A Cognitive Analysis of CEO Speeches and Their Effects on Stock Markets

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Abstract. The cognitive state of a CEO can have a great impact on the company's operational results and stock market performance. Conventional cognitive analysis often relies on interviews with cognitive scientists or psychologists, which are not readily scalable for big data applications in finance. In this work, we leverage a novel method to analyze the cognitive states of top-tier managers of 14 well-known companies. We analyze the concept mappings from their speeches and metaphorical expressions over 15 years. We also conduct breakdown analysis for the concept mappings, according to the trends of stock prices. We identify four distinct types of stock market performance and illustrate the featured concept mappings associated with each category. These representative concept mappings reflect the cognitive states of CEOs and provide insights into which cognitive states are most likely to correlate with positive stock market performance.

Keywords: Cognitive Analysis · Concept Mapping · FinTech · Metaphor

1 Introduction

In the modern financial landscape, the role of a CEO in influencing their company's stock price cannot be overstated. Time and again, we have seen how CEO speeches and their perception by the general public can lead to significant fluctuations in stock prices. With a surge in unstructured multimedia data, every statement made by CEOs is carefully analyzed. A popular example is Steve Jobs's iconic announcement of the iPhone in 2007, which revolutionized the smartphone industry and significantly impacted Apple's stock price[5]. His charismatic presentation and the groundbreaking features of the iPhone captivated investors and consumers alike, leading to a surge in Apple's market value.

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[5] https://www.slashgear.com/how-steve-jobs-iphone-keynote-changed-everything-12706925/

Several studies have analyzed CEOs' speeches using various NLP techniques to find correlations with stock prices [1,22,24]. Additionally, CEOs' cognition has been studied in depth using various manual methods to understand their impact on overall firm performance, management style, and CSR efforts [3, 12, 18]. Despite these extensive studies, there remains a significant gap in understanding the cognitive states of CEOs through their speeches and how these cognitive states correlate with stock market performance. This study aims to fill this gap by leveraging a novel approach: analyzing CEOs' speeches in Letters to Shareholders" from a cognitive perspective using metaphorical concept mappings. We examine CEOs' speeches through a cognitive lens, investigating their relationship with stock markets by analyzing metaphorical concept mappings. Metaphors, which use language to convey meanings beyond their literal interpretations, illustrate the conceptual mappings between target and source domains. These mapping patterns reveal the unique cognitive perspectives of speakers toward specific concepts. As such, metaphors serve as valuable tools for cognitive analysis, as further detailed in Section 3. MetaPro[6] [31] is employed to identify metaphorical expressions from text and parse metaphor interpretation and concept mappings. It includes NLP modules in the tasks of metaphor identification [29], metaphor interpretation [30], and concept mapping generation [15].

In this work, we try to answer the question: What are the representative cognitive patterns of CEOs that result in stock prices having a constant or fluctuating rate of growth or decline? The major findings are as follows: (1) CEOs in consistently stock-price-growing companies emphasize action and optimism. The metaphorical concept mappings also suggest a high valuation of stability and quality, linking them to sustained growth through public confidence. (2) Companies with fluctuated growth rates in stock prices share some cognitive patterns with consistently growing companies. However, presenting achievements without future direction creates uncertainty and contributes to fluctuating stock trends. (3) Predominantly negative cognitive patterns among decision-makers in companies experiencing fluctuating declines. Delayed decision-making and instability, fostering a perception of ineffectiveness. However, occasional positive mappings provide temporary optimism, which creates minor fluctuations in an otherwise declining trend. (4) The absence of forward-looking actions in cognitive patterns leads to a consistent negative market trend, as stakeholders remain skeptical about the company's future. In our analysis, the term "CEO" is used as a synecdoche, representing not merely the individual holding the title but the collective decision-making and strategic intent of the company's senior leadership. As the public face of corporate strategy and performance, the EO symbolizes the entire top-level management's vision and actions. Decisions attributed to the CEO, especially those articulated in formal communications such as the "Letters to Shareholders", are often shaped collaboratively by the executive team, including the Chairman of the Board, CFO, and other key leaders. Thus, the term "CEO" in our paper embodies the strategic mindset of the entire executive leadership rather than a single individual acting in isolation.

[6] https://metapro.ruimao.tech/

Regarding the fact that the "Letter to Shareholders" may be written by a secretary or other professional writer, it is important to understand that: Although a secretary or communication professional may assist in drafting the "Letter to Shareholders", such letters are nonetheless a reflection of the core strategic messages intended by the company's top-level decision-makers. These letters undergo rigorous reviews by the CEO and other senior executives to ensure that they accurately convey the company's priorities, vision, and performance narrative. The content is thus an authentic representation of the company's official stance and reflects the collective perspective of its executive leadership. The drafting process involves aligning with the strategic insights and directives provided by top-level decision-makers, meaning that even if the exact wording is developed by someone other than the CEO, the essence of the message represents the will and intention of the company's highest leadership.

Together, we argue that the cognitive patterns analyzed in these shareholder letters genuinely represent the thinking and strategic orientation of the company's executive leadership, regardless of whether the letter is written directly by the CEO or by another member of the team.

2 Related Work

2.1 Cognitive Analysis for CEOs' Speeches

Various studies have explored CEOs' cognition to understand how their mental processes influence organizational outcomes. Calori et al. [3] used in-depth interviews to create cognitive maps, identifying key industry concepts and their interconnections. Kiss et al. [18] demonstrated through surveys and experiments that cognitively flexible CEOs perform more persistent and effortful information searches. Eggers and Kaplan [12] conducted a longitudinal study using content analysis of CEOs' letters to shareholders to examine how CEO attention influences strategic decisions. Li et al. [23] used panel regression analysis to show that CEOs with higher cognitive abilities boost both performance and CSR efforts in SMEs. Fernández-Pérez et al. [14] explored how CEO temporal focus affects organizational ambidexterity, showing that balancing a future and present focus enhances ambidexterity. Analyzing CEOs' speeches has been pivotal for predicting stock prices, with sentiment analysis being the most commonly employed technique in this domain [5, 6, 8, 10, 25, 34]. Researchers [2, 24, 38] have analyzed correlations between the sentiment of CEO speech transcripts and stock prices. Baker and Wurgler [1] highlighted the role of investor sentiment in stock market fluctuations. Leitch and Sherif [22] examined the relationship between Twitter sentiment on CEO succession announcements and stock returns.

While these studies provide valuable insights, they often focus on sentiment analysis or vocal cues without delving into the deeper cognitive processes underlying CEOs' communications. Our study goes beyond sentiment analysis by employing metaphorical concept mappings to reveal the cognitive patterns of CEOs and their relationship with stock market performance.

2.2 Application of Conceptual Metaphor Theory

Conceptual metaphors have been widely used in cognitive analysis, particularly in political discourse. Charteris-Black [9] contrasted the use of metaphors in British and American political discourse. Negro [37] analyzed metaphors describing political corruption in the Spanish press. Koller [19,20] examined metaphors in leadership and management, focusing on war metaphors' impact on perceptions of female leadership. With advancements in computational metaphor processing, researchers have uncovered deep cognitive insights by examining how metaphors map concepts. Han et al. [16] and Mao et al. [26,33,35] used computational methods to investigate cognitive patterns among financial analysts, public responses to weather disasters, and mental health indicators, demonstrating the impact of metaphors on perception and decision-making.

Despite progress in metaphor processing, comprehensive cognitive analysis related to CEOs' thinking has not been extensively explored with these advanced methods. Our study leverages MetaPro to fill this gap, providing a scalable, automated approach to uncover metaphorical concept mappings in CEO speeches and letters to shareholders, and their correlation with stock market trends.

3 Preliminaries

3.1 Conceptual Metaphor Theory

Metaphors are a fundamental aspect of our everyday language use. Conceptual Metaphor Theory, as proposed by Lakoff and Johnson [21], suggests that metaphors not only enrich our linguistic expressions but also reflect our cognitive processes by mapping elements from a concrete or familiar source domain onto an abstract or complex target domain. This cognitive mechanism allows us to grasp and communicate intricate ideas more effectively. For instance, in the metaphor "I spent two days learning baking", the concrete notion of MONEY (source domain) is used to describe the abstract notion of TIME (target domain), implicating the idea that TIME IS MONEY[7] and highlighting the value of time through the metaphor of financial expenditure. They argued that without metaphors like "magic, attraction, madness, union, nurturance", our understanding of LOVE would be incomplete.

There are several reasons why metaphors are valuable for studying cognition. First, the distinctive patterns of conceptual mappings between source and target domains can reveal unique cognitive processes among individuals. Individuals may employ different metaphors to explain their unique cognitive perspectives on concepts. These distinct cognitive frameworks are likely shaped by personal experiences and cultural influences. Second, examining metaphorical expressions from everyday language provides higher ecological validity compared to traditional interview-based psychological assessments, as it captures how people

[7] In this work, the mapping relationship between a target and a source concept is represented as the form of "a target concept is a source concept.

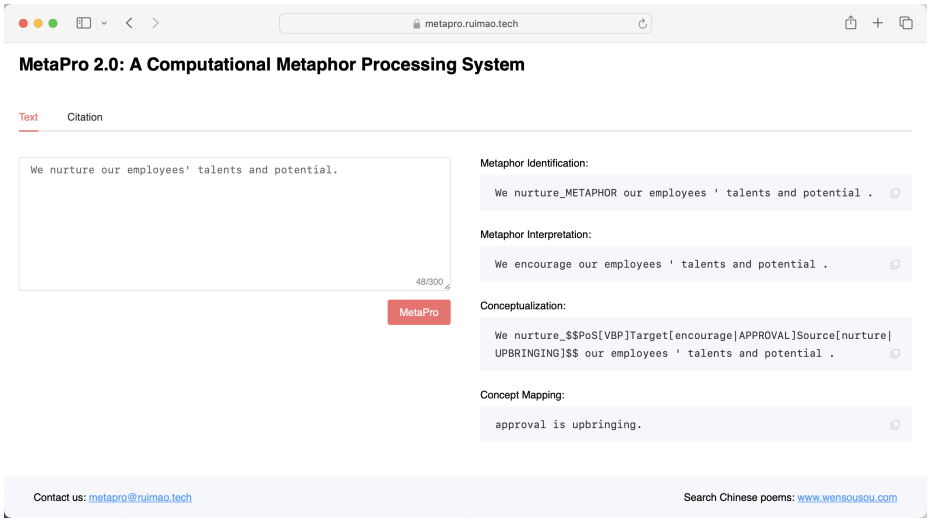


Fig. 1: An example output from MetaPro.

naturally think and communicate in real-world contexts. Third, the advent of automated tools for metaphor processing facilitates large-scale cognitive studies, making it possible to analyze data from extensive corpora and derive insights that are more representative of broader populations [7].

In summary, metaphors serve as a bridge between the familiar and the abstract, enhancing our ability to understand and articulate complex ideas. They offer a powerful lens through which to study cognitive processes, providing a rich source of data that reflects natural language use and enabling large-scale analysis through modern computational techniques.

3.2 MetaPro

In this work, MetaPro is used to parse concept mappings from CEO's speech. Then, the findings are delivered upon the statistics of the concept mappings. MetaPro can identify metaphors and generate concept mappings from an open domain. To our knowledge, it is the only tool specifically designed for metaphor processing that can produce end-to-end concept mappings in an open domain [27]. MetaPro consists of 3 technical modules: metaphor identification [29], metaphor interpretation [30], and concept mapping [15]. The latest version of MetaPro is enhanced by a novel pre-training task, termed anomalous language modeling [28]. The detailed algorithms and evaluation can be viewed from these works.

The computational process of MetaPro can be explained from Figure 1. Given an input, "we nurture our employees' talents and potential", MetaPro first identifies "nurture" is a metaphor. This is achieved by a multitask learning framework [29], which identifies both metaphoricity and Part of Speech (PoS) for each token. The PoS tagging task works as an auxiliary task that enhances

Table 1: Data Statistics. # denotes "the number of".

		Text
Raw Text	# speeches	222
	# companies/CEOs	14
	Avg. len. of speeches	4,131
MetaPro Output	# concept mappings	40,880
	# unique concept mappings	10,245
	# unique source concepts	1,182
	# unique target concepts	1,016

the metaphor identification accuracy, meantime, it provides useful knowledge for the following metaphor interpretation task. Next, the metaphor interpretation module paraphrases the identified metaphor, e.g., "nurture" into its literal counterpart "encourage". Such linguistic paraphrasing can enhance the natural language understanding ability for downstream tasks [4, 32]. The paraphrased text serves as the seed word for generating the target concept in the subsequent concept mapping phase. This paraphrase is predicted from a pre-trained language model, which identifies the most probable word to appear at the position of the identified metaphor [30]. The word is one of synonyms or hypernyms of the original metaphor, sharing the same PoS, where the synonyms and hypernyms are obtained from WordNet [13]. Finally, the concept mapping module abstracts the target concept from the paragraph word; the source concept is abstracted from the original metaphor [15]. The target concept represents the domain that is being understood or explained through the metaphor. It is the concept that the metaphor is intended to illuminate. The source concept represents the domain that provides the conceptual framework through which the target domain is understood. It is the familiar domain that is used to make sense of the unfamiliar or abstract target concept. In the example in Figure 1, the target concept, APPROVAL, and the source concept, UPBRINGING are abstracted from "encourage" and "nurture", respectively, representing the underlying conceptual domains and their mapping relationship, e.g., APPROVAL IS UPBRINGING. The metaphor conveys the speaker's endorsement of the employees' talents and potential by means of supporting their career development.

4 Data

In this study, we analyzed speeches from "Letters to Shareholders" authored by the CEO or Chairman of the Board of Directors, with the objective to gain insights into the cognitive frameworks of top decision-makers. To enhance the depth and breadth of our analysis, we selected companies from diverse sectors, including Investment Banking, Technology, and Energy. We collected letters from 2008 to 2024, covering 14 leading companies in these three sectors (see Table 1). This period was specifically chosen to capture the transition from high sentiment

during the 2008 market crash and its aftermath, through a stable period of low sentiment, to another period of high sentiment in 2020. These sentiment transitions provided a compelling timeline for analysis, as demonstrated in the works of Baker and Wurgler [1].

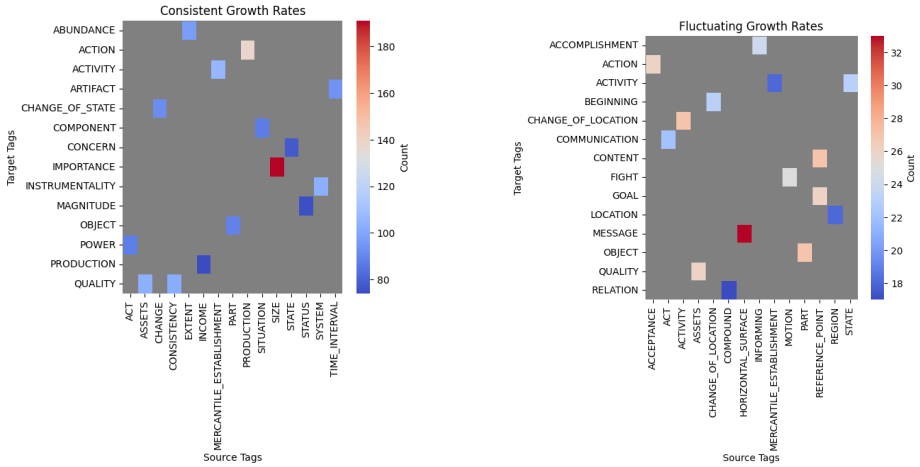
5 Findings

We conducted an analysis of the data to identify metaphors and correlate them with the cognitive processes of CEOs. By employing statistical methods on the results derived from the metaphor analysis, we examined trends in the company's stock prices to categorize the companies into distinct groups, namely companies with consistent growth rates, fluctuating growth rates, fluctuating decline rates, and consistent decline rates. This classification allowed us to systematically explore the relationship between the metaphors used by CEOs and the resulting impacts on company performance, as reflected in stock price movements.

Following the Consistent/Fluctuating Rates of Growth/Decline, we applied a meticulously curated criterion to identify representative target-to-source concept mappings. These mappings, characteristically found within each category, significantly influence public opinion and provide insight into the cognition of decision-makers within these companies. Representative target-to-source concept mappings were identified by normalizing the frequencies of all target-to-source concept mappings and selecting mutually exclusive keys within the first quartile of these normalized frequencies. This ensured that the selected mappings were characteristic of the given category. For the remaining common keys, we employed a threshold to filter out those without significant overlap with other categories. This method allowed us to isolate the key cognitive patterns that distinguish each group, thereby offering a deeper understanding of how executive cognition shapes corporate strategies and public perceptions.

Figure 2a illustrates that decision-makers predominantly focus on taking action in challenging situations and maintaining an optimistic outlook, rather than expressing concern. This cognitive pattern is evident from the warm regions corresponding to the ACTIVITY IS MERCANTILE_ESTABLISHMENT, ACTION IS SITUATION, and IMPORTANCE IS SIZE mappings, while cooler regions are observed in the CONCERN IS STATUS mappings. An additional factor contributing to the positive market trends for companies in this category is the connotation of quality associated with consistency, where quality is perceived as an asset. This cognitive pattern is reflected in the higher frequency of QUALITY IS CONSISTENCY and QUALITY IS ASSETS mappings.

These metaphorical concept mappings suggest that decision-makers in consistently growing companies prioritize stability and value, thereby reinforcing public confidence and contributing to sustained growth. This emphasis often attracts large-scale investors and, due to the herding phenomenon, other investors are inclined to follow [17]. Figure 2b reveals that companies with fluctuating growth rates convey connotations similar to those of companies with consistent ones. However, concept mappings in these companies indicate different nuances.



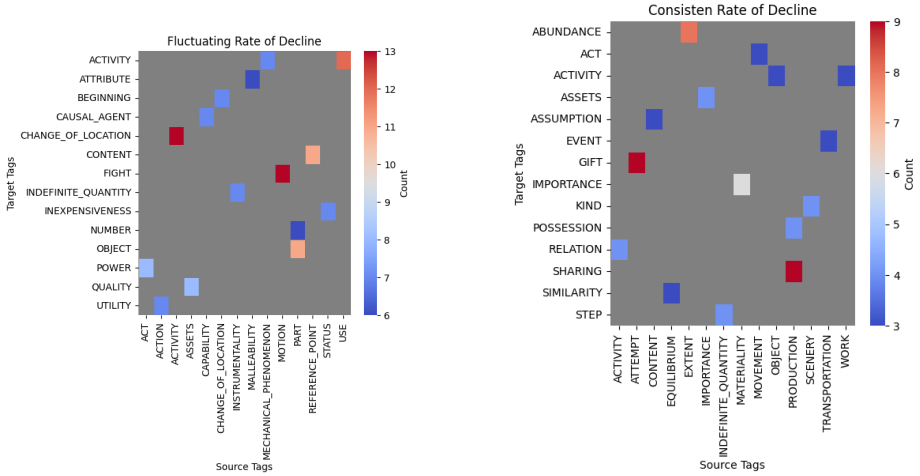
(a) Consistent Rate of Growth. (b) Fluctuating Rate of Growth.

Fig. 2: Growth categories concept mappings.

For instance, the FIGHT IS MOTION mapping suggests a delay in conflict resolution, indicating that issues are acknowledged but not promptly addressed, while ACCOMPLISHMENT IS INFORMATION highlights the communication of achievements to the public, yet this information is presented without references to future implications or plans, creating uncertainty about the company's future direction.

These cognitive patterns imply that while the companies project a positive image by acknowledging achievements, the lack of clarity and delayed resolutions may lead to public skepticism regarding long-term stability and growth. A similar instance was found in the study Zhou, Xu and Zhao [40]. This uncertainty is reflected in the fluctuating stock trends, as investors and stakeholders may find it challenging to maintain confidence in the company's sustained success. By understanding these metaphorical mappings, we can better comprehend the underlying factors contributing to the fluctuating growth rates and the resultant market behaviors. Figure 3a shows that many concept mappings in the letters to shareholders, reflecting the cognition of decision-makers in companies within this category, carry negative connotations. Concept mappings like CASUAL_AGENT IS CAPABILITY, FIGHT IS MOTION, and CHANGE_OF_LOCATION IS ACTIVITY depict an image of delayed decision-making, instability, and insufficient seriousness in critical activities.

These negative cognitive patterns contribute to an overall perception of ineffectiveness and volatility. However, the presence of some redeeming concept mappings, which are typically found in companies with positive growth rates, introduces fluctuations within the otherwise negative market trends. These positive mappings provide intermittent stability and optimism, temporarily alleviating the negative perceptions. Understanding these cognitive patterns helps explain the inconsistent performance and market behavior observed in compa-



(a) Fluctuating Rate of Decline. (b) Consistent Rate of Decline.

Fig. 3: Decline categories concept mappings.

nies experiencing a fluctuating decrease. The negative connotations trigger loss aversion behavior among investors. However, due to the gambler's fallacy, which arises from certain redeeming qualities, fluctuations are inevitable [11].

In Figure 3b (the heat map for consistent decrease), although there are no frequent concept mappings that leave a distinctly negative impression, there is a notable and subtle difference from other categories. Mappings such as IMPORTANCE IS MATERIALITY, GIFT IS ATTEMPT, POSSESSION IS PRODUCTION, EVENT IS TRANSPORTATION, and ABUNDANCE IS EXTENT, while carrying positive connotations, fail to imply any significant achievements, conflict resolutions, or future plans [39]. This results in an unclear and often deceptive portrayal of the company's operations and decision-making processes. This lack of clarity and direction is a contributing factor to the consistently negative market trends observed in these companies. The subtle yet significant absence of forward-looking or resolute actions in these metaphorical mappings undermines stakeholder confidence, leading to sustained declines in market performance. Once the company is stuck in this trend, it gets difficult to get out of [36].

6 Conclusion

In this work, we leveraged the state-of-the-art cognitive analysis tool, MetaPro to analyze the cognitive states of CEOs. We link the cognitive patterns to the stock market performance of the companies and deliver insightful findings. We found that decision-makers in companies with consistently growing stock prices focus on action, valuing stability and quality, which boosts public confidence and sustained growth.

In contrast, companies with fluctuating growth rates often fail to provide a clear future direction when presenting achievements, leading to uncertainty and variable stock trends. Companies experiencing declining trends typically show negative cognitive patterns like delayed decision-making and instability, perceived as ineffective, though occasional positive insights cause slight improvements in their overall downward trend. A lack of proactive, forward-looking actions in some companies contributes to persistently negative market perceptions and trends, as stakeholders doubt the company's future prospects.

From this analysis, it emerges that the cognitive orientation of CEOs plays a critical role not only in navigating the current business environment, but also in shaping perceptions of companies' future potential. The ability of CEOs to communicate stability, action, and a coherent forward-looking strategy translates directly into the market trust, which in turn influences the financial trajectory of their organizations. This interaction suggests that enhancing CEOs' cognitive consistency in long-term value-driven thinking may be a powerful lever for improving market performance. Thus, developing executive training programs that emphasize strategic foresight, adaptability, and effective communication of vision may offer tangible benefits to companies seeking to improve their market position and achieve sustained growth.

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