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ARTICLE

Effect of Executives' Vigilant Managerial Cognition on Enterprise Resilience: A Natural Language Processing and Machine Learning Analysis

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Abstract
Resilient enterprises thrive under adverse conditions given their preparedness for crises. This study proposes that executives' vigilant managerial cognition is essential for enhancing enterprise resilience. To measure this cognition, the study developed a textual index using machine learning methods and analyzed a sample of Chinese enterprises to assess the impact of executives' vigilant managerial cognition on enterprise resilience. The findings indicate that this cognition is positively related to enterprise resilience, where the relationship is stronger in enterprises with robust internal controls. The primary contribution of this study is the conceptualization of vigilant managerial cognition and its established positive relationship with enterprise resilience. Furthermore, by introducing a novel quantitative measure of managerial cognition through textual analysis and machine learning, the study paves the way for future research on managerial cognition within firms.

摘要
具备韧性的企业通常能在危机前未雨绸缪,即便在逆境中也能维持发展势头。本研究表明,企业高管的忧患型管理认知对企业韧性的提升至关重要。我们首先通过机器学习方法,构造文本指标来衡量高管的忧患型管理认知。然后我们对中国上市公司的样本展开分析,检验高管忧患型管理认知对企业韧性的影响。结果发现高管的忧患型管理认知确实与企业韧性呈正相关系, 而且对于内部控制较强的企业,该作用更强烈。本研究结合文本分析和机器学习构建了衡量管理认知的量化方法,为管理认知的后续研究提供了参考。

Keywords: enterprise resilience; internal controls; machine learning; textual analysis; vigilant managerial cognition
关键词: 忧患型管理认知; 企业韧性; 内部控制; 机器学习; 文本分析

Introduction

To navigate an increasingly turbulent marketplace, enhancing enterprise resilience is crucial (Wulandhari, Budhwar, Mishra, Akbar, Do, & Milligan, 2022). Enterprise resilience refers to the capacity to pursue long-term development and adapt strategies in response to crises, enabling organizations to cope with external shocks (Branzei & Abdelnour, 2010; Hamel & Välikangas, 2003). Executives play a pivotal role in guiding organizations to comprehend evolving situations and make informed decisions (Combe & Carrington, 2015; Crossan, Vera, & Nanjad, 2008). Consequently,

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researchers have begun to investigate the microfoundations of enterprise resilience from the executive perspective, emphasizing managers' personalities and psychological resources (Buyl, Boone, & Wade, 2019; Fang, Prayag, Ozanne, & Vries, 2020; Sajko, Boone, & Buyl, 2020).

Among various executive factors, managerial cognition is a significant element influencing decision-making, strategic choice, and organizational performance (Johnson & Hoopes, 2003; Levy, Beechler, Taylor, & Boyacigiller, 2007). Prior research indicates that positive-focused managerial cognition – such as the perception of opportunities and entrepreneurial alertness – enables executives to seize opportunities and enhance organizational dynamic capabilities (Durán & Aguado, 2022). For instance, prioritizing new product development (e.g., research and development) can help reverse performance declines (He, Huang, & Yang, 2021), while a focus on proactive environmental strategies can drive innovation (Yang, Wang, Zhou, & Jiang, 2019). Conversely, negative-focused cognition, which emphasizes threats and potential failures, is often linked to detrimental emotions such as self-blame and catastrophizing (van Wijk-herbrink, Andrea, & Verheul, 2011) and has been criticized for potentially stifling innovation (Plambeck, 2012). However, recent research has revealed that managers' attention to negative signals can be crucial for problem prevention and enhancing proactivity (Gao, Liu, Zhao, Fu, & Schriesheim, 2024). Therefore, it is essential not to dismiss negative-focused managerial cognition outright. The key consideration is the ability to manage negative signals from a vigilant perspective, using them as a basis for proactive and well-prepared responses.

As enterprise resilience relies on long-term, future-oriented capabilities to prepare for potentially disruptive events (Duchek, 2020; Sanchis, Canetta, & Poler, 2020; Sanchis & Poler, 2019), executives must consider potential negative outcomes and prepare before crises arise. This approach aligns with traditional philosophies, such as 'forewarned is forearmed' (derived from the Latin proverb *praemonitus, praemunitus*) and the Chinese philosophy of 'being vigilant in peacetime', which emphasizes the importance of considering potential future crises rather than adopting blind optimism. These philosophies underscore vigilance, which has been historically significant and offers valuable insights for modern managers. Research indicates that executives' vigilance can foster a shared mindset focused on alertness, mindfulness, and precaution – qualities essential for developing resilience (Lengnick-Hall, Beck, & Lengnick-Hall, 2011). This mindset can also ensure continuity in enterprise operations during disruptions (Sincorá, Oliveira, Filho, & Ladeira, 2018). Thus, the positive relationship between vigilance cognition and enterprise resilience suggests that negative-focused managerial cognition can yield beneficial effects.

The concept of 'vigilance' in managerial cognition research is still in its nascent stages. While existing studies have examined leaders' vigilance through vigilant leadership behaviors (Gao et al., 2024), they often focus on microlevel teams, lacking an exploration of how executive vigilance contributes to overall enterprise resilience. Although scholars have identified executives' cognitive capacity as a significant predictor of firm performance (Partlow, Medeiros, & Mumford, 2015; Vries, 2012), there remains a gap in understanding what constitutes vigilant managerial cognition and its impact on enterprise resilience. Therefore, this study aims to explore whether and how vigilant managerial cognition contributes to enterprise resilience, providing new insights into its antecedents. Additionally, recognizing that executives' managerial cognition is often implicit and may encounter organizational resistance, including rigid cognitive frameworks, this study will also investigate the boundary conditions of the relationship between vigilant managerial cognition and enterprise resilience. A critical factor in this relationship is the role of institutions that support managerial decision-making (Leroy, Segers, Van Dierendonck, & Den Hartog, 2018). The extent to which executives' intentions can be translated into actions depends on the institutional support available. Specifically, internal controls – comprising efficient communication, resource coordination, and supervision mechanisms – are essential. Effective internal controls enable executives to execute strategic transformations in a timely and efficient manner (Vogus & Sutcliffe, 2007). Thus, this study will also examine the role of internal controls in the relationship between vigilant managerial cognition and enterprise resilience.

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This study contributes to the understanding of managerial cognition in organizational functioning in several key areas. First, we conceptualize executives' vigilant managerial cognition, demonstrating that a negative-focused perspective can positively impact enterprise resilience. Second, we investigate the antecedents of enterprise resilience through the interaction of managerial cognition and institutional factors, emphasizing that internal controls serve as a critical institutional contingency influencing the relationship between vigilant managerial cognition and enterprise resilience. Third, we offer an empirical contribution by developing a novel quantitative measure of vigilant managerial cognition utilizing machine learning and textual analysis. Finally, the findings provide practical implications for enhancing managers' cognitive capabilities in crisis response and clarify the dynamic managerial skills executives must cultivate to effectively anticipate and manage potential crises.

Theoretical Background and Hypotheses Development

Vigilant Managerial Cognition

Managerial cognition encompasses the beliefs and mental models that inform managerial decision-making (Adner & Helfat, 2003). Research indicates that executives develop subjective psychological representations of their environment, shaping their strategic decisions and organizational actions (Nadkarni & Barr, 2008). Studies have highlighted that a positive focus on managerial cognition correlates with improved innovation and performance (Durán & Aguado, 2022; Yang et al., 2019). This perspective aligns with Teece, Pisano, and Shuen (1997), who argued that a firm's capabilities depend on available opportunities and resources, with managers' cognition influencing the types of resources they seek (Danneels, 2011).

Conversely, the significance of negative-focused managerial cognition has been less explored, though some suggest that minimizing attention to negative information may be advantageous (Plambeck, 2012). However, other viewpoints assert that a top management team's awareness of threats and negative signals is crucial for driving organizational change (Staw & Dutton, 1981). This awareness is vital for organizations to respond effectively to turbulent environments and crises (Duchek, 2020). Therefore, negative-focused cognition should be viewed dialectically, suggesting that its effectiveness relies on managers' ability to interpret and respond to negative signals appropriately. Rather than adopting passive strategies in response to challenges, vigilance and proactive preparation are essential. Recent studies indicate that leaders' vigilance can aid organizations in preemptively addressing potential issues (Gao et al., 2024). This suggests that examining managerial cognition in relation to vigilance may yield new insights into the beneficial aspects of negative-focused cognition.

Vigilance has long been a focus within academia. Some studies define vigilance in terms of maintaining attention on management practices, such as decision vigilance (Tsai, 2015) and attention vigilance (Rhee, 2024), emphasizing managers' external behaviors in specific contexts. Other research explores vigilance from leadership perspectives, aiming to characterize the enduring vigilance of managers. For example, Day and Schoemaker (2006, 2008) introduced the concept of vigilant leadership, while Manuel (2018) proposed 'leadegilance', which merges leadership and vigilance to highlight a managerial style focused on monitoring organizational compliance. However, these concepts often lack rigorous academic definitions and theoretical frameworks regarding how vigilant traits impact organizational objectives. Gao et al. (2024) formally introduced vigilant leadership, distinguishing it from existing concepts and establishing a novel leadership style. Nonetheless, this concept remains concentrated on microlevel team management, addressing behaviors between managers and immediate subordinates rather than serving as a psychological foundation influencing strategic changes and dynamic capabilities at the enterprise level. Given that managerial cognition is recognized as a microfoundation of dynamic capabilities (Helfat & Martin, 2015), a focus on vigilance within managerial cognition, particularly regarding potential threats, represents a key advancement in explaining organizational resilience.

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The primary objective of introducing the concept of vigilant managerial cognition is to clarify its essence (Copi, Cohen, & Rodych, 2019). Helfat and Martin (2015) summarized managerial cognition's fundamental components, which include knowledge structures, cognitive capabilities, and emotional regulation. Knowledge structures influence leaders' biases and heuristics, affecting their anticipation, comprehension, and responses in dynamic environments. Cognitive capabilities pertain to the ability to engage in cognitive activities, while emotional regulation is essential for guiding behavioral responses in management. In summary, vigilant managerial cognition emerges from the interplay between managerial vigilance and dynamic managerial capabilities (Gao et al., 2024; Helfat & Martin, 2015). According to dynamic capability theory, enterprise resilience is a form of dynamic capability (Duchek, 2020; Hamel & Välikangas, 2003). Since dynamic managerial capabilities, such as managerial cognition, form the microfoundations of dynamic capabilities (Helfat & Martin, 2015), examining vigilance through the lens of managerial cognition offers a more effective explanation of the relationship between vigilance and resilience than other concepts.

Vigilant managerial cognition distinguishes itself from other forms of managerial cognition, such as managerial hubris (Li & Sullivan, 2020) and sustainability orientations (Lei, Wu, & Fu, 2019), by its specific emphasis on vigilance. The Latin root of 'vigilance', *vigilia*, reveals interconnected aspects: wakefulness and watchfulness (Lewis & Short, 2002). Semantically, it connotes precaution and proactive responses to signals of potential threats or crises. This connotation suggests three essential attributes of vigilant managerial cognition: it is negative-focused, future-oriented, and precaution-oriented.

Building on existing descriptions of leaders' vigilance (Gao et al., 2024), we define vigilant managerial cognition as the managerial cognition that supports managers' awareness, detection, and precaution toward negative signals that may indicate future crises, including problems, threats, dangers, challenges, and setbacks at both strategic and individual employee levels. The functionality of vigilant managerial cognition aligns with the sensing-seizing-reconfiguring framework (Teece, 2007) and incorporates three key components of managerial cognition (Helfat & Martin, 2015; Helfat & Peteraf, 2014). First, knowledge structures serve as mental templates for processing external information, enabling managers to detect potential threat signals (sensing). Second, managerial cognitive capabilities facilitate the mental processing of these signals (seizing). Third, emotional reactions – where individuals typically act based on their emotions at the time of decision-making – prompt managers to implement reconfiguration as a precaution against potential threats (Hodgkinson & Healey, 2011). In summary, vigilant managerial cognition encompasses the full spectrum from detecting potential issues to implementing precautionary measures.

It is important to clarify that vigilant managerial cognition pertains to managers focusing on negative signals, rather than reflecting an inherent negativity about themselves. This distinction aligns it with other existing negative-focused concepts, such as prevention focus (Crowe & Higgins, 1997), and allows it to coexist with positive-focused concepts. For example, while positive-focused managerial cognition, such as vision articulation, encourages opportunity-seeking, negative-focused cognition, such as vigilance, facilitates the navigation of potential pitfalls during opportunity-seeking (Gao et al., 2024). These two types of managerial cognition are not mutually exclusive; rather, they can coexist and collaboratively contribute to optimal outcomes.

The concept of vigilant managerial cognition is distinct from existing frameworks. Table 1 illustrates the differences between vigilant managerial cognition and related concepts such as prevention focus, pessimism, transformational leadership, attention vigilance, and management-by-exception. First, while both vigilant managerial cognition and prevention focus emphasize negative outcomes, prevention focus is limited to basic goals, such as responsibility (Crowe & Higgins, 1997; Freitas, Liberman, Salovey, & Higgins, 2002), and relies on an avoidance strategy characterized by lower openness to change (Liberman, Idson, Camacho, & Higgins, 1999). In contrast, vigilant managerial cognition adopts a precautionary strategy that prepares for worst-case scenarios, prompting managers to implement changes in anticipation of future crises (Gao et al., 2024). Consequently,

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Table 1. Comparing vigilant managerial cognition with other concepts

Concept	Definition	Commonalities	Differences
Prevention focus	The self-regulatory principle concerned with safety, responsibilities, and obligations in the goal-attainment process (Crowe & Higgins, 1997)	Negative-focused	Prevention focus adopts avoidance as a strategy and has low openness to change, while vigilant managerial cognition employs precaution as a strategy, prompting managers to change for potential crises.
Pessimism	The anticipation of bad things to happen in the future. The pessimist observes mainly the negative aspects of everything around and is likely to have little hope for the future (Hecht, 2013)	Negative-focused	Pessimism adopts passive actions toward negative information, while vigilant managerial cognition takes proactive actions.
Transformational leadership	The leadership behaviors that stimulate subordinates' creativity, identification, and motivation through charisma, intellectual inspiration, intellectual stimulation, and individualized consideration in complex environments (Bass, 1985)	Future-oriented	Vigilant managerial cognition is negative-focused, while transformational leadership is positive-focused.
Attention vigilance	The process by which individuals sustain concentration on a particular stimulus (Rhee, 2024)	Attention-oriented	Attention vigilance focuses on allocating attention to various signals, while vigilant managerial cognition focuses only on future negative signals.
Management-by-exception	The supervision of task completion and dealing with any problems that might arise and correcting them to maintain performance (Schweitzer, 1980)	Negative-focused	Management-by-exception actively focuses on current issues, while vigilant managerial cognition focuses on future issues.

although both focus on negative signals, the nature of their concerns differs. Managers with a prevention focus worry about the negative consequences of not meeting responsibilities, leading them to maintain the status quo. Conversely, those with vigilant managerial cognition are concerned about the risks of failing to change, which motivates them to alter the status quo to prepare for crises. Thus, prevention focus tends to evade crises without altering conditions, while vigilant managerial cognition actively promotes precautionary measures.

Second, while vigilant managerial cognition and pessimism both concentrate on negative signals, they differ in outlook. Pessimism tends to lack hope for the future, fixating on negative aspects. In contrast, individuals with high vigilant managerial cognition acknowledge negative signals but maintain a proactive belief in addressing future crises. Therefore, pessimism does not positively influence organizational resilience, whereas vigilant managerial cognition fosters it. Third, both vigilant managerial cognition and transformational leadership are future-oriented; however, their focuses diverge. Vigilant managerial cognition prioritizes negative signals that may indicate future crises, while transformational leadership emphasizes positive signals and motivates subordinates through charisma and vision (Bass, 1985; van Knippenberg & Sitkin, 2013). The former encourages risk management and precautionary changes, while the latter promotes changes aimed at achieving ideal goals. Despite empirical evidence suggesting their coexistence (Gao et al., 2024), their impact processes are rooted in different organizational aspects. Fourth, vigilant managerial cognition may be confused with attention vigilance. The primary distinction is that attention vigilance allocates attention to various signals, whereas vigilant managerial cognition concentrates on future-oriented negative signals. This leads to divergent impacts: in adverse conditions, attention

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vigilance encourages comprehensive situational understanding, which is often beneficial (Rhee, 2024). Conversely, the effectiveness of vigilant managerial cognition may be more pronounced during periods of growth than during stagnation or decline (Gao et al., 2024). Thus, possessing vigilant managerial cognition prior to a crisis is often more critical than employing it post-crisis, contrasting with the effectiveness of attention vigilance during crises. Finally, vigilant managerial cognition differs from management-by-exception, a component of transactional leadership (Bass, 1985). Management-by-exception prompts leaders to respond to current or impending problems. In contrast, leaders exhibiting vigilant managerial cognition possess the cognitive ability to identify weak and ambiguous signals of future threats during stable periods, preparing for potential issues. Unlike those who passively await problems, vigilant managers actively target and address possible negative situations before crises arise. Therefore, management-by-exception typically responds when a crisis first emerges, while vigilant managerial cognition is proactive in crisis anticipation. In summary, vigilant managerial cognition is characterized by its unique focus on and response to future negative probabilities, distinguishing it from other management cognition constructs.

Executives' Vigilant Managerial Cognition and Enterprise Resilience

Teece's (2007) sensing-seizing-reconfiguring model clarifies the impact of vigilant managerial cognition on enterprise resilience. Executives' ability to sense future-oriented negative signals, seize relevant information, and reconfigure resources shapes this resilience. Any disruption in this cognitive flow impedes the formulation of preventive measures against potential crises and undermines enterprise resilience. Vigilant managerial cognition comprises three components: knowledge structures, cognitive capabilities, and emotions (Helfat & Martin, 2015).

Executives identify latent threat signals through their knowledge structures, which serve as mental templates for organizing information within an environment (Walsh, 1995). These structures enable executives to interpret complex information, thereby facilitating the processing of future-oriented negative signals (Helfat & Martin, 2015). The subsequent seizing of organized negative information relies on cognitive capabilities, allowing executives to interpret and derive meaning from these signals, thus maintaining a focused perception of potential crises (Weber & Johnson, 2009).

The reconfiguring aspect of vigilant managerial cognition predominantly involves emotional processes. Managers' emotions significantly influence organizational attention and responses. Decision-making is often driven by emotions experienced during choices, informed by mental images of potential outcomes (Hodgkinson & Healey, 2011). Managers with vigilant managerial cognition possess precaution-oriented goals, generating emotional responses that facilitate the integration and reconfiguration of organizational resources in anticipation of crises. As Helfat et al. (2007) discuss in their examination of 'asset orchestration', executives are crucial in resource allocation. Thus, vigilant managerial cognition motivates executives to act within established routines, effectively addressing gaps and enhancing enterprise resilience.

Overall, vigilant managerial cognition encapsulates the full framework of sensing-seizing-reconfiguring, with knowledge structures, cognitive capabilities, and emotion regulation forming its foundation. This cognition impacts enterprise resilience by guiding the reception, processing, and response to signals, thereby enabling effective reconfiguration in the face of threats. However, a concern arises regarding the potential overkill effect of vigilant managerial cognition, wherein an excessive focus on negative threats may hinder executives' recognition of other information. This study posits that vigilant managerial cognition enhances executives' understanding of potential threats while maintaining their capacity to process diverse information. Stronger cognitive capabilities enable executives to manage an increased volume of threat-related information without detracting from their ability to process other relevant data. Furthermore, knowledge structures aid in assessing the urgency and severity of threats, allowing executives to identify critical issues effectively and prepare proactively. While over-preparation may lead to resource constraints, vigilant executives

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should consider this risk in their planning. Hence, this study posits a linear relation between vigilant managerial cognition and enterprise resilience. Thus, the first hypothesis is:

Hypothesis 1 (H1): Executives' vigilant managerial cognition positively relates to enterprise resilience.

Moderating Role of Internal Controls

The effectiveness of executives' vigilant managerial cognition in shaping enterprise resilience largely depends on leaders' preparedness prior to a crisis. While preparedness plans can enhance crisis response, their impact is often limited. Enterprise resilience is influenced by a diverse set of mechanisms that integrate management activities and institutional frameworks (Helfat & Martin, 2015; Huy & Zott, 2018). Strong institutions can expedite consensus-building among leaders and followers regarding necessary adjustments during crises (Carrington, Combe, & Mumford, 2019). Internal controls serve as institutional arrangements that mitigate business risks by optimizing resource allocation (Haelterman, 2020), thus enhancing the impact of executives' vigilant managerial cognition on enterprise resilience. Specifically, internal controls comprise a comprehensive system that includes the internal environment, risk assessment, control activities, information disclosures, and internal supervision (Li, Wang, Wu, & Zhou, 2021). A rational arrangement of these elements promotes executives' efficient sensing, seizing, and reconfiguring of latent threat signals.

In the context of vigilant managerial cognition, executives engage with the external environment primarily through initial signal sensing and final reconfiguration. Internal controls reinforce this cognition within organizational institutions, particularly during these two stages, facilitating a more effective and flexible environment for information input and behavioral output. Although all five components of internal controls strengthen these stages, each has distinct emphases. Effective risk assessment and internal supervision significantly enhance signal transmission to executives. Risk assessment entails a comprehensive mechanism for identifying, analyzing, and tracking risks. Internal supervision includes daily oversight, identification and disclosure of internal control defects, and evaluation of controls. Rigorous risk assessment and supervision reveal misconduct, especially amid imminent or ongoing crises (Haelterman, 2020), enabling executives to detect hidden threats and make informed decisions.

Moreover, a favorable internal environment and robust control activities empower executives to reconfigure resources and strategies effectively. The internal environment encompasses governance structures, audit processes, cultural values, and social responsibility policies. Control activities relate to management's capabilities in job allocation, authorization, accounting, asset protection, performance evaluation, and major risk management. A strong governance environment and control system reduce resistance for executives when integrating resources and strategies (Ge, Li, Liu, & McVay, 2020), significantly enhancing actions taken in response to threat signals and thereby boosting enterprise resilience. Additionally, information disclosures – which include internal and external communication, application of information technology, anti-fraud mechanisms, and grievance procedures – are crucial for both information input and behavioral output for executives. Effective communication enhances transparency and reduces information asymmetry within the enterprise (Doyle, Ge, & McVay, 2007), allowing executives to access high-quality information and improve understanding accuracy. Furthermore, information interchange provides institutional support for aligning overarching goals across different organizational units (Helfat & Peteraf, 2014).

Consistent handling of potential threat signals helps executives communicate vigilance throughout the organization, facilitating upward influence from management-level cognition to enterprise-level strategic transformation. Overall, internal controls represent a composite system of interdependent components; the absence of any single component can compromise the effectiveness of other institutional arrangements. These components complement one another, enhancing the accuracy of

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signals perceived by executives and promoting effective reconfiguration. Consequently, the impact of vigilant managerial cognition is more pronounced within a robust internal control system. We, hence, propose the second hypothesis:

Hypothesis 2 (H2): The relationship between executives' vigilant managerial cognition and enterprise resilience is more positive with sound internal controls.

Methods

Sample

We utilized the COVID-19 pandemic as our research context. It triggered the worst global recession since World War II (Saif & Ruan, 2021), resulting in complex economic challenges with far-reaching consequences. Crises typically exhibit five characteristics (Fishman, 1999): unpredictability, significant threats to organizational values, unexpectedness, urgency, and complex dynamics involving multilateral relationships. The COVID-19 pandemic embodies all these characteristics, indicating its representativeness. Reports indicate that COVID-19 began to materially impact Chinese enterprises in mid-January 2020 (Huang, Chen, & Nguyen, 2020).

Following DesJardine, Bansal, and Yang (2019), who employed a 12-month observation period post-crisis to measure enterprise resilience through stock prices, we analyzed stock prices from January 15, 2020 to January 15, 2021. This period accounts for the seasonality of COVID-19, characterized by higher infection rates in winter and lower rates in summer, along with seasonal population movements such as Spring Festival travel, which intensified epidemic control measures. We assessed executives' vigilant managerial cognition using data from the 2019 annual reports of China's listed companies. Given the time lag between the annual report content and the onset of COVID-19 in early 2020, the pandemic did not uniformly affect all industries. For instance, the healthcare sector absorbed many social resources, while the popularity of remote work and online education spurred growth in internet-related industries. Thus, we selected enterprises from eight severely affected industries – agriculture, mining, manufacturing, energy, construction, wholesale and retail, transportation, and accommodation and catering – based on the industry classification provided by STOCKSTAR, a Chinese stock-data website.

Data processing involved four steps: (1) We consulted the management discussion and analysis (MD&A) sections of the annual reports for A-share listed companies from 2005 to 2019 using WinGo, a Chinese financial data platform. This dataset trained our study's machine-learning model to extract text indices related to vigilant managerial cognition. (2) We employed crawler software from houyicaiji.com to obtain stock codes and names of listed companies from STOCKSTAR, calculating the vigilant managerial cognition indices based on the 2019 annual reports. (3) We used Tushare, a Python package for financial data acquisition (www.tushare.pro), to obtain stock prices and other financial data (e.g., total assets and liabilities) for the observation period. (4) After calculating enterprise resilience and other relevant variables from the raw data, we eliminated samples with missing values, resulting in 1,644 valid samples. The data, syntax, and study materials are available on the Open Science Framework at https://osf.io/hjzye/?view_only=8196c9f7b938432b9bd1ca40fd9bfae0

Measures

Executives' vigilant managerial cognition

Existing studies indicate that natural languages can reflect leaders' cognition (Pennebaker, Mehl, & Niederhoffer, 2003). This perspective has led to several fruitful findings in the literature (Cao, Yang, & Liu, 2021; Caserio, Panaro, & Trucco, 2019; Davis & Tama–Sweet, 2011). More recently, researchers have utilized the MD&A corpus to evaluate executives' cognitive capabilities (Certo, Jeon, Raney, & Lee, 2022). Drawing on prior research regarding executives' vigilant managerial cognition (Day & Schoemaker, 2008; Gao et al., 2024) and the characteristics of the MD&A Chinese corpus, this

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study employed Word2Vec machine-learning technology to develop a Chinese word set that reflects the vigilant managerial cognition of executives. Subsequently, we constructed a text index using this word set. The machine-learning approach offers several advantages, including the following: It mitigates subjectivity from artificial definitions and weak correlations from synonym-screening tools; The model, trained on the MD&A corpus, fits the context well and possesses good validity; and machine learning efficiently processes large text datasets, ensuring scalability.

A critical section of a company's annual report is the MD&A, which contains executives' analyses of significant historical information and outlines business plans, opportunities, risks, and challenges for the coming year. This study captured vigilant managerial cognition in the MD&A sections of the 2019 annual reports of listed companies in China. The research process included the following steps: First, we developed a Chinese seed-word set reflecting three central aspects of vigilant management: awareness, detection, and precaution. Second, we trained our machine-learning model using the MD&A corpus and Word2Vec technology, specifically the Skip-Gram model, with Python-based training code. Except for a training window size of 200 words, other hyperparameters were set to default values. Given that China revised MD&A content standards in 2005, we incorporated MD&A data from the annual reports of listed companies from 2006 to 2017. Additionally, we included interim annual report data to ensure sufficient data for model training. We segmented the MD&A corpus using Python's Jieba for Chinese word segmentation and filtered out stop words. The resulting text was converted into word vectors for storage. The use of machine-learning techniques allowed us to train the model and ultimately obtain a machine-learning framework (Mikolov, Chen, Corrado, & Dean, 2013). Finally, we calculated vector similarities to identify words similar to the seed-word set, following the principle that 'words with the same context contain similar semantics'. This yielded word vectors with higher cosine similarity for semantically related words in Euclidean space (Mikolov et al., 2013). The cosine similarity formula is as follows:

$$\cos\theta = \frac{\sum_{i=0}^{n}(x_i \times y_i)}{\sqrt{\sum_{i=0}^{n}(x_i)^2} \times \sqrt{\sum_{i=0}^{n}(y_i)^2}} = \frac{X \cdot Y}{|X| \times |Y|},$$

where $X = [x_1, x_2, x_3 \ldots x_n]$ and $Y = [y_1, y_2, y_3 \ldots y_n]$ respectively represent two-word vectors. Considering both similarity and vocabulary size, this study selected an initial word set comprising words with a cosine similarity of 0.60 or higher. Ultimately, 12 seed words were selected, producing an average of 40.17 words per seed word, resulting in a total of 482 words. After removing duplicates, 267 unique words were retained.

Third, we invited two academic experts and two doctoral students in management to participate in the screening and validation of the initial word set. Each participant completed the screening individually, followed by a discussion of the results. This process identified 176 dictionary words that reflect vigilant managerial cognition (see Appendix A). To quantify executives' vigilant managerial cognition, we calculated the ratio of vigilant managerial vocabulary in each MD&A text. A higher index value indicates stronger vigilant managerial cognition among executives. Some firms may employ vigilance-related terms as a structured communication strategy. To mitigate potential interference, we conducted topic modeling analysis on sentences containing vigilant vocabulary in the MD&A, identifying nine clusters (see Appendix H). We calculated frequency vectors of topic words in the MD&A text from semi-annual and annual reports in 2019. The mean cosine similarity of these two vectors was 0.769, and a one-sample t-test revealed a significant difference from 0.8 (Δ Mean = − 0.031, $N = 2113$, 95% CI = [−0.040, − 0.022]). Thus, executives often discuss different themes when using vigilant vocabulary, rather than adhering to a structured communication strategy.

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Enterprise resilience

We adopt the methodology of Ilseven and Puranam (2021) to assess enterprise resilience by examining stock price fluctuations in response to the COVID-19 pandemic. Initially, we employ Holt-Winters exponential smoothing to model the historical stock prices of a company from 2017 to 2019. This model then forecasts stock performance during the pandemic observation period, representing the expected trend had the pandemic not occurred. Ilseven and Puranam (2021) propose measuring resilience by comparing the predicted stock price curve with the actual curve – where irregular, non-linear trends are approximated as linear trends – and calculating the integral of the area between these curves. However, this method sacrifices accuracy by treating non-linear curves as linear. Moreover, the stock trends of many companies do not conform to the patterns assumed in their framework, complicating the application of their approach.

To address this limitation, we utilize computational techniques to calculate the daily differences between the predicted and actual curves during the observation period, thereby achieving an integration-like effect (as described by Ilseven and Puranam, when the actual value is lower than the predicted value, the difference is negative; conversely, when the actual value exceeds the predicted value, the difference is positive). This methodology mitigates inaccuracies associated with approximation. In instances where stock prices are not disclosed daily, we substitute missing values with the most recent non-empty stock price.

Internal controls

We utilize the internal control indexes compiled by DIB, which measure the quality of internal controls in listed enterprises and are widely cited in academic research (Hao, Qi, & Wang, 2018; Li, Zheng, Liu, & Sial, 2018; Zhu & Song, 2021). The index comprises five indicators – internal control evaluation, internal environment synthesis, risk assessment, control activities, and information disclosures – further divided into 31 secondary indicators and 87 tertiary indicators, providing a comprehensive overview of a company's internal controls. To reflect the internal control quality prior to COVID-19, we select the 2019 internal control indexes from DIB. To simplify the data and enhance distribution, we apply the natural logarithm to the internal control indexes, following Yang, Qin, Gan, and Su (2020).

Control variables

The financial health of enterprises prior to the crisis may significantly influence their performance during it. Drawing from the research of DesJardine et al. (2019) and Hu, Song, and Guo (2020), both of whom employed stock prices as a measure of enterprise resilience, we include eight fundamental control variables: enterprise size, age, profitability, financial leverage, capital intensity, operational efficiency, intangible assets, and fixed assets. Additionally, we recognize that pre-pandemic conditions could affect stock trends post-pandemic; therefore, we incorporate environmental uncertainty and stock crash risk as control variables. Environmental uncertainty, linked to resilience performance, is measured using the method proposed by Ghosh and Olsen (2009), while stock crash risk is assessed through negative conditional return skewness (NCSKEW), as introduced by Kim, Li, and Zhang (2011).

Finally, as the dependent variable in this study relates to executives, the stability and heterogeneity of the executive team may impact a company's operations and resilience. We include stability, measured as per Crutchley, Garner, and Marshall (2002), and heterogeneity – encompassing age, occupation, and education diversity. Age heterogeneity is quantified using the coefficient of variation, while occupation and education heterogeneity are measured using the Herfindahl-Hirschman index. Table 2 details the specific variable measurements.

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Table 2. The measures of study variables

Variable	Measure
Vigilant managerial cognition	100%*Word frequency of vigilant managerial cognition vocabulary
Enterprise resilience	Accumulated difference between the predicted and actual values
Internal controls	Natural logarithm of (DIB internal control index + 1)
Enterprise size	Natural logarithm of (total assets + 1)
Enterprise age	Difference between the year of establishment of an enterprise and the year of the observation period
Profitability	Net profit/total assets
Financial leverage	Total liabilities/total assets
Capital intensity	Capital expenditure/total assets
Operational efficiency	Sales revenue/total assets
Intangible assets	Intangible assets/total assets
Fixed assets	Fixed assets/total assets
Environmental uncertainty	Referring to Ghosh and Olsen (2009)
Crash risk	Referring to Kim, Li, and Zhang (2011)
Stability of the executive team	Referring to Crutchley, Garner, and Marshall (2002)
Age heterogeneity of executive team	Coefficient of variation of the age of executives
Occupation heterogeneity of executive team	Herfindahl-Hirschman index of the occupation of executives
Education heterogeneity of executive team	Herfindahl-Hirschman index of the education of executives

Results

Table 3 presents descriptive statistics and correlations for all variables. The average value for vigilant managerial cognition is 0.30, indicating that vigilance-related vocabulary constitutes 0.30% of the total vocabulary in MD&A texts. The average value for internal controls is 6.47. Additionally, the average value for enterprise resilience is − 903.59, suggesting that the average stock performance of enterprises is below expectations. Vigilant managerial cognition is positively correlated with enterprise resilience ($r = 0.06$, $p < 0.05$).

Table 4 reports the results of the multiple regression analysis. Model 1 reveals a positive relationship between vigilant managerial cognition and enterprise resilience ($\beta = 1371.40$, $p < 0.05$). This coefficient indicates the change in a company's stock price resilience (i.e., cumulative losses during the 12-month observation period) when the frequency of vigilant words increases by one percentage point. Model 3 shows a positive relationship between the interaction term of internal controls and vigilant managerial cognition with enterprise resilience ($\beta = 7823.57$, $p < 0.01$). These findings support H1 and H2, demonstrating that higher-quality internal controls enhance the positive effect of vigilant managerial cognition on enterprise resilience.

Bootstrap analysis, a resampling technique, involves randomly drawing multiple subsets from the original dataset and modeling each subset to provide unbiased and stable estimates of performance metrics. We employed this method to further examine the interaction effect. Based on 20,000 bootstrap analyses using the SPSS plugin Process, results indicated that when internal control is at a low level (mean – standard deviation), the effect of vigilant managerial cognition is not significant ($\beta = 100.60$, 95% CI = [−1376.51, 1577.72]). Conversely, when internal control is at a high level (mean + standard deviation), the effect of vigilant managerial cognition is positively significant

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Table 3. Descriptive statistics and correlations

Variable	Mean	Std	VIF	1	2	3	4	5	6	7	8	9	10
1. Vigilant managerial cognition	0.30	0.19	1.04										
2. Internal controls	6.47	0.16	1.15	−0.02									
3. Enterprise resilience	−903.59	8453.47	-	0.06*	−0.01								
4. Enterprise size	12.82	1.42	1.31	0.51*	0.18***	0.04*							
5. Enterprise age	22.80	6.66	1.07	0.12***	−0.04*	0.03	0.22***						
6. Profitability	0.16	0.60	1.37	0.02	0.18***	−0.01	0.06***	0.01					
7. Financial leverage	0.57	0.20	2.60	−0.04†	0.08***	0.08***	−0.30***	−0.13***	−0.07***				
8. Capital intensity	0.31	10.29	1.21	0.00	0.03	0.00	−0.03	0.01	−0.01	0.05**			
9. Operational efficiency	0.69	0.54	1.55	0.02	0.16***	0.03	0.04*	−0.01	0.06**	0.26***	0.07***		
10. Intangible assets	0.05	0.06	1.29	0.04*	−0.03	−0.01	0.09***	0.02	−0.11***	−0.34***	−0.04†	−0.10***	
11. Fixed assets	0.14	0.11	2.02	0.01	−0.03	−0.05*	0.16***	0.01	0.10***	−0.59***	−0.03†	−0.04*	0.05**
12. Environmental uncertainty	1.29	1.13	1.07	0.04	−0.18***	−0.06**	−0.07**	−0.01	−0.18***	−0.03	0.04†	−0.04	0.05†
13. Crash risk	−0.43	0.79	1.01	0.00	−0.02	0.01	−0.01	−0.04*	−0.03	0.02	−0.02	−0.01	−0.01
14. Stability of the executive team	0.86	0.16	1.02	−0.02	0.03	0.03	−0.06**	−0.04*	0.06**	0.09***	−0.04†	0.07***	−0.06**
15. Age heterogeneity	0.13	0.05	1.11	−0.06**	−0.07**	−0.04	−0.23***	−0.05**	−0.11***	0.07***	0.01	−0.07***	−0.02

(*Continued*)

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Table 3. (*Continued.*)

Variable	Mean	Std	VIF	1	2	3	4	5	6	7	8	9	10
16. Occupation heterogeneity	0.70	0.08	1.07	0.01	0.01	−0.03	0.02	0.02	0.01	0.00	−0.01	−0.08***	−0.03
17. Education heterogeneity	0.41	0.23	1.09	−0.09***	−0.03	−0.01	−0.13*	−0.15***	−0.09***	0.08***	−0.02	−0.05*	−0.03
Variable		*11*	*12*	*13*	*14*	*15*	*16*						
12. Environmental uncertainty		−0.02											
13. Crash risk		−0.00	0.00										
14. Stability of the executive team		0.01	−0.05*	0.00									
15. Age heterogeneity		−0.07**	0.09***	0.02	0.01								
16. Occupation heterogeneity		0.01	−0.01	−0.04†	0.05*	0.02							
17. Education heterogeneity		−0.04*	0.03	0.04†	0.08***	0.11***	0.11***						

Notes: †$p < 0.10$. *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$. The variance inflation factor (VIF) values for each variable derived from the baseline regression.

Table 4. Multiple regression analysis

Model	(1)	(2)	(3)
Variable	Enterprise resilience	Enterprise resilience	Enterprise resilience
Enterprise size	349.25***	372.69***	380.07***
	(106.52)	(108.60)	(108.35)
Enterprise age	−15.83	−17.81	−16.17
	(23.81)	(23.88)	(23.82)
Profitability	−1070.93	−898.10	−722.82
	(852.95)	(867.10)	(866.86)
Financial leverage	5021.22***	5125.34***	5224.61***
	(1033.40)	(1037.61)	(1035.53)
Capital intensity	−27.94	−29.53	−28.71
	(102.36)	(102.37)	(102.11)
Operational efficiency	−78.96	−48.53	−51.78
	(277.59)	(278.93)	(278.23)
Intangible assets	939.55	941.77	1425.76
	(2218.09)	(2217.94)	(2218.15)
Fixed assets	−693.90	−770.58	−786.66
	(1547.74)	(1549.19)	(1545.32)
Environmental uncertainty	−235.94*	−252.54*	−262.16*
	(118.12)	(119.07)	(118.81)
Crash risk	104.91	101.98	89.26
	(158.38)	(158.39)	(158.05)
Stability of the executive team	714.21	726.06	615.18
	(799.46)	(799.48)	(798.31)
Age heterogeneity	−6957.43**	−6924.01**	−6847.45**
	(2593.56)	(2593.55)	(2587.17)
Occupation heterogeneity	−1912.53	−1892.27	−1889.79
	(1556.75)	(1556.75)	(1552.85)
Education heterogeneity	262.87	257.13	261.28
	(545.92)	(545.90)	(544.54)
Vigilant managerial cognition	1371.40*	1344.75*	−49,092.94**
	(632.07)	(632.48)	(16,682.54)
Internal controls		−834.34	−3637.15**
		(754.65)	(1193.66)
Vigilant managerial cognition*Internal controls			7823.57**
			(2585.84)
Constant	−4523.92	550.88	18,510.24*
	(2962.67)	(5463.03)	(8057.93)
Industry category	Controlled	Controlled	Controlled
Adjusted R^2	0.04	0.04	0.05
N	1644	1644	1644

Notes: Standard errors are in parentheses; *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

($\beta = 2884.47$, $p < 0.001$, 95% CI = [1294.60, 4474.34]), as illustrated in Figure 1. This finding suggests that when internal control is inadequate, vigilant managerial cognition fails to exert a significant influence.

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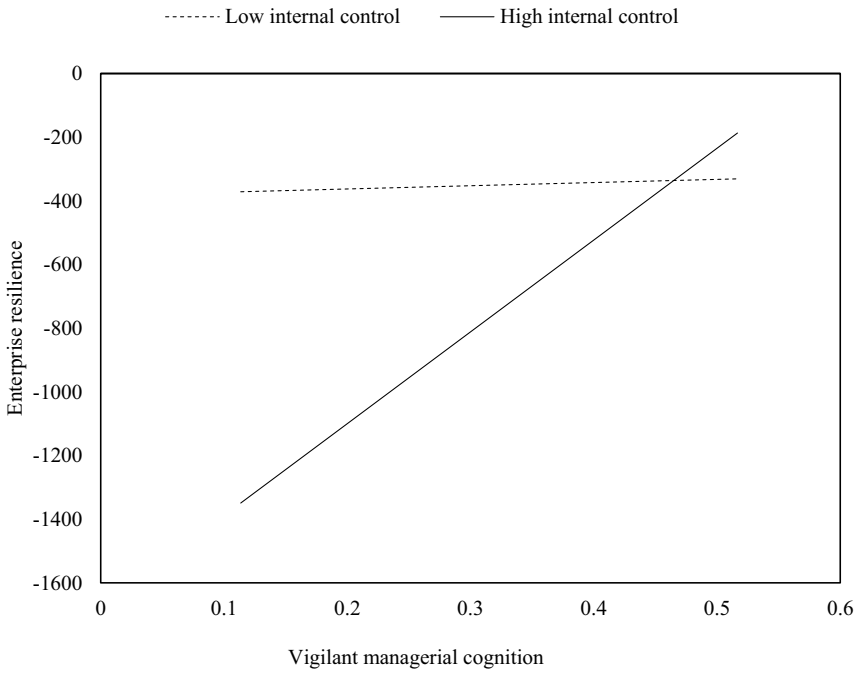


Figure 1. Moderating effect of internal controls

Robustness Checks

We conducted eight robustness checks. First, in the main analysis, we used 2019 annual reports to extract our study's independent variables. Although these reports present 2019 financial data, most were published between January and April 2020. Consequently, COVID-19 may have influenced the text index of vigilant managerial cognition. To address potential endogeneity, we followed Boubaker, Gounopoulos, and Rjiba (2019) and performed a two-stage least squares (2SLS) analysis. In the first stage, the text index from the 2018 annual reports acted as an instrumental variable (vigilant(t-1)). In the second stage, the regression-fit value from the first stage acted as an independent variable (Vigilant_fit) for our analysis of enterprise resilience. Results presented in Appendix B are consistent with our overall empirical analysis, alleviating concerns regarding reversed causality.

Second, we examined whether our findings held in a different context, specifically during the second wave of the COVID-19 outbreak in early 2022 in Shanghai, China. This setting was comparable in scope and severity to our main research context. We measured enterprise resilience by predicting and comparing stock prices. The first wave in 2020 may have contaminated historical data used for predictions. Therefore, we utilized data on confirmed COVID-19 cases in China, selecting stock data from May 1, 2020, when cases stabilized, to March 1, 2022, when the Shanghai government announced control policies, as training data for Holt-Winters exponential smoothing. We then calculated enterprise resilience for the observation period from March 1 to December 7, 2022, when China officially reopened and the stock market experienced new fluctuations. Regression analysis based on second-wave data, shown in Appendix C, aligns with our main study findings.

Third, we controlled for interference from other textual variables. This study extracts vigilant managerial cognition from the MD&A corpus using text analysis methods that may be influenced by various text features. We selected potentially relevant variables from the WinGo database as controls and repeated the baseline regression. Specifically, we included (1) text tone, reflecting the degree of

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positive or negative semantic meaning; (2) risk orientation, indicating the proportion of vocabulary related to risk concepts; (3) forward-looking vocabulary; (4) readability, reflecting text complexity; (5) innovation orientation; and (6) prevention words, determined by translating the English dictionary into Chinese (using the first definition from Google Dictionary). Among these variables, prevention words (Gamache, Mcnamara, Mannor, & Johnson, 2015), risk orientation (Qiu, Hu, Liang, & Dow, 2022), forward-looking language (Hu & Xue, 2018), and innovation orientation (Hu, Zhang, & Li, 2018) reflect executive characteristics similar to vigilant managerial cognition, such as prevention focus and transformational leadership. Controlling for these variables mitigates their potential influence on the results. Appendix D presents results consistent with the benchmark regression.

Fourth, to address the limitations of MD&A transcripts, which may not always be authored by executives, we compiled textual data from sample companies' earnings call transcripts in 2019. These texts consist of direct statements by the executive team in response to journalists' questions, providing a more accurate reflection of managerial cognition. We refined our independent variables based on these transcripts and conducted robustness checks, controlling for textual indicators similar to vigilant managerial cognition, such as prevention words, risk orientation, innovation orientation, and forward-looking language. Regression and moderation analysis results after substituting the independent variables are presented in Appendix E and align with the conclusions of this study.

Fifth, although the dependent variable in this study is measured by stock volatility, the influence of stock price levels remains relevant. To control for this, we retested the outcome variable by dividing it by the average stock price of the corresponding company in 2019 as a robustness check. Regression results and moderated effect test results are shown in Appendix F. Following this substitution, the findings are consistent with the conclusions of this study.

Sixth, this study measures enterprise resilience by computing the difference between stock prices and predicted values, which may lead to overfitting. To address this concern, we recalculated the dependent variable using Ilseven and Puranam's (2021) linear formula and conducted repeated tests. Detailed results are provided in Appendix G and support the study's hypotheses.

Seventh, to examine endogeneity issues related to potentially omitted variables, we employed the impact threshold of confounding variables (ITCV) analysis method. Results are detailed in Appendix I. The ITCV value for vigilant managerial cognition is 0.0101, while the maximum absolute impact coefficient of control variables on enterprise resilience is −0.0092 for risk orientation, which is less than the ITCV value. Assuming the representativeness of the selected control variables, if all impact coefficients are below the ITCV value, it is unlikely that omitted variables will exceed this threshold. Thus, endogeneity issues related to omitted variables in this study are not significant.

Finally, to reduce the impact of outliers, we utilized the classical statistical outlier detection method known as the PauTa criterion (3σ rule). Per this rule, the probability of a variable falling within the normal range $[\mu - 3\sigma, \mu + 3\sigma]$, where μ is the mean and σ is the standard deviation, is 0.9973. Therefore, samples outside this range are considered outliers (Zhao, Shi, Ren, & Jiao, 2020). To mitigate sample loss from indiscriminate deletions, we employed winsorization, replacing outliers below $\mu - 3\sigma$ and above $\mu + 3\sigma$ with the 1st and 99th percentiles, respectively. After applying this treatment, we repeated the regression tests, and the results, presented in Appendix J, support the study's conclusions.

Discussion

This study conceptualizes executives' vigilant managerial cognition and develops a theoretical model illustrating its positive effect on enterprise resilience. By employing textual analysis and machine learning, we constructed a measurement index based on a comprehensive collection of MD&A texts. The empirical results indicate that executives' vigilant managerial cognition significantly enhances enterprise resilience, suggesting that organizations should cultivate this quality among their leaders.

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Furthermore, the findings support the idea that interactions between executives' vigilant managerial cognition and internal controls can influence enterprise resilience. Specifically, higher-quality internal controls amplify the positive effect of executives' vigilant managerial cognition on resilience.

Theoretical Contributions

This study has significant theoretical contributions. First, it conceptualizes executives' vigilant managerial cognition and examines its influence on enterprise resilience, particularly via the lens of negative-focused managerial cognition. This perspective enhances the understanding of enterprise resilience and advances the theoretical framework surrounding managerial cognition. While previous research has explored executives' roles in enhancing enterprise resilience (Buyl et al., 2019; Fang et al., 2020), it has largely neglected the significance of negative-focused managerial cognition, which entails precaution against potential future crises (Duchek, 2020). Utilizing Teece's (2007) sensing-seizing-reconfiguring framework of dynamic capability, we define vigilant managerial cognition as a proactive response to potential threats, allowing for establishing a link between vigilant managerial cognition and enterprise resilience.

Second, we investigate the interplay between vigilant managerial cognition and internal controls in fostering enterprise resilience. Prior studies have acknowledged the importance of institutional factors in shaping executives' managerial cognition (Yang et al., 2019); however, the interaction between leaders' vigilance and institutional factors remains underexplored. Effective enterprise resilience necessitates coordinated efforts across departments, and leaders must often navigate organizational resistance (Helfat & Peteraf, 2014). Thus, in addition to cultivating executives' vigilant managerial cognition, it is essential to leverage this cognition to engage the entire organization. Our findings suggest that internal controls serve as a catalyst in the relationship between executives' vigilant managerial cognition and enterprise resilience, thereby enriching the literature on the interaction between managerial cognition and institutional factors and clarifying the boundary conditions affecting managerial cognition's effectiveness.

Practical Implications

In light of escalating international trade frictions and slowing global economic growth, enterprises must enhance their resilience. Our findings yield two key practical implications for leaders aiming to foster enterprise resilience. First, enterprises should prioritize the vigilance of their management teams by developing dynamic managerial capabilities and remaining alert to negative signals and potential crises. When selecting and training management teams, organizations should emphasize the cultivation of executives' vigilant managerial cognition, which includes recognizing danger signs and implementing preventive measures. Targeted training should enhance executives' abilities in risk identification and opportunity recognition, covering areas such as strategic risk management, market analysis, and competitive positioning. Additionally, clear goal and reward mechanisms, such as stock options and career advancement for effective risk management, should be established to motivate managers to proactively identify and address potential threats.

Second, we emphasize the importance of high-quality internal controls. Managerial cognition significantly influences effective management, relying on accurate signal detection and timely reconfiguration, which necessitates robust internal controls to support decision-making. Enhancing internal controls involves several strategies: (1) Strengthening internal supervision through regular assessments and audits and implementing multi-party evaluations of managerial decisions to create a sound governance environment; (2) Utilizing advanced techniques such as big data analytics and market monitoring, combined with diverse risk mitigation strategies, to bolster risk assessment; (3) Implementing independent and flexible approval mechanisms for asset movements and business adjustments to enhance executive control over operations; (4) Improving information dissemination

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among executives and departments by establishing effective communication platforms, facilitating information sharing, and enhancing digital integration within business operations; (5) Instituting oversight mechanisms for management decision-making, including standardizing reporting systems for identifying and addressing internal control deficiencies and forming committees for ongoing monitoring and review of corrective actions. These measures collectively reinforce the management framework necessary for cultivating enterprise resilience.

Limitations and Future Research

The findings of this study should be considered in light of several limitations. First, we did not explore the mechanisms that may mediate the relationship between executives' vigilant managerial cognition and enterprise resilience. Although it has been proposed that dynamic managerial capabilities can be transformed into dynamic capabilities (Helfat & Martin, 2015), the specific mechanisms underlying this transformation remain unclear. Further research could investigate mediators from the perspectives of leadership behavior and organizational-level cognition. Second, more complex mechanisms may underlie the causal relationship between vigilant managerial cognition and enterprise resilience, particularly as prevention focus and future orientation may intertwine with vigilant managerial cognition (Gao et al., 2024). Subsequent studies could analyze the unique effects of vigilant managerial cognition on enterprise resilience and the complexities involved. Third, the study's design limits the ability to establish causality between vigilant managerial cognition and enterprise resilience. Future research would benefit from a longitudinal design to clarify the causal relationship between these constructs. Fourth, while this study examines enterprise resilience in the context of the COVID-19 pandemic, there is ongoing debate about whether the pandemic exemplifies general crises. Previous studies on resilience have addressed large-scale crises, such as influenza (Rao & Greve, 2017), the 9/11 attacks (Gittell, Cameron, Lim, & Rivas, 2006), and the 2008 financial crisis (DesJardine et al., 2019), indicating a need for more research on resilience in broader crisis contexts. Finally, while using stock prices as a measure of resilience is common, their inherent unpredictability and volatility render them imperfect indicators. Future research may consider employing alternative methods, such as surveys, to provide a more nuanced understanding of the phenomenon under investigation.

Data availability statement. The final dataset that support the findings of this study are available at https://osf.io/hjzye/?view_only=8196c9f7b938432b9bd1ca40fd9bfae0

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Appendix A. Seed Words and Their Corresponding Word Sets

The seed-word set was selected based on three key factors: (1) it pertains to three central aspects of vigilant management: awareness, detection, and precaution; (2) certain words were excluded given their rare occurrence in the corpus. For instance, terms such as '警醒, '谨防, and '戒备' returned 'Key "戒备" not present' in our model. Although these terms are common in everyday language, they are infrequently used in Management Discussion and Analysis sections, rendering them ineffective for our purposes; and (3) some words yielded numerous irrelevant results. For example, the top 20 results for '小心' (be cautious) illustrate this issue.

	Words	Similarity		Words	Similarity		Words	Similarity		Words	Similarity
1	求证	0.780857205	6	头脑冷静	0.729419231	11	固步自封	0.723691285	16	时势	0.721421063
2	坏处	0.769630075	7	墨守成规	0.727314711	12	头脑清醒	0.723487616	17	总能	0.720043480
3	看待	0.760505199	8	惧	0.726697028	13	度势	0.723470867	18	这令	0.716999829
4	所惧	0.742220223	9	淡定	0.726471841	14	正确对待	0.722153842	19	果敢	0.715611041
5	谋定	0.735886216	10	而发	0.724672079	15	变求	0.721934974	20	胆识	0.715284467

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While a few terms reflect vigilant managerial cognition, many are unrelated. Additionally, vigilant managerial cognition can be expressed through various terms, such as '警惕' (be cautious). To minimize data noise, we chose not to include seed words exhibiting this problem. The seed words and their corresponding word sets are presented in the table below:

Component	Seed word	Derivative words
Awareness	警惕、清醒、警觉、忧患	警觉、保持警惕、头脑清醒、理智、头脑冷静、提高警惕、密切注意、看清、正确对待、淡定、紧绷、敏锐地、清醒认识、警惕性、敏锐性、理性认识、理性分析、不容小视、仔细分析、稍有不慎、如履薄冰、忧患意识、需谨慎、正确看待、绷紧、需注意、意想不到、严紧、小觑、冷静、面对现实、从容应对、居安思危、正视、认清形势、稳住阵脚、度势、认清、掉以轻心、科学认识、紧迫感、危机感、沉着、只争朝夕、危机意识、戒骄戒躁、正确认识、科学分析、充分认识、内忧外患、审时度势、时不我待、不进则退、振作精神、不容忽视、警钟长鸣
Detection	排查、侦察、检查、侦测	检查、监督、抽查、督查、排查、巡查、自检、互查、自纠、自查、内审、自评、督察、查缺、互检、复查、大排查、巡检、及时发现、自审、自测、严查、巡回检查、抽验、监查、监察、侦察、侦测、常抓、查漏、查错、定期维护、协查、辩识、抽测、抽检、核查、排摸、巡视、复检、日检、对照检查、加强监督、检视、执法检查、检核、辨析、检控、群众监督、追根溯源、财务监督、一查到底、跟踪调查、安全监管、漏检、终检、查岛、零打碎敲、举一反三、零敲碎打、摸排、排险、消缺、突击检查、安全检查、定期检查、检查督促、检查指导、质量检查、财务检查
Precaution	防范、预备、预防、抵御	控制、防控、于未然、规避、亡羊补牢、堵截、补救、防止出现、管控、防范措施、严防、防微杜渐、预控、预警、有备无患、风控、防患于未然、抵御、拒腐防变、纠正错误、防患未然、抗御、事前、防守、抵抗能力、补漏、节控、消除隐患、盯防、风险意识、案防、严密控制、互救、内控、侦破、紧守、纠弊、事中、健全制度、惩防、捂紧、防御能力、吸取教训、严守、纠偏、吸取经验、严加防范、预防、可防、未雨绸缪

Appendix B. Robustness Check Based on Two-Stage Least Square Analysis

Table B1. Two-stage least square analysis

	2SLS (1)	2SLS (2)		
Model	(1)	(2)	(3)	(4)
Variable	Vigilant managerial cognition	Enterprise resilience	Enterprise resilience	Enterprise resilience
$Vigilant_{(t-1)}$	0.72***			
	(0.02)			
Vigilant_fit		2160.87*	2159.62*	−74,620.91*
		(901.87)	(901.75)	(29,305.46)
Internal controls			−898.37	−4607.01**
			(753.78)	(1602.47)
Internal controls*Vigilant_fit				11,861.47**
				(4525.13)
Constant	0.05	−4698.71	759.60	24,628.89*
	(0.08)	(2965.40)	(5455.81)	(10,610.33)
Other control variables	Controlled	Controlled	Controlled	Controlled
Industry category	Controlled	Controlled	Controlled	Controlled
Adjusted R^2	0.50	0.05	0.05	0.05
N	1694	1643	1643	1643

Notes: Standard errors are in parentheses; *p < 0.05. **p < 0.01. ***p < 0.001.

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Appendix C. Robustness Check Based on the Second Observation Period

Table C1. Multiple regression analysis for the second observation period

Model	(1)	(2)	(3)
Variable	Enterprise resilience	Enterprise resilience	Enterprise resilience
Vigilant managerial cognition	1665.99*** (498.01)	1666.38*** (498.12)	−60,798.45** (20,180.10)
Internal controls		−198.42 (664.46)	−2843.49** (1081.38)
Vigilant managerial cognition*Internal controls			9640.69** (3113.61)
Constant	−1490.05 (2673.36)	−261.97 (4905.41)	16,847.98* (7382.13)
Other control variables	Controlled	Controlled	Controlled
Industry category	Controlled	Controlled	Controlled
Adjusted R^2	0.02	0.02	0.02
N	2021	2021	2021

Notes: *p < 0.05. **p < 0.01. ***p < 0.001.

Appendix D. Robustness Check with Other Textual Variables Controlled

Table D1. Multiple regression analysis with other textual variables

Model	(1)	(2)	(3)
Variable	Enterprise resilience	Enterprise resilience	Enterprise resilience
Tone	237.64 (1209.71)	429.79 (1218.31)	754.57 (1220.22)
Forward-looking	−144,630.94 (124,821.81)	−141,702.48 (124,813.77)	−144,847.80 (124,510.92)
Risk orientation	−174,132.94† (93,113.14)	−176,464.38† (93,109.22)	−167,816.42† (92,925.55)
Readability	91.65 (71.43)	99.17 (71.65)	94.06 (71.49)
Prevention words	−546.97 (589.23)	−561.42 (589.20)	−547.52 (587.77)
Innovation orientation	−16,112.31 (41923.63)	−13,403.12 (41,965.26)	−17,349.37 (41,882.99)
Vigilant managerial cognition	1689.02* (708.67)	1651.62* (709.08)	−48,833.62** (17,009.12)
Internal controls		−1047.79 (800.48)	−3928.69** (1256.21)
Vigilant managerial cognition*Internal controls			7829.83** (2635.69)

(*Continued*)

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Table D1. (*Continued.*)

Model	(1)	(2)	(3)
Variable	Enterprise resilience	Enterprise resilience	Enterprise resilience
Constant	619.74 (3377.41)	7059.60 (5967.11)	25,286.71** (8548.52)
Other control variables	Controlled	Controlled	Controlled
Industry category	Controlled	Controlled	Controlled
Adjusted R^2	0.05	0.05	0.05
N	1613	1613	1613

Notes: Standard errors are in parentheses; †$p < 0.10$. *$p < 0.05$. **$p < 0.01$.

Appendix E. Robustness Check Based on Earnings Call Corpus

Table E1. Multiple regression analysis

Model	(1)	(2)
Variable	Enterprise resilience	Enterprise resilience
Vigilant managerial cognition	890.34 (578.50)	−44,335.73** (16,810.22)
Internal controls		−2866.88† (1658.12)
Vigilant managerial cognition * Internal controls		7037.71** (2613.71)
Prevention words	−8320.72 (35,782.44)	−10,876.94 (35,690.95)
Risk orientation	−30,723.18 (22,248.93)	−34,029.90 (22,191.99)
Innovation orientation	26,283.35 (45,503.87)	19,512.98 (45,384.98)
Forward-looking	−2134.63 (23,293.08)	−576.99 (23,199.19)
Constant	−3279.25† (4849.21)	14,888.24 (11,374.61)
Other control variables	Controlled	Controlled
Industry category	Controlled	Controlled
Adjusted R^2	0.02	0.03
N	593	593

Notes: Standard errors are in parentheses; †$p < 0.10$. **$p < 0.01$.

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Table E2. Effect of vigilant managerial cognition on resilience under different conditions

		95% CI	
Internal controls	Effect value	LLCI	ULCI
Low (−1SD)	−122.60	−1097.83	853.49
Mean	1109.55	102.81	2173.50
High (+1SD)	2342.41	868.09	3939.75
Difference	2465.01	1006.34	4140.27

Appendix F. Robustness Check After Dividing the Dependent Variable by the Average Price

Table F1. Multiple regression analysis

Model	(1)	(2)
Variable	Enterprise resilience	Enterprise resilience
Vigilant managerial cognition	120.15* (60.20)	−5206.36** (1588.13)
Internal controls		−354.96** (113.63)
Vigilant managerial cognition*Internal controls		825.92*** (246.16)
Constant	−712.95* (282.17)	1 542.31* (767.09)
Other control variables	Controlled	Controlled
Industry category	Controlled	Controlled
Adjusted R^2	0.08	0.09
N	1674	1674

Notes: *p < 0.05. **p < 0.01. ***p < 0.001

Table F2. Effect of vigilant managerial cognition on resilience under different conditions

		95% CI	
Internal controls	Effect value	LLCI	ULCI
Low (−1SD)	−16.18	−189.64	99.70
Mean	128.68	39.71	232.28
High (+1SD)	273.63	141.73	420.53
Difference	289.81	151.00	571.89

Appendix G. Robustness Check with the Independent Variables Calculated by the Linear Method

Drawing on the insights of Ilseven and Puranam (2021), we posit that each intersection between the predicted and actual curves forms a triangular region. For example, two intersections create three triangular regions (2 + 1 = 3) before the lines become parallel, while no intersection results in one triangular region (0 + 1 = 1). We anchor the timing in Ilseven and Puranam's formula to the time points of each intersection and the moments when actual values reach their extremum following each intersection. By measuring half of the product of the time distance between consecutive intersections and the difference

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between actual and predicted values at the extremum, we quantify the area of each triangular region. For the final triangular region, which occurs between the last intersection and the subsequent parallelization of the curves, we approximate this area using the difference between them at the end of the observation period and the elapsed time since the last intersection. The sum of these areas serves as the dependent variable, being negative when actual values fall below predictions and positive otherwise. Regression results and tests of moderating effects are presented in Tables D1 and D2 following the substitution of the dependent variable.

Table G1. Multiple regression analysis

Model	(1)	(2)
Variable	Enterprise resilience	Enterprise resilience
Vigilant managerial cognition	1289.68*	−33,898.11*
	(653.66)	(17,271.38)
Internal controls		−3226.65**
		(1235.79)
Vigilant managerial cognition*Internal controls		5451.79*
		(2677.11)
Constant	245.85	20,506.84
	(3063.89)	(8342.35)
Other control variables	Controlled	Controlled
Industry category	Controlled	Controlled
Adjusted R^2	0.02	0.02
N	1644	1644

Notes: *p < 0.05. **p < 0.01.

Table G2. Effect of vigilant managerial cognition on resilience under different conditions

		95% CI	
Internal controls	Effect Value	LLCI	ULCI
Low (−1SD)	361.56	−694.39	1515.36
Mean	1317.75	196.08	2626.64
High (+1SD)	2274.49	819.11	3866.29
Difference	1912.93	1023.49	3265.15

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Appendix H. Themes of Sentences Containing Vigilant Vocabulary

Table H1. Themes of sentences containing vigilant vocabulary and example terms

Themes	Words	Themes	Words	Themes	Words
Security Management	安全;工作;环保;安全生产;检查;重点;排查;问题;隐患;责任;专项;考核;应急;培训;标准化;指标;安全风险;事故;教育;全员;督查;定期;整治...	Financial Management	风险;成本;业务;销售;价格;原材料;调整;波动;账款;活动;产生;汇率;利用;库存;融资;衍生品;报告期;同比;利润...	Macroenvironment	行业;措施;政策;环境;全球;变化;经济;规划;改革;国际;因素;形势;程度;有序;压力;基本;全国;贸易;政府;消费;挑战;机遇;不确定性;宏观经济...
Internal Management	管理;管控;经营;体系;制度;运营;规范;机制;流程;计划;结构;管理体系;信息;信息化;整体;管理水平;业绩;管理制度;部门;决策...	Shareholding	公司;企业;有限公司;报告;客户;监督;实际;投资;子公司;股东;股权;核心;集团;供应商;范围;控制权;董事;承诺;关联方...	Production Management	生产;质量;过程;工艺;产品质量;标准;现场;环节;材料;检测;评价;监督管理;关键;全过程;品质;原料;阶段;检验;临床;办法;方法;生产工艺...
Technique	技术;研发;系统;智能;设备;平台;领域;控制系统;工业;自动化;数据;控制器;智能化;电机;设计;预警;工程;电子;监控;汽车;驱动;监测;机器人...	Business Market	发展;市场;能力;目标;服务;效率;创新;优势;战略;资源;模式;综合;升级;产业;效益;盈利;品牌;深化;竞争;营销;合作;供应链;竞争力...	Financial Market	资金;人民币;核准;费用;中国证券监督管理委员会;证监;资产;年度;投资者;上市公司;意见;监管;机构;董事会;普通股;核查;规定;发行股票;证券...

Appendix I. Robustness Check Based on the Impact Threshold of Confounding Variables

Table I1. Impact threshold of confounding variables (ITCV) examination

Variable	ITCV	Impact	Variable	Impact
Vigilant managerial cognition	0.0101		Crash risk	0.0002
Internal controls		−0.0006	Stability of the executive team	−0.0002
Enterprise size		0.0001	Age heterogeneity	0.0052
Enterprise age		−0.0009	Occupation heterogeneity	−0.0002
Profitability		−0.0085	Education heterogeneity	0.0004
Financial leverage		−0.0044	Tone	0.0024
Capital intensity		−0.0001	Forward-looking	0.0017
Operational efficiency		0.0018	Risk orientation	−0.0092
Intangible assets		−0.0014	Readability	0.0002
Fixed assets		−0.0016	Prevention words	−0.0085
Environmental uncertainty		−0.0028	Innovation orientation	−0.0007

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Appendix J. Robustness Check for Outliers

Table J1. Multiple regression analysis

Model	(1)	(2)	(3)
Variable	Enterprise resilience	Enterprise resilience	Enterprise resilience
Vigilant managerial cognition	1136.13*	1116.47*	−42,194.46***
	(519.32)	(519.76)	(12,454.93)
Internal controls		−550.75	−3022.25**
		(586.76)	(919.86)
Vigilant managerial cognition*Internal controls			6717.16***
			(1929.98)
Constant	644.63	4029.61	19,666.52**
	(2475.01)	(4373.93)	(6259.65)
Other control variables	Controlled	Controlled	Controlled
Industry category	Controlled	Controlled	Controlled
Adjusted R^2	0.07	0.07	0.08
N	1613	1613	1613

Notes: *p < 0.05. **p < 0.01. ***p < 0.001

Table J2. Effect of vigilant managerial cognition on resilience under different conditions

		95% CI	
Internal controls	Effect value	LLCI	ULCI
Low (−1SD)	−28.23	−1440.72	1082.44
Mean	1184.20	164.16	2252.78
High (+1SD)	2397.32	1120.05	3719.58
Difference	2425.55	1516.99	4548.38

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