms may opt for signaling as a means to distinguish themselves from competitors, highlighting their superior qualities and potential. They undertake this signaling, especially when in-depth disclosures could jeopardize their competitive edge by unveiling proprietary insights ([Trueman, 1986](#); [Graham et al., 2005](#)). When factoring in CEOOC, an intriguing dynamic comes into play. The intricacy observed in financial reporting might not be driven by a need to conceal information. Instead, it could arise from an effort to craft a thorough – though potentially convoluted – narrative encapsulating the firm's strategies and visions for the future. While an overconfident CEO might view this detailed disclosure as a transparent avenue of communication, it could unintentionally heighten the complexity and ambiguity for external observers ([Bloomfield, 2008](#)).

The obfuscation hypothesis suggests that CEOs, notably the overconfident ones, might intentionally diminish the transparency of their disclosures when conveying less favorable news. Their heightened confidence might lead them to believe that their strategic actions and results are merely experiencing temporary setbacks. As such, they may choose obfuscation as a shield against adverse market reactions ([Li, 2008](#); [Bens et al., 2011](#); [Graham et al., 2005](#)). This perspective, deeply rooted in both agency and signaling theories ([Smith and Taffler, 1992](#)), highlights a juncture where overconfidence not only spurs CEOs to embrace riskier choices but also affects how these choices are portrayed or masked in financial reports. Furthermore, the incomplete revelation hypothesis contends that high-cost information deters trading interest and is not fully reflected in prices, leading to reduced efficiency and increased ambiguity ([Kim and Verrecchia, 1991](#); [Guay et al., 2016](#)). This hypothesis meshes with the concept of overconfidence by proposing that overconfident CEOs might underestimate the information processing costs they place on stakeholders. They may mistakenly believe that the detailed, complex information they disseminate is effortlessly comprehended and leveraged by the market and its participants, not recognizing the potential of spawning uncertainty and eroding price efficiency.

To conclude, given its explicit tie to managerial conduct and its potential to introduce intricacy in financial disclosures, especially during periods of subpar performance or audacious endeavors the obfuscation hypothesis seems to occupy a commanding position. It underscores how CEOOC amplifies the complexity of financial reporting.

2.2 Literature review and hypothesis development

Hambrick (2007) underscored the profound influence top executives exert on organizational outcomes, noting, “If one wants to understand why organizations do the things they do, or why they perform the way they do, one must consider the biases and dispositions of their most powerful actors—their top executives.” This perspective, deeply embedded in the upper echelon theory, emphasizes the critical role of CEOs’ personality traits in shaping corporate trajectories. Over the decades, there has been considerable attention to various CEO characteristics, from narcissism (Buyl *et al.*, 2019) to greed (Sajko *et al.*, 2021), self-oriented perfectionism (Wang *et al.*, 2023) and, notably, overconfidence (Kunz and Sonnenholzner, 2023). CEOOC, in particular, has gained prominence in recent management theories. While a healthy dose of self-confidence is crucial for effective leadership, overestimation of one’s abilities can lead to costly mistakes. Johnson and Fowler (2011) pointed out the propensity of overconfident CEOs to make flawed decisions, misjudging their capabilities and often underestimating associated risks. This observation has been echoed in a series of recent studies. For instance, Yang and Xue (2023) highlighted the inclination of overconfident CEOs toward outsourcing strategies, with asset specificity playing a moderating role, especially in larger private firms. They argue that such overconfidence-induced inefficiencies should be viewed as genuine errors, emphasizing the protective role of strong corporate governance. Meanwhile, Yung and Long (2022) discovered overconfident CEOs tend to favor high cash reserves and low leverage, often reducing firm leverage unexpectedly, suggesting their aversion to external monitoring.

Further enriching the discussion, Burkhard *et al.* (2023) revealed, through a comprehensive meta-analysis, that CEOOC might indeed encourage strategic risk-taking, subsequently enhancing firm performance. This challenges the conventional notion that views overconfidence solely as a harmful cognitive bias. On the other hand, Sutrisno *et al.* (2023) commented that CEOOC appears to reduce firm risk, noting that the role of a founder CEO does not significantly alter this relationship. When exploring organizational turnarounds, Kowalczik *et al.* (2023) delved into the intricate dynamics of CEOOC. Their research suggests that while existing overconfident CEOs might impede turnaround initiatives, overconfident successors introduced during periods of decline might bolster performance. This draws attention to the unique biases each type of CEO brings when evaluating organizational decline. In another intriguing study, Galariotis *et al.* (2023) associated CEOOC with heightened inside debt incentives, a phenomenon particularly evident among less powerful CEOs in firms grappling with significant overconfidence-induced agency costs of debt. The complex interactions of CEOOC’s outcomes, from initiating high-risk product ventures (Simon and Houghton, 2003) to influencing dividend policies (Deshmukh *et al.*, 2013), underlines the deep and varied influence of this psychological attribute. The dual nature of overconfidence, having the power to both propel and hinder depending on the situation, underscores the urgency for a thorough comprehension, especially as CEOs persist in guiding corporate choices in a constantly shifting business environment (Moore and Healy, 2008; Chung and Hribar, 2021).

With a rich tapestry of literature as the backdrop, this research aims to delve deeper into the intricacies of CEOOC, aiming to bridge existing knowledge gaps and provide a fresh perspective on its diverse implications for contemporary businesses. A notable manifestation of this overconfidence is evident in the domain of financial reporting, where behaviors such as postponing loss recognition and a tendency toward less conservative accounting approaches emerge (Ahmed and Duellman, 2013). These behaviors often stem from an inherent belief in

anticipated returns. Thus, it is not just in strategic and investment decisions that CEOOC leaves its mark; it also seeps into financial disclosures. A clear link emerges between overconfidence and the probability of financial statement inaccuracies (Schrand and Zechman, 2012), preferences for debt maturity (Huang *et al.*, 2016) and even optimistic financial forecasting (Hribar and Yang, 2016). Furthermore, literature points toward the significant influence of overconfidence on corporate innovation endeavors (Hirshleifer *et al.*, 2012), which plays out in the company's risk appetites and willingness to launch new products (Simon and Houghton, 2003).

Simultaneously, financial reporting and its complexity have garnered notable attention. Evidence suggests that market reactions and investor responses are indeed influenced by the nature of financial reports, which provide valuable insights into future firm performance and are associated with subsequent economic outcomes (Schumaker and Chen, 2009; You and Zhang, 2009; Lang and Stice-Lawrence, 2015; Kim *et al.*, 2016). Yet, certain managers appear to mask poorer performances through complex disclosures, leveraging intricate textual expressions to navigate through periods of reduced earnings or unmet forecasts (Bloomfield, 2008; Li, 2008; Miller, 2002). Further, several studies have emphasized the potential for CEOs to influence the tone and complexity of narrative disclosures due to their individual characteristics, including overconfidence (Brennan and Conroy, 2013; Davis *et al.*, 2015; Buchholz *et al.*, 2018; DeBoskey *et al.*, 2019). Gong (2023) delves specifically into this aspect, exploring the influence of CEOOC on the tone of press releases. In this comprehensive study spanning from 2000 to 2018, Gong discovers that firms led by overconfident CEOs tend to issue press releases with a more positive spin, subsequently attracting more favorable reactions from the market. Interestingly, this correlation becomes even more pronounced in firms that are performing well operationally and is particularly noticeable in announcements related to investments. These insights underscore the propensity of overconfident CEOs to introduce biases in press releases, emphasizing the need for a discerning approach to corporate communications.

While a multitude of studies have extensively analyzed the impact of CEOOC on diverse organizational decisions and outcomes, their primary lens has been affixed on aspects like strategic choices and investment tendencies (Ben-David *et al.*, 2013; Hilary and Hsu, 2011). As expounded in the literature review, while there is abundant evidence of CEOOC influencing financial disclosures and even introducing biases in narrative elements like press releases, a comprehensive exploration into the specifics of how overconfidence correlates with the intricacies of financial reporting complexity remains relatively uncharted. This nuanced intersection between overconfidence and financial reporting is pivotal, especially given that financial reports serve as pivotal tools for investors to gauge future firm performance and are closely associated with consequential economic outcomes. The present research shall delve into unraveling whether, and to what extent, CEOOC inflects financial reporting complexity. Overconfident CEOs may believe they have a clear and accurate understanding of their company's financial situation, but their overly positive self-perception may lead them to overlook critical information. As a result, they may unintentionally obfuscate financial disclosures or resist feedback that could improve the clarity of such disclosures. Informed by the theories, reviewed literature and identified gap, the study hypothesizes:

H. CEO overconfidence increases the financial reporting complexity.

3. Research design

3.1 Sample and data

The sample comprises all firms listed on the TSE from the second quarter of 2010–2021. The starting year of 2010 was selected due to the increased accessibility of comprehensive electronic records of financial statements for firms listed on the TSE. Prior to this year,

inconsistent electronic uploads of financial statements posed a challenge for systematic data collection and textual analysis. The end year of 2021 was chosen because, as of 2023 when the study was conducted, not all listed firms had released complete financial information for 2022. By choosing 2021 as the final year, the study ensures data completeness and consistency, and also provides for a one-year buffer ($t+1$ year). This buffer year is crucial for analyses involving lagged or forward-looking variables, such as sales growth or future cash flows, avoiding potential issues related to missing or incomplete data. Table 1 outlines the step-by-step procedure followed to process the sample, ultimately resulting in the final sample composition. The total observations are 3,509 observations [11 (years) $\times$ 319 (firms)]. Financial and utility industry firms are excluded [11 (years) $\times$ 138 (firms) = $1,518$] due to differences in the nature of various metrics and regulations, making their financial information characteristics incomparable to those in other industries (Jiraporn *et al.*, 2009). During the textual feature processing, some financial statement PDF files were damaged, protected or could not be merged or extracted, affecting 170 PDF files. Additionally, 376 firm-years with insufficient information for variable calculation are removed. Hence, the final sample for the main analysis is 1,445. For more information about textual features and the data extraction and calculation process, please refer to Appendix 1.

3.2 Dependent variable: complexity

In line with the extensive recent literature (Guay *et al.*, 2016; Bozanic *et al.*, 2019; Chychyla *et al.*, 2019; Hesarzadeh *et al.*, 2020), this study employs three measures of readability to calculate complexity of annual financial statements (*Complexity*): the Fog index, SMOG and ARI.

The first measure of readability is the Fog index (*Complexity1*), developed by Robert Gunning. This well-known and simple formula measures readability (Li, 2008). The relationship between the Fog index and reading ease is as follows: Fog >18 (unreadable), 14–18 (difficult), 12–14 (ideal), 10–12 (acceptable) and 8–10 (childish). Higher scores on the Fog index indicate lower readability scores for the text. To measure readability, the study relies on the following calculation:

$$\text{Fog} = 0.4 \times [\text{number of words} / \text{number of sentences} \\ + 100 \times (\text{number of words with more than two syllables} / \text{number of words})] \quad (1)$$

The second measure of readability is the SMOG (*Complexity2*). Similar to the Fog index, a higher level of SMOG is associated with a lower level of readability. The relationship between SMOG and reading ease is as follows: 4.9 or lower (elementary school), 5–8.9 (Middle school), 9–12.9 (high school), 13–16.9 (undergraduate) and 17 or higher (graduate). The formula counts the words with three or more syllables in three 10-sentence samples, estimates the count's square root (from the nearest perfect square) and adds 3 to the result.

Step	Description	Observations
1	Initial sample of firms listed on the TSE from 2010 to 2021 [11 (years) $\times$ 319 (firms)]	3,509
2	Exclusion of financial and utility industry firms due to industry-specific metrics and regulations [11 (years) $\times$ 138 (firms)]	(1,518)
3	Removal of PDF files that were damaged, protected or could not be merged or extracted	(170)
4	Exclusion of firm-years with insufficient information for variable calculation	(376)
5	Final research sample	1,445

Source(s): Author's own creation

Table 1.
Research sample
determination process

$$\text{SMOG} = 1.043 \times \sqrt{[30 \times \text{number of words with more than two syllables} / \text{number of sentences}]} + 3.1291 \tag{2}$$

The third measure of readability is the ARI (*Complexity3*) which, similar to the Fog and SMOG index, provides an approximate representation of the US grade level required to understand a given text. The scores correspond to age and grade levels as follows: age 5–6: kindergarten, age 6–7: first grade . . . age 17–18: twelfth grade and age 18–22: college student. Hence, a higher level of SMOG is associated with a lower level of readability.

$$\text{ARI} = 4.71 \times (\text{characters/words}) + 0.5 \times (\text{words/sentences}) - 21.43 \tag{3}$$

In addition, following the broader literature (e.g. [Lawrence, 2013](#); [Lehavy et al., 2011](#); [Li, 2008](#)), this study employs the Flesch-Kincaid (FK) index (*Complexity4*), Flesch Reading Ease (FRE) index (*Complexity5*) (in contrast to the other readability indexes, a high FRE score indicates a more readable text, making it easier to interpret even for readers with less understanding) and the natural logarithm of total words (*Complexity6*) as alternative measures of readability in robustness tests.

3.3 Independent variable: CEO overconfidence

The primary indicator for investment-related overconfidence, termed *CEOOC*, is a binary variable. This variable is given a value of 1 if a firm’s yearly capital expenditures, adjusted by the assets from the previous year, exceed the median ratio of capital expenditures to the lagged total assets in its industry category for that specific year. Otherwise, it is given a value of 0 ([Ahmed and Duellman, 2013](#)). The foundation for this measure stems from the findings by [Malmendier and Tate \(2005\)](#), which propose that overconfident CEOs tend to excessively invest in capital ventures. The advantage of this variable is its applicability to a broader sample, as it solely demands firm-specific data and eschews the need for data on executive option holdings [\[2\]](#).

In robustness tests, two alternative measures of *CEOOC* are used. The first alternative measure, *CEOOC1*, is an investment-linked indicator proposed by [Ahmed and Duellman \(2013\)](#), which represents the degree of excess asset investment obtained from the residual of an industry-year regression of total asset growth on sales growth. The *CEOOC1* variable is set to 1 if the residual from the excess investment regression is positive, and 0 otherwise. The underlying logic is that when assets are growing faster than sales, it implies that managers may be overinvesting in their organization compared to their industry peers. Furthermore, this study adopts a second alternative measure of overconfidence, *CEOOC2*, in line with [Ishikawa and Takahashi \(2010\)](#) and [Lin et al. \(2010\)](#), to evaluate the extent of managerial overconfidence. This measure calculates the difference between managerial forecasts of earnings per share (EPS) and the actual values, assigning 1 if the difference is positive, and 0 otherwise. Since the managerial forecast serves as a more direct reflection of managers’ revealed beliefs, it is considered an appropriate supplement to investment-based measures for this study’s purposes.

3.4 Main model

The primary regression model for this paper is [Equation \(4\)](#). In the following model, if β_1 is positive and significant, the main hypothesis would be supported, indicating that *CEOOC* increases financial reporting complexity by creating more complex reports (less readable).

$$\begin{aligned}
Complexity_{it} = & \beta_0 + \beta_1 CEOOC_{it} + \beta_2 CEOTen_{it} + \beta_3 CEOFinExpt_{it} + \beta_4 Blind_{it} \\
& + \beta_5 BFinExpt_{it} + \beta_6 InstOwn_{it} + \beta_7 Size_{it} + \beta_8 ROA_{it} + \beta_9 Accruals_{it} \\
& + \beta_{10} Loss_{it} + \beta_{11} SalesG_{it} + \beta_{12} MTB_{it} + \beta_{13} LnAge_{it} + \beta_{14} ForeignS_{it} \\
& + \beta_{15} Segment_{it} + \sum YEAR + \sum INDUSTRY + \varepsilon_{it}
\end{aligned}
\tag{4}$$

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In the model, *Complexity* encompasses three readability measures, including Fog (*Complexity1*), SMOG (*Complexity2*) and (*Complexity3*). *CEOOC* serves as the main independent variable, representing CEOOC. When testing the primary model, managerial and corporate governance factors, as well as firm characteristics, are controlled based on previous studies (Chen *et al.*, 2019; Nadeem, 2021; Ma *et al.*, 2021; Hesarzadeh and Rajabalizadeh, 2019, 2020; Hesarzadeh *et al.*, 2020). These factors include CEO tenure (*CEOTen*), CEO financial expertise (*CEOFinExpt*), board independence (*Blnd*), board financial expertise (*BFinExpt*), institutional ownership (*InstOwn*), firm size (*Size*), return on assets (*ROA*), total accruals (*Accruals*), loss (*Loss*), sales growth (*SalesG*), market-to-book ratio (*MTB*), firm age (*LnAge*) [3], foreign sales (*ForeignS*) and business segments (*Segment*). The complete definition of the control variables can be found in Appendix 2.

4. Results

4.1 Descriptive statistics

Table 2, Panel A, showcases the descriptive statistics for the primary regression model. A winsorization method was used to tackle extreme values present in the dataset. To reduce the influence of outliers on the statistical analyses, all continuous variables in the research were winsorized at the 1st and 99th percentiles. Three complexity measures – *Complexity1* (Fog), *Complexity2* (SMOG), and *Complexity3* (ARI) – convey notable mean values of 14.521, 15.877 and 13.207, respectively, hinting at a pervasive complexity across financial reports. This is consistent with related studies in the Iranian context (Hesarzadeh and Rajabalizadeh, 2019, 2020; Hesarzadeh *et al.*, 2020). *CEOOC* (CEO Overconfidence) exhibits a balanced mean (0.497), mirroring findings both locally (Hasas Yeganeh *et al.*, 2015; Sarlak *et al.*, 2018) and internationally (Ahmed and Duellman, 2013). Key control variables are highlighted, with *CEOTen* (CEO Tenure) demonstrating a wide range from 1 to 15 years, and *BFinExpt* (Board Financial Expertise) signifying most boards lack substantial financial expertise with a mean of 0.177. The CEO financial expertise, represented by *CEOFinExpt*, portrays that a limited subset of CEOs have significant financial knowledge, given its mean of 0.126. Additionally, *InstOwn* (Institutional Ownership) signifies a substantial proportion of shares (mean: 0.688) being institutionally owned, while variables like *Size* and *ROA* reflect diverse firm sizes and mixed profitability within the sample, respectively.

Panel B illustrates a comparative analysis between firms with rational and overconfident CEOs. Clear disparities in financial reporting complexity are evidenced with significant mean differences in *Complexity1*, *Complexity2* and *Complexity3* between the two CEO types. Specifically, *Complexity1* reveals a notable mean difference of 0.372 (*t*-stat = 2.417, *p* < 0.05), with overconfident CEOs exhibiting a higher mean (14.708) compared to their rational counterparts (14.335). Similarly, *Complexity2* and *Complexity3* yield significant mean differences of 0.276 (*t*-stat = 2.524, *p* < 0.05) and 0.421 (*t*-stat = 2.298, *p* < 0.05), respectively, with again higher means evident for firms under overconfident CEOs (16.016 and 13.419, respectively) compared to those with rational CEOs (15.740 and 12.998, respectively). The results can be aligned with the agency and signaling theories, as well as the obfuscation hypothesis presented in the study's theoretical framework. In particular, overconfident CEOs might use financial report complexities either to hide overinvestments and

MD
61,13

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Panel A: descriptive statistics							
Variables	Mean	Std.Dev	Minimum	Q1	Median	Q3	Maximum
<i>Complexity1</i>	14.521	1.100	11.608	13.713	14.522	15.373	17.098
<i>Complexity2</i>	15.877	0.781	13.844	15.310	15.874	16.480	17.676
<i>Complexity3</i>	13.207	1.306	8.407	12.290	13.345	13.969	16.561
<i>CEOOC</i>	0.497	0.501	0.000	0.000	0.000	1.000	1.000
<i>CEOTen</i>	3.643	3.378	1.000	1.000	2.000	5.000	15.000
<i>CEOFinExpt</i>	0.126	0.332	0.000	0.000	0.000	0.000	1.000
<i>Blnd</i>	0.655	0.190	0.000	0.600	0.600	0.800	1.000
<i>BFinExpt</i>	0.177	0.142	0.000	0.000	0.200	0.200	0.600
<i>InstOwn</i>	0.688	0.199	0.112	0.610	0.743	0.837	0.955
<i>Size</i>	14.857	1.517	10.533	14.018	14.694	15.480	20.307
<i>ROA</i>	0.177	0.152	−0.235	0.065	0.166	0.292	0.595
<i>Accruals</i>	0.062	0.184	−0.321	−0.048	0.043	0.136	1.355
<i>Loss</i>	0.075	0.265	0.000	0.000	0.000	0.000	1.000
<i>SalesG</i>	0.386	0.486	−0.577	0.088	0.252	0.587	2.742
<i>MTB</i>	4.528	3.109	0.683	2.242	3.434	6.339	10.872
<i>LnAge</i>	3.666	0.365	2.639	3.401	3.738	3.970	4.234
<i>ForeignS</i>	0.784	0.413	0.000	1.000	1.000	1.000	1.000
<i>Segment</i>	0.422	0.495	0.000	0.000	0.000	1.000	1.000

Panel B: mean difference test between firms with rational CEOs and firms with overconfident CEOs				
	Rational CEO	Overconfident CEO	Mean Dif	t-stat
<i>Complexity1</i>	14.335	14.708	0.372**	2.417
<i>Complexity2</i>	15.740	16.016	0.276**	2.524
<i>Complexity3</i>	12.998	13.419	0.421**	2.298
<i>CEOTen</i>	2.920	4.370	1.454***	3.097
<i>CEOFinExpt</i>	0.180	0.070	−0.109**	−2.351
<i>Blnd</i>	0.713	0.598	−0.115***	−4.485
<i>BFinExpt</i>	0.192	0.162	−0.030	−1.510
<i>InstOwn</i>	0.712	0.664	−0.048*	−1.717
<i>Size</i>	15.072	14.640	−0.432**	−2.022
<i>ROA</i>	0.170	0.183	0.013	0.610
<i>Accruals</i>	0.086	0.037	−0.048*	−1.867
<i>Loss</i>	0.040	0.110	0.071*	1.903
<i>SalesG</i>	0.332	0.441	0.109	1.588
<i>MTB</i>	4.361	4.697	0.336	0.763
<i>LnAge</i>	3.725	3.606	−0.119**	−2.330
<i>ForeignS</i>	0.680	0.890	0.213***	3.757
<i>Segment</i>	0.340	0.500	0.157**	2.254
Observations	726	719		

Table 2.
Descriptive statistics and mean difference test
(observations = 1,445)

Note(s): This table presents the descriptive statistics and the mean difference test results between firms with rational CEOs and firms with overconfident CEOs. The level of statistical significance is indicated by * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$. The definitions of the variables can be found in [Appendix 2](#)
Source(s): Author's own creation

potential resource misallocation, in line with the agency theory (Jensen and Meckling, 1976; Ahmed and Duellman, 2013), or to convey a sophisticated but seemingly clear narrative of their firm's strategies to stand out in a competitive landscape, as proposed by the signaling theory (Trueman, 1986). The evident disparities in complexities and CEO attributes between the two groups highlight the influential role of CEOOC in determining financial reporting, echoing previous studies that detail the diverse consequences of CEOOC on business decisions and disclosure (Malmendier and Tate, 2005; Ahmed and Duellman, 2013; Brennan and Conroy, 2013).

Additionally, variations are observed in CEO traits and several company facets, including CEO tenure, financial proficiency and institutional ownership. Conversely, board financial expertise and specific financial metrics of the firm (e.g. *ROA*, *Accruals*) remain consistent. Notably, overconfident CEOs tend to have extended tenures, lack significant financial knowledge but are visibly engaged in international sales, as indicated by the differences in variables such as *CEOTen*, *CEOFinExpt* and *ForeignS*.

Table 3 displays the correlation matrix for all variables used in this research. Notably, the significant and positive correlations among complexity measures suggest they are harmonious with each other. Moreover, the significant and positive correlation between *CEOOC* and the three complexity measures strengthens the assertions derived from the primary regression analysis. This underscores the idea that *CEOOC* correlates with a rise in financial reporting complexity. The potential problem of multicollinearity was also examined. Multicollinearity arises when there is a high correlation among two or more predictors in a regression model. This can lead to unstable coefficient estimates and possibly misleading conclusions about the associations between predictors and the outcome. To evaluate multicollinearity in the regression models, the variance inflation factor (VIF) was calculated for each predictor. VIF quantifies how much a regression coefficient's variance is amplified due to multicollinearity. Generally, a VIF value surpassing 5 is viewed as indicative of severe multicollinearity (Gujarati, 1995; Rajabalizadeh, 2023). In this research, all VIF values were observed to be under 5, indicating that multicollinearity does not pose a significant issue in the models. Such evaluations solidify the confidence in the regression analysis, ensuring it yields trustworthy and relevant insights about the relationships among the focal variables.

4.2 Regression results

In the quest to decipher the intricate relationship between *CEOOC* and financial reporting complexity, the regression findings in Table 4 demonstrate significant relationships between these variables, with each complexity measure showing statistical importance. However, it is paramount to embed these statistical observations within the existing theoretical and empirical frameworks, grounding them in established research.

- (1) *Complexity1* (measured by the Fog index) has a coefficient of 0.593, $p < 0.01$.
- (2) *Complexity2* (measured by the SMOG index) showcases a coefficient of 0.422, $p < 0.01$.
- (3) *Complexity3* (measured by the ARI index) stands at a coefficient of 0.610, $p < 0.01$.

The potent affinity between *CEOOC* and reporting complexity is evinced through the significantly positive coefficients. From an agency theory perspective, overconfident CEOs might instigate obfuscation mechanisms to veil suboptimal investment decisions, thereby aligning with the obfuscation hypothesis (Healy and Palepu, 2001; Li, 2008). These results mirror the assertions of prior research such as Bens *et al.* (2011) and Graham *et al.* (2005), elucidating that CEOs might employ perplexing linguistic constructs to escalate information processing costs, thereby muting or delaying market reactions. Parallely, drawing from signaling theory, such complexity might not be solely born out of a desire to cloud judgment. Overconfident CEOs could view this as thorough disclosure, unintentionally intensifying the perceived complexity for external parties (Leland and Pyle, 1977; Bloomfield, 2008). In such a scenario, the purportedly clear communication might ironically obfuscate the message meant for the market, harmonizing with the observed positive correlation between overconfidence and reporting complexity.

Empirical findings from prior research, such as those by Ahmed and Duellman (2013), highlight the propensities of overconfident CEOs to engage in overinvestment and resist loss recognition. When intertwined with this research findings, this can imply that CEOs, confident in their ventures, may produce labyrinthine financial statements that, while

Table 3.
Correlation matrix
(observations = 1,445)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) <i>Complexity1</i>	1								
(2) <i>Complexity2</i>	0.996**	1							
(3) <i>Complexity3</i>	0.939**	0.940**	1						
(4) <i>CEOOC</i>	0.170*	0.177*		1					
(5) <i>CEOTen</i>	0.117	0.128	0.088	0.216**	1				
(6) <i>CEOFinExpt</i>	-0.133	-0.136	-0.089	-0.165*	-0.090	1			
(7) <i>BInd</i>	0.111	0.105	0.156*	0.305**	0.045	-0.095	1		
(8) <i>BFinExpt</i>	0.083	0.079	0.028	-0.107	-0.093	-0.066	0.085	1	
(9) <i>InstOwn</i>	0.152*	0.146*	0.149*	-0.121	-0.434**	-0.047	-0.133	0.099	1
(10) <i>Size</i>	0.292**	0.288**	0.237**	-0.143*	0.004	-0.074	0.185**	0.080	0.118
(11) <i>ROA</i>	0.125	0.137	0.207**	0.043	0.217**	-0.020	0.135	0.116	-0.059
(12) <i>Accruals</i>	-0.016	-0.011	0.000	-0.132	-0.001	0.003	-0.023	-0.061	-0.004
(13) <i>Loss</i>	-0.047	-0.046	-0.077	0.135	-0.100	-0.051	0.140*	-0.029	-0.142*
(14) <i>SalesG</i>	-0.045	-0.035	-0.071	0.113	0.152*	-0.094	0.067	-0.039	0.011
(15) <i>MTB</i>	0.016	0.020	0.016	0.054	0.031	-0.223**	-0.081	0.199**	-0.179*
(16) <i>LnAge</i>	-0.032	-0.039	0.001	-0.164*	-0.110	-0.116	-0.195**	0.104	0.032
(17) <i>ForeignS</i>	0.156*	0.150*	0.139	-0.259**	-0.074	0.199**	-0.131	0.182*	-0.249**
(18) <i>Segment</i>	0.124	0.133	0.061	-0.158*	0.229**	0.137			
Variables	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(10) <i>Size</i>	1								
(11) <i>ROA</i>	0.159*	1							
(12) <i>Accruals</i>	-0.006	0.462**	1						
(13) <i>Loss</i>	0.052	-0.494**	-0.330**	1					
(14) <i>SalesG</i>	-0.057	0.202**	0.333**	-0.030	1				
(15) <i>MTB</i>	0.035	0.216**	0.266**	0.006	0.356**	1			
(16) <i>LnAge</i>	0.155*	-0.022	0.137	0.119	0.005	0.028	1		
(17) <i>ForeignS</i>	0.249**	0.123	-0.011	-0.174*	-0.175*	-0.157*	0.317**	1	
(18) <i>Segment</i>	0.424**	0.114	0.161*	-0.090	-0.005	-0.201**	0.129	0.152*	1

Note(s): The level of statistical significance is indicated by * $p < 0.05$, and ** $p < 0.01$. Variables are as defined in [Appendix 2](#)

Source(s): Author's own creation

Variables	Complexity1		Complexity2		Complexity3	
	Coef	t-stat	Coef	t-stat	Coef	t-stat
<i>CEOOC</i>	0.593***	3.457	0.422***	3.460	0.610***	2.909
<i>CEOTen</i>	0.066**	2.206	0.047**	2.189	0.061*	1.680
<i>CEOFinExpt</i>	−0.161	−0.696	−0.127	−0.772	0.021	0.074
<i>Blnd</i>	0.967*	1.965	0.619*	1.769	1.086*	1.806
<i>BFinExpt</i>	0.604	1.127	0.402	1.054	0.230	0.351
<i>InstOwn</i>	1.409***	2.571	0.998**	2.559	1.311*	1.957
<i>Size</i>	0.295***	4.065	0.206***	3.981	0.344***	3.880
<i>ROA</i>	0.481	0.623	0.429	0.782	2.209**	2.343
<i>Accruals</i>	0.146	0.277	0.117	0.312	−0.149	−0.230
<i>Loss</i>	−0.127	−0.362	−0.053	−0.213	0.006	0.014
<i>SalesG</i>	0.154	0.903	0.115	0.950	0.057	0.274
<i>MTB</i>	0.001	0.297	0.001	0.317	0.002	0.343
<i>LnAge</i>	−0.596**	−2.296	−0.434**	−2.352	−0.422	−1.332
<i>ForeignS</i>	−0.011	−0.039	−0.010	−0.048	−0.339	−0.985
<i>Segment</i>	0.436**	2.263	0.330**	2.410	0.375	1.594
<i>Intercept</i>	8.699***	5.380	11.885***	10.330	5.624***	2.846
<i>YEAR_FE</i>	YES		YES		YES	
<i>IND_FE</i>	YES		YES		YES	
<i>Adj_R²</i>	0.240		0.239		0.196	
<i>F</i>	3.318***		3.298***		2.784***	
<i>Observations</i>	1,445		1,445		1,445	

Note(s): Statistical significance is denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Variables are as defined in Appendix 2

Source: Author's own creation

Table 4. Regression results of CEO overconfidence on financial reporting complexity

intended to be comprehensive, end up shrouding the actual performance and risk involved, thus aligning with studies that underscored a proclivity for overconfident CEOs to produce convoluted financial statements (Malmendier and Tate, 2005; Banerjee *et al.*, 2015). Moreover, the complexity might be a mechanism to shield their strategic, albeit risk-laden, decisions from negative market reactions, echoing the strategic complexity explored by Bens *et al.* (2011) and Graham *et al.* (2005). Furthermore, intertwining with the incomplete revelation hypothesis, the findings suggest that CEOs might underestimate the processing costs imposed on stakeholders, assuming that the complex, detailed information they provide is seamlessly absorbed and utilized by the market. The outcomes underscore a notable contrast. Overconfident CEOs, in their endeavor for transparency, might unintentionally establish obstacles hindering efficient information assimilation and the market's price discovery process. Such barriers could foster increased uncertainty, in line with the observations made by Kim and Verrecchia (1991) and Guay *et al.* (2016).

5. Robustness analyses

5.1 Firm performance and tone of the financial statements

The nuanced findings from this empirical analysis offer insightful perspectives on how financial statement preparers, especially those with divergent levels of profitability, manipulate transparency by adjusting the clarity of information displayed. Such perceived manipulation of transparency, potentially a strategy to hide or highlight information depending on their fiscal performance, undergoes detailed scrutiny by dividing the sample, following Rajabalizadeh and Oradi (2022), based on median profitability (*Profitability*, defined as net income after tax divided by total assets). Notably, untabulated regression results

present a split narrative where firms with suboptimal profitability (below the median) display a pronounced, positive and statistically significant relationship at the 1% level between *CEOOC* and *Complexity*. Conversely, their more profitable peers (above the median) also show a positive relationship but are significant at a slightly more lenient 5% level. The economic significance, evidenced by coefficients of 0.189 and 0.098 for the less and more profitable samples, respectively, further supports the primary regression conclusions. A comprehensive analysis indicates that CEOs in firms facing economic challenges tend to increase financial reporting complexity, a trend noticeably more evident than in financially flourishing firms.

Agency theory suggests a disparity between the interests of management and shareholders, often appearing as informational asymmetry (Jensen and Meckling, 1976). The findings draw concrete associations with agency theory, proposing that CEOs in financially thriving firms are more inclined to disclose additional information, a strategic decision to underscore their success and thereby bolster investor confidence (Aly *et al.*, 2018). Although CEOs might be more willing to release more information during prosperous periods, the obfuscation theory posits that they might design these disclosures with intricate complexity to shape perceptions and guide the narrative shared with stakeholders (Bloomfield, 2002). As such, CEOs, despite being more open to information dissemination during buoyant financial periods, may strategically obfuscate information by embedding it within complex, elaborate financial narratives. This concealment might mask underlying challenges or upcoming risks, perpetuating a positive perception among investors and other stakeholders. This behavior aligns with the agency theory's assertion about differing interests and actions between management and shareholders. In contrast, signaling theory suggests that organizations communicate essential information to the market through their actions and disclosures, which might otherwise be hidden. Observing the results, which show that more profitable firms (above the median) partake in complex financial reporting, albeit less intensely than their less profitable peers, necessitates a more intricate interpretation.

CEOs of top-performing companies might still adopt complex financial reporting, not just as a diversory tactic but possibly as a signaling tool. In this context, the complexity might convey an impression of detailed, strategic management skills, possibly deterring potential competitors from entering their market domain. While this complexity offers abundant information, it obliges stakeholders to interpret the enclosed data, which could align with signaling theory if the relayed message sustains or bolsters the company's competitive edge and stakeholder trust. As a result, the complexity in financial reporting, regardless of a firm's profitability status, emerges as a dual-faceted instrument. It serves as an obfuscation method, particularly for struggling firms, and concurrently, a subtle signaling strategy, especially for companies achieving notable success.

5.2 Alternative measures of complexity and CEO overconfidence

In this section, the analyses are reestimated using three additional measures of complexity (readability): *Complexity4* (FK), *Complexity5* (FRE) and *Complexity6* (the natural logarithm of total words). A higher value of FK and total words indicates higher complexity (lower readability), while the opposite is true for the FRE measure.

The results in Panel A of Table 5 support the main regression findings, indicating that overconfident CEOs (*CEOOC*) are associated with higher complexity (less readable annual financial statements). Panel B presents the results of regression analyses using two alternative measures of CEO overconfidence (*CEOOC1* and *CEOOC2*). Based on the regression coefficients and significance, these two measures have a positive and significant relationship with *Complexity1* and *Complexity2*, but not with *Complexity3*. Overall, the results of Table 5, using

Panel A: regression results of CEOs' overconfidence on financial reporting complexity alternatives

Variables	<i>Complexity4</i>		<i>Complexity5</i>		<i>Complexity6</i>	
	Coef	<i>t</i> -stat	Coef	<i>t</i> -stat	Coef	<i>t</i> -stat
<i>CEOOC</i>	0.562***	2.926	−2.071*	−1.738	0.102**	2.430
Intercept	Yes		Yes		Yes	
Controls	Yes		Yes		Yes	
YEAR_FE	Yes		Yes		Yes	
IND_FE	Yes		Yes		Yes	
Adj_ <i>R</i> ²	0.202		0.195		0.414	
F	2.860***		2.773***		6.181***	
Observations	1,445		1,445		1,445	

Panel B: regression results of CEOs' overconfidence alternatives on financial reporting complexity

	<i>Complexity1</i>	<i>Complexity2</i>	<i>Complexity3</i>	<i>Complexity1</i>	<i>Complexity2</i>	<i>Complexity3</i>
	Coef. [<i>t</i> -stat]	Coef. [<i>t</i> -stat]	Coef. [<i>t</i> -stat]	Coef. [<i>t</i> -stat]	Coef. [<i>t</i> -stat]	Coef. [<i>t</i> -stat]
<i>CEOOC1</i>	0.067** [2.167]	0.047** [2.147]	0.062 [1.653]			
<i>CEOOC2</i>				0.064** [2.071]	0.045** [2.050]	0.061 [1.619]
Intercept	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
YEAR_FE	Yes	Yes	Yes	Yes	Yes	Yes
IND_FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj_ <i>R</i> ²	0.189	0.186	0.156	0.190	0.188	0.156
F	2.705***	2.679***	2.354***	2.718***	2.702***	2.359***
Observations	1,445	1,445	1,445	1,445	1,445	1,445

Note(s): Statistical significance is denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Variables are as defined in Appendix 2

Source(s): Author's own creation

Table 5.
Regression results of
CEOs' overconfidence
and financial reporting
complexity
alternatives

both alternative measures of CEO overconfidence and complexity, reinforce the main regression results, demonstrating the robustness of the findings presented in Table 4.

In addition, untabulated analyses are conducted using the natural logarithm of pages (*LnPages*), file size (*FileSize*) and the natural logarithm of the number of sentences (*LnSentences*) as measures of complexity. However, these measures were not statistically significant, with coefficients of 0.033 (*LnPages*), 0.146 (*FileSize*), and 0.008 (*LnSentences*), *t*-statistics of 1.014, 0.429 and 0.183, and *p*-values of 0.312, 0.669 and 0.855, respectively.

5.3 Controlling for unobserved heterogeneity and observable characteristics

To address the potential issue of omitted variables, a supplementary test using firm fixed-effects is conducted, following the guidance of Himmelberg *et al.* (1999). By implementing firm fixed-effects, unobserved heterogeneity is controlled, taking into account the unique attributes of each firm. The results from this test, shown in Panel A of Table 6, indicate that the primary conclusions derived from the initial analysis hold true.

Furthermore, it is essential to note that if firms with overconfident CEOs differ from those with rational CEOs, the control variables in the regression capturing linear relationships might not suffice. This insufficiency could lead to skewed estimates due to omitted variables or self-selection bias. To mitigate these concerns, two similar data samples are crafted that differ solely based on whether the CEO is overconfident or rational. This distinction is made possible by using PSM to pair firms with overconfident CEOs to firms with analogous characteristics but

Variables	Complexity1		Complexity2		Complexity3	
	Coef	t-stat	Coef	t-stat	Coef	t-stat
<i>Panel A: firm fixed effects</i>						
CEOOC	0.459**	1.976	-0.197**	-2.376	0.346**	2.390
Intercept	Yes		Yes		Yes	
Controls	Yes		Yes		Yes	
YEAR_FE	Yes		Yes		Yes	
IND_FE	No		No		No	
FIRM_FE	Yes		Yes		Yes	
Adj_R ²	0.459		0.445		0.376	
F	4.240***		4.065***		3.298***	
Observations	1,445		1,445		1,445	
<i>Panel B: propensity score matching</i>						
CEOOC	0.502***	2.970	0.366***	3.041	0.102**	2.430
CEOTen	0.049**	1.785	0.035	1.790	0.035	1.034
CEOFmExpt	-0.320	-1.319	-0.240	-1.390	-0.182	-0.612
BInd	0.642	1.492	0.401	1.313	0.898*	1.712
BFinExpt	0.264	0.477	0.170	0.434	-0.118	-0.175
InstOwn	1.154**	2.251	0.804**	2.206	0.962	1.538
Size	0.183***	2.694	0.126***	2.645	0.186**	2.233
ROA	-0.670	-0.948	-0.375	-0.746	0.739	0.857
Accruals	0.295	0.549	0.209	0.545	-0.022	-0.033
Loss	-0.276	-0.787	-0.162	-0.649	-0.216	-0.506
SalesG	-0.075	-0.425	-0.044	-0.351	-0.193	-0.897
MTB	0.043	1.044	0.031	1.077	0.037	0.738
LnAge	-0.189	-0.791	-0.151	-0.886	0.024	0.082
ForeignS	0.564***	2.637	0.397***	2.614	0.476*	1.824
Segment	0.219	1.136	0.177	1.290	0.086	0.367
Intercept	10.171***	6.875	12.909***	12.276	8.039***	4.453
Controls	Yes		Yes		Yes	
YEAR_FE	Yes		Yes		Yes	
IND_FE	Yes		Yes		Yes	
Adj_R ²	0.142		0.142		0.094	
F	2.494***		2.490***		1.950***	
Observations	530		530		530	

Table 6.

Regression results:
firm fixed effects and
PSM methods

Note(s): Statistical significance is denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Variables are as defined in [Appendix 2](#)
Source(s): Author's own creation

with a rational CEO. The PSM method calculates propensity scores based on the likelihood of having an overconfident CEO using all control variables. All control variables in the study serve as covariates in a logistic regression model to compute these propensity scores. The scores lie between 0 and 1, with elevated scores signaling a higher probability of having an overconfident CEO. Upon deriving propensity scores, the nearest-neighbour matching technique with replacement is utilized to pair firms with overconfident CEOs (treatment firms) to those with similar traits but rational CEOs (control firms). Specifically, for each firm-year with an overconfident CEO, the firm-year with a rational CEO possessing the closest propensity score is identified. The same control firm is allowed to be matched to multiple treatment firms if it showcases the nearest propensity score. The PSM method yields 384 pairs of matched firm-years, each comprising a treatment firm with an overconfident CEO and a control firm with a rational CEO. This matched sample is used to re-analyze model (4) to probe the relationship between CEO overconfidence and financial statement complexity. The findings from the PSM method, detailed in Panel B of [Table 6](#), validate the primary observation that overconfident

CEOs correlate with heightened complexity (reduced readability) in yearly financial statements. Crucially, this relationship stands firm after considering the endogeneity stemming from self-selection bias [4]. The data imply that CEO overconfidence influences financial statement complexity even when factoring in other firm attributes.

In addition, potential confounding factors and biases are addressed by using entropy balancing, a method that accurately adjusts disparities in the covariate distributions, ensuring that the covariate distributions of firms with overconfident CEOs and those with non-overconfident CEOs align perfectly on the pre-specified moments of the distributions. Unlike other matching or propensity score techniques that exclude units to enhance covariate balance, entropy balancing preserves all units by giving them different weights, which leads to advantages like increased statistical power (Hainmueller, 2012). For this analysis, balance constraints are imposed on all firm-level control characteristics included in the regression model, Equation (4). It is pre-specified that the covariate distributions of firms with overconfident CEOs and those with non-overconfident CEOs align perfectly on the first three moments of the distributions (mean, variance and skewness). The entropy balancing method looks for a set of weights that meet these balance constraints and employs them in the regression estimation. This process helps to address concerns about unobservable firm attributes that might correlate with financial reporting complexity and the hiring of overconfident CEOs. A primary advantage of the entropy balancing approach is that it gives different weights to units instead of omitting them. This characteristic is particularly beneficial for this analysis, enabling the full utilization of the entire data set and preserving the depth of information in the sample.

Panels A and B in Table 7 display the pre-and post-balancing descriptive statistics of the weighting variables. The figures in these panels confirm that the entropy matching method has applied weights resulting in control sample covariate moments almost identical to those of the Overconfidence CEO group. This technique ensures that the control group is comparable to the Overconfidence CEO group in terms of size, profitability, governance, accruals and other pertinent variables known to be the primary drivers of CEO behavior and corporate outcomes (Le et al., 2023; Elnahas et al., 2022). Panel C of Table 7 presents results where *Complexity1*, *Complexity2* and *Complexity3* are the dependent variables, respectively. Like the baseline models, all models in Panel C incorporate the same control variables and year and industry fixed effects. The entropy models confirm the baseline outcomes and discount the notion that selection bias affects the results (see Table 8).

From the outcomes, the Overconfidence CEO group demonstrates a *Complexity1* that is 34.2% higher than the control group, a difference statistically significant at the 1% level. Similarly, the Overconfidence CEO group reveals a *Complexity2* that is 29.4% more than the control group, also significant at the 1% level. Moreover, the Overconfidence CEO group displays a *Complexity3* that is 43.7% more than the control group, significant at the 1% level. These outcomes are both economically and qualitatively consistent with the baseline results, underscoring the strength of the findings. The entropy balancing method bolsters the belief in the conclusion that CEO overconfidence correlates with elevated complexity in their respective firms. The marked differences in complexity metrics between overconfident CEOs and rational CEOs underscore the value of incorporating behavioral biases in corporate decision-making.

Furthermore, the potential endogeneity challenges linked to CEO overconfidence (*CEOC*) are addressed by adopting an instrumental variable (IV) approach. Unobserved variables might simultaneously influence CEO overconfidence and the complexity of financial reports, resulting in potential estimation biases. Drawing from existing literature (e.g. Chen et al., 2019; Bellucci et al., 2010; Huang and Kisgen, 2013; Levi et al., 2014; Graham et al., 2013; Bertrand and Schoar, 2003), instrumental variables are identified that are closely related to CEO overconfidence but remain orthogonal to the error term in the complexity regression. A notable dimension is the gender composition within corporate boards. Chen et al. (2019) identified a clear inverse relationship between female board representation and

	Treatment (overconfidence CEO = 1)			Control (rational CEO = 0)		
	Mean	Variance	Skewness	Mean	Variance	Skewness
<i>Panel A: pre-balancing first, second and third moments of control variables</i>						
<i>CEOTen</i>	4.374	13.540	1.084	2.920	8.357	2.246
<i>CEOFinExpt</i>	0.070	0.066	3.349	0.180	0.149	1.666
<i>Blnd</i>	0.713	0.036	−0.333	0.598	0.029	−0.654
<i>BFinExpt</i>	0.161	0.020	0.791	0.192	0.019	0.415
<i>InstOwn</i>	0.663	0.035	−0.815	0.711	0.042	−1.520
<i>Size</i>	14.640	2.767	0.641	15.070	1.768	0.677
<i>ROA</i>	0.183	0.026	0.031	0.170	0.020	0.622
<i>Accruals</i>	0.037	0.035	3.664	0.085	0.031	0.710
<i>Loss</i>	0.111	0.099	2.475	0.040	0.038	4.695
<i>SalesG</i>	0.440	0.295	1.694	0.331	0.174	2.017
<i>MTB</i>	4.698	10.270	0.843	4.361	9.114	1.154
<i>LnAge</i>	3.606	0.126	−0.461	3.725	0.134	−0.821
<i>ForeignS</i>	0.676	0.221	−0.755	0.890	0.098	−2.493
<i>Segment</i>	0.343	0.227	0.659	0.500	0.252	0.000
<i>Panel B: post-balancing first, second and third moments of control variables</i>						
<i>CEOTen</i>	4.374	13.540	1.084	2.950	8.250	2.200
<i>CEOFinExpt</i>	0.070	0.066	3.349	0.180	0.145	1.600
<i>Blnd</i>	0.713	0.036	−0.333	0.600	0.028	−0.620
<i>BFinExpt</i>	0.161	0.020	0.791	0.190	0.018	0.400
<i>InstOwn</i>	0.663	0.035	−0.815	0.710	0.041	−1.450
<i>Size</i>	14.640	2.767	0.641	15.050	1.750	0.650
<i>ROA</i>	0.183	0.026	0.031	0.170	0.020	0.600
<i>Accruals</i>	0.037	0.035	3.664	0.085	0.030	0.700
<i>Loss</i>	0.111	0.099	2.475	0.040	0.037	4.650
<i>SalesG</i>	0.440	0.295	1.694	0.330	0.170	2.000
<i>MTB</i>	4.698	10.270	0.843	4.360	9.100	1.150
<i>LnAge</i>	3.606	0.126	−0.461	3.720	0.133	−0.800
<i>ForeignS</i>	0.676	0.221	−0.755	0.890	0.095	−2.450
<i>Segment</i>	0.343	0.227	0.659	0.501	0.250	0.011
<i>Panel C. Models with entropy balancing weights</i>						
Variables	<i>Complexity1</i>		<i>Complexity2</i>		<i>Complexity3</i>	
	Coef	<i>t</i> -stat	Coef	<i>t</i> -stat	Coef	<i>t</i> -stat
<i>CEOOC</i>	0.342***	3.624	0.294***	3.754	0.437***	3.275
Intercept		Yes		Yes		Yes
Controls		Yes		Yes		Yes
YEAR_FE		Yes		Yes		Yes
IND_FE		Yes		Yes		Yes
Adj_ <i>R</i> ²						
	0.213		0.224		0.178	
F						
	3.121***		3.324***		3.106***	
Observations						
	1,445		1,445		1,445	

Table 7.
Addressing selection
bias using entropy
balancing

Note(s): Statistical significance is denoted by **p* < 0.10, ***p* < 0.05, ****p* < 0.01. Variables are as defined in [Appendix 2](#)
Source(s): Author’s own creation

CEO overconfidence, indicating that boards with female representation might moderate overconfident tendencies. In this context, “*FemaleDirector*” is incorporated as an instrumental variable, assigned a value of 1 if at least one female director is present on the

Variables	Coef	Std. Err	Wald	p-value
<i>FemaleDirector</i>	0.259	0.631	0.169	0.681
<i>MaleCEO</i>	0.124	0.024	5.184	0.000
<i>CEODegree</i>	0.987	0.682	2.095	0.148
<i>CEOQual</i>	1.079	0.570	3.576	0.059
Intercept and controls		Included		
YEAR_FE included				
IND_FE		Included		
Chi-square		0.278		
Observations		1,445		

Dependent variables Variables	<i>Complexity1</i> Coef	<i>Complexity1</i> t-stat	<i>Complexity2</i> Coef	<i>Complexity2</i> Stat	<i>Complexity3</i> Coef	<i>Complexity3</i> Stat
<i>PredCEOOC</i>	1.999***	3.031	1.331***	2.818	2.099**	2.586
<i>CEOTen</i>	0.044	1.478	0.032	1.494	0.040	1.071
<i>CEOFinExpt</i>	0.000	0.002	-0.022	-0.123	0.188	0.618
<i>Blnd</i>	-0.208	-0.326	-0.143	-0.314	-0.155	-0.198
<i>BFinExpt</i>	0.827	1.565	0.550	1.454	0.441	0.679
<i>InstOwn</i>	1.568***	2.828	1.095***	2.756	1.500**	2.198
<i>Size</i>	0.388***	4.968	0.267***	4.784	0.439***	4.567
<i>ROA</i>	0.260	0.360	0.281	0.542	1.941**	2.180
<i>Accruals</i>	0.902	1.628	0.616	1.552	0.643	0.943
<i>Loss</i>	-0.381	-1.028	-0.219	-0.824	-0.258	-0.566
<i>SalesG</i>	0.142	0.843	0.106	0.878	0.051	0.244
<i>MTB</i>	0.085**	2.135	0.059**	2.065	0.081*	1.657
<i>LnAge</i>	0.012	0.041	-0.034	-0.155	0.207	0.549
<i>ForeignS</i>	0.054	0.189	0.037	0.178	-0.276	-0.778
<i>Segment</i>	0.479**	2.240	0.358**	2.337	0.420	1.595
<i>Intercept</i>	4.079***	1.973	8.834***	5.967	0.888	0.349
YEAR_FE included						
IND_FE	Included		Included		Included	
Adj_ R^2	0.265		0.254		0.212	
F	3.555***		3.409***		2.898***	
Observations	1,445		1,445		1,445	

Note(s): Statistical significance is denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Variables are as defined in Appendix 2

Source(s): Author's own creation

Table 8.
Addressing
endogeneity problems
using instrumental
variable (IV) method

board, and 0 otherwise. This perspective aligns with insights from [Bellucci et al. \(2010\)](#), [Huang and Kisgen \(2013\)](#) and [Levi et al. \(2014\)](#), emphasizing gender-based behavioral distinctions and highlighting the generally reduced overconfidence in women. Concurrently, “*MaleCEO*” is also introduced, with a value of 1 for male CEOs, and 0 otherwise.

Another consideration is the CEO's educational background and credentials. Earning degrees from prestigious institutions or achieving advanced qualifications, such as an MBA or Ph.D., might act as indicators of innate intelligence and accumulated human and social capital, potentially influencing CEO behaviors and overconfidence perceptions. [Bertrand and Schoar \(2003\)](#) empirically showed a tendency for MBA-holding CEOs to be more assertive. This insight led to the introduction of “*CEODegree*,” a binary variable set at 1 if the CEO holds an MBA or Ph.D., and 0 for other qualifications. Additionally, “*CEOQual*” is factored in, with a value of 1 for CEOs with professional certifications, like Certified Public Accountant, and 0 otherwise. Together, these instrumental variables aim to address endogeneity issues, offering a deeper grasp of the effects of CEO overconfidence in the corporate domain.

The first-stage self-selection model is formulated as:

$$CEOOC_{it} = \beta_0 + \beta_1 FemaleDirector_{it} + \beta_2 MaleCEO_{it} + \beta_3 CEODegree_{it} + \beta_4 CEOQual_{it} + \sum Controls + \sum YEAR + \sum INDUSTRY + \varepsilon_{it} \quad (5)$$

All variable definitions can be found in the supplementary variable section of [Appendix 2](#). After determining the predicted values for CEOOC in the first stage (*PredCEOOC*), the second stage uses these values to analyze their effect on the complexity of financial disclosures.

$$Complexity_{it} = \beta_0 + \beta_1 PredCEOOC_{it} + \sum Controls + \sum YEAR + \sum INDUSTRY + \varepsilon_{it} \quad (6)$$

This two-step process ensures that any potential endogeneity of *CEOOC* is addressed, thereby providing robust insights. The second stage captures the causal impact of the (now instrumented) CEO overconfidence on the complexity of financial reports, having controlled for potential confounding effects. The essence of this IV methodology is to offer a clearer, unbiased lens through which the ramifications of CEO behavior, in terms of overconfidence, on financial reporting can be discerned. As observed in [Table 8](#), the results of the primary regression model based on the three complexity measures mirror the main outcomes even after accounting for potential endogeneity.

6. Conclusion and remarks

The literature has provided in-depth insights into the impact of CEO overconfidence on various corporate behaviors. From corporate innovation ([Hirshleifer et al., 2012](#)) and risky product introduction ([Simon and Houghton, 2003](#)) to corporate dividend policies ([Deshmukh et al., 2013](#)) and press release tone ([Gong, 2023](#)), the consequences of CEO overconfidence are well-explored. Grounded in the foundational frameworks of agency and signaling theory, this research delves into the mechanisms through which CEO overconfidence might influence financial reporting complexity. In detail, agency theory underscores the possibility of misalignments between CEOs and shareholders. Overconfident CEOs may stray from optimal strategies, leading to potential overinvestment and resource misallocation ([Healy and Palepu, 2001](#); [Ahmed and Duellman, 2013](#)). Such CEOs could also mask their actions with convoluted financial reporting, behavior highlighted by the obfuscation hypothesis, thereby obscuring information and manipulating market perceptions ([Li, 2008](#)). At the same time, signaling theory emphasizes that organizations might use intricate reporting as a signaling mechanism to tout their capabilities without revealing crucial proprietary information ([Leland and Pyle, 1977](#); [Trueman, 1986](#)). Yet, the resultant complexity might foster misperceptions between overconfident CEOs and stakeholders, posing challenges related to transparency versus perceived complexity ([Bloomfield, 2008](#)). Informed by these theories, the findings illuminate a concrete representation of these theoretical implications in practical management actions. The behaviors of overconfident CEOs, as postulated, appear to influence the complexity of financial disclosures, impacting the decision-making of investors and stakeholders.

Furthermore, within the domain of corporate accounting decisions, CEO overconfidence has been connected to various outcomes, including the probability of financial misstatements ([Schrand and Zechman, 2012](#)) and decisions related to goodwill impairment ([Chung and Hribar, 2021](#)). However, despite the substantial existing research, this paper fills a noteworthy void by investigating the link between CEO overconfidence and financial reporting complexity in the unique Iranian setting. This environment is characterized by prevailing Islamic traditions, weak Iranian civil law and corporate governance enforcement,

limited shareholder protection and considerable autonomy given to top executives, particularly CEOs, in Iranian listed firms. This backdrop offers a fresh lens to examine this association, leading to impactful practical implications.

The analysis indicates that overconfident CEOs tend to increase the complexity of financial reporting, making it less user-friendly. This supports the notion that such CEOs might aim to conceal suboptimal performance by complicating their financial statements. Additional tests offer deeper insights: companies with below-average performance led by overconfident CEOs show a higher tendency to amplify financial reporting complexity compared to their high-performing peers. Conversely, high-performing entities maintain a more upbeat tone in their financial disclosures to highlight their outstanding results. Uniquely, this research utilizes textual analysis techniques on Persian texts in the context of financial reporting, representing an innovative methodological approach. Although an initial study was conducted and the results compared with previous studies, considering the nuances of text mining and the nature of the extracted data, it is essential to approach the findings cautiously.

From a practical management viewpoint, the outcomes provide actionable insights for corporate boards and investors. Understanding the behavioral inclinations of overconfident CEOs can facilitate more effective board oversight, ensuring that reporting practices reflect shareholders' best interests. This knowledge provides firms with a clearer pathway to tackle the challenges posed by CEO overconfidence and its ramifications on financial transparency. Moving forward, while this research has aimed to elucidate the association between CEO overconfidence and financial reporting complexity in the Iranian context, some limitations are acknowledged. Future research could expand the scope by including other types of disclosure documents, such as MD&A. Investigating the effects of various CEO characteristics – both observable ones like age and financial expertise and intangible ones like narcissism and trust – on financial reporting complexity could be enlightening. Probing into the potential impacts of CEO power dimensions, like ownership, on financial statements and other reports also presents a promising research direction. By examining this intricate relationship in Iran, this study not only augments the current literature but also provides valuable practical insights. For investors, the results act as a warning: there is a need to be meticulous when evaluating the financial reports of companies led by overconfident CEOs, as these executives may have a tendency to obfuscate financial information, especially during downturns. With this awareness, investors can make more informed investment choices. On the regulatory side, these insights can guide policymakers. They can devise policies to enhance the clarity and quality of financial disclosures, promoting greater responsibility and fortifying the overall health of capital markets.

Notes

1. The upper echelons theory (UET) posits that the characteristics of top executives shape the strategic decisions and outcomes of their organizations (Hambrick and Mason, 1984). Within this framework, strategic choices are seen as having a behavioral dimension, where the cognitive foundations, values and perceptions of top managers manifest in their strategic decisions, consequently affecting company performance. These perceptions subsequently inform their strategic choices (Hambrick, 2007).
2. Past research efforts (including those by Malmendier and Tate, 2005, 2008; Hirshleifer *et al.*, 2012; Ahmed and Duellman, 2013; Chen *et al.*, 2020) have characterized CEO overconfidence using an indicator variable, pivoting on the behavior of CEOs when exercising options. Notably, Malmendier and Tate (2005, 2008) posit that a CEO's degree of overconfidence can be discerned from the degree to which they postpone the exercise of their options. Regrettably, such data remain absent from Iranian financial statements or other public sources.

3. An additional analysis was undertaken without tabulation, utilizing the raw year count for firm age as opposed to its natural logarithm, a modification suggested by a reviewer. The outcomes from this alternate evaluation aligned with the principal findings, signifying that the results remain steadfast regardless of the scaling preference for the firm age variable.
4. Following Galariotis *et al.* (2023), a diagnostic test is performed to investigate the success of the PSM approach in removing biases related to observable firm characteristics. The untabulated results show that only two out of the 14 independent variables are statistically significant, and the pseudo-R2 drops significantly, indicating that the PSM process successfully removes potential sample selection biases.

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Appendix 1

Text mining procedure and methodology for Persian annual financial statements

In the text mining process for this study, annual financial statements for the research period, which are in Persian and in PDF format (many containing images), are manually downloaded from the comprehensive and official database of the Security Exchange Organization (SEO) of Iran, that is, CODAL. CODAL contains comprehensive and up-to-date information related to companies listed on the TSE. Due to uploading issues, some extracted PDF files for each year are split into different subfiles. These subfiles are then merged without reducing their size to calculate file size. Before any textual processing, the number of pages and file size (in MB) are calculated using Python code.

Utilizing Python packages and Optical Character Recognition (OCR), code is written to open the input PDFs, iterate through pages, remove tables, convert pages to images and extract text using OCR. The extracted text is then written to output files, converting all PDFs to TXT files to facilitate further processing. During this process, specific characters and Persian figures, tables and special characters in the Persian language (·٠١٢٣٤٥٦٧٨٩٠/+-_ = ,#><[]{}|"«) are removed, while sentence-ending characters are retained for readability index calculation.

At this stage, all PDF files are transformed into TXT files, ready for textual analysis. This marks the first time textual analysis techniques have been applied to text mining on Persian annual financial statements. Specifically, the use of Python packages and APIs to clean, process and structure the text data could be considered a form of Natural Language Processing (NLP). Prior to this, researchers used manual processes. And before that, researchers used manual processes.

To ensure the extracted text is suitable for analysis, two pilot tests are conducted. In the first test, approximately 50 financial statements are converted to text files and the process of calculating textual features (i.e. number of pages, words, readability indices, tone) is performed manually. The results are then saved for comparison with the textual analysis method. In the second test, the calculated textual features of manually extracted data and textual analysis method are both compared with previous studies in the Iranian market. For the first test, the results are nearly identical that is compared based on the mean difference test in statistical software. For the second test, the results are comparable to previous studies in Iran, as mentioned in the descriptive statistic section.

After confirming the pilot tests are satisfactory, metrics are calculated for the full sample using Python codes. As Python packages like NLTK are not fully suitable for the Persian language, other packages such as the Hazm library are used for Persian text processing. This library performs various tasks such as text cleaning, tokenizing sentences and words, lemmatizing words, POS tagging, shallow parsing, dependency parsing, providing interfaces for Persian corpora and offering compatibility with NLTK (for more information, refer to [hazm·PyPI](#) and [GitHub-roshan-research/hazm](#): Python library for digesting Persian text).

To calculate tone, negative and positive words are needed. In the English language, [Loughran and McDonald's \(2011, 2016\)](#) bag of words is commonly used, but in Persian, the most reliable resource is Kaggle's Sentiment Lexicons, which is defined for 81 languages ([Sentiment Lexicons for 81 Languages | Kaggle](#)). In this data set, the total number of positive words is 860 and negative words is 1,394. It is important to note that the tone calculation in this paper does not require ambiguous words. To ensure the results are reliable, the last process for readability indices is repeated for tone calculation. The results are satisfactory and comparable between both manual and textual analysis method, full sample and previous research findings.

Source(s): Author's own creation

Variable	Description
<i>Complexity1</i>	FOG = $0.4 \times [\text{number of words/number of sentences} + 100 \times (\text{number of words with more than three syllables/number of words})]$ computed precisely as in Li (2008)
<i>Complexity2</i>	SMOG = $1.043 \times \sqrt{30 \times \text{number of words with more than two syllables/number of sentences}} + 3.1291$
<i>Complexity3</i>	ARI = $4.71 \times (\text{characters/words}) + 0.5 \times (\text{words/sentences}) - 21.43$
<i>CEOOC</i>	1 if capital expenditures deflated by lagged total assets exceed the industry-year median, 0 otherwise
<i>CEOTen</i>	The number of years working as a CEO in the firm
<i>CEOFinExpt</i>	1 if the CEO is a financial expert, 0 otherwise
<i>Blnd</i>	The proportion of independent directors on the board
<i>BFinExpt</i>	The percentage of financial experts on the board of directors
<i>InstOwn</i>	The percentage of the company's shares owned by institutional owners
<i>Size</i>	The natural log of total assets
<i>ROA</i>	Return on assets calculated as the ratio of net income to total assets
<i>Accruals</i>	Total accruals calculated as earnings minus operating cash flows to total assets
<i>Loss</i>	1 if net income is negative, and 0 otherwise
<i>SalesG</i>	One-year growth rate in sales
<i>MTB</i>	Market-to-book ratio calculated as the market value of the firm divided by its book value
<i>LnAge</i>	The natural logarithm of the number of years the firm is established
<i>ForeignS</i>	1 if the firm has foreign sale, and 0 otherwise
<i>Segment</i>	1 if the firm has subsidiaries
<i>Additional variables</i>	
<i>Complexity4</i>	FK = $0.39 \times [\text{number of words/number of sentences}] + 11.8 \times [\text{number of syllables/number of words}] - 15.59$
<i>Complexity5</i>	FRE = $206.835 - 1.015 (\text{total words/total sentences}) - 84.6 (\text{total syllables/total words})$
<i>Complexity6</i>	The natural logarithm of words number
<i>CEOOC1</i>	1 if the residual of industry-year regressions of total asset growth on sales growth is positive, and 0 otherwise
<i>CEOOC2</i>	1 if the difference between managerial forecasts of earnings per share (EPS) and the actual values is positive, and 0 otherwise
<i>LnPages</i>	The natural logarithm of the number of pages
<i>FileSize</i>	File size in megabyte (MB)
<i>LnSentences</i>	The natural logarithm of the number of sentences
<i>Profitability</i>	Net income after tax divided by the total assets
<i>Tone</i>	(Positive words – negative words)/(positive words + negative words)
<i>FemaleDirector</i>	A binary variable that takes the value 1 if there is at least one female director on the board, and 0 otherwise
<i>MaleCEO</i>	A binary variable that takes the value 1 if the CEO is male, and 0 otherwise
<i>CEODegree</i>	A binary variable that takes the value 1 if the CEO possesses an advanced degree such as Master of Business Administration (MBA) or Doctor of Philosophy (Ph.D). It is set to 0 if CEOs hold bachelor's degrees or other higher education qualifications
<i>CEOQual</i>	A binary variable that takes the value 1 if the CEO has professional qualifications (e.g. Certified Public Accountant), and 0 otherwise
<i>PredCEOOC</i>	Predicted values for <i>CEOOC</i> from the first stage of the regression model in the instrumental variables method

Source(s): Author's own creation

Table A1.
Variable definition**Corresponding author**Javad Rajabalizadeh can be contacted at: javad.j.rajabalizadeh@utu.fi

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