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Exploring the green edge: the role of market orientation and knowledge management in achieving competitive advantage through creativity

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This study examines the interconnectedness between Green Market Orientation (GMO) and Green Knowledge Management (GKM) in connection to Green Competitive Advantage (GCA) within Chinese green businesses. This research also focuses on the mediating influence of Green Creativity (GC). Drawing on the Knowledge-Based View (KBV), we examine how GMOs and GKM improve enterprises' green creativity and subsequent green competitive advantage. Using a comprehensive survey of 325 environmentally conscious Chinese companies and an advanced PLS-SEM analysis, our findings offer several important insights. Our findings reveal that GMOs substantially affect both GC and GCA, highlighting their crucial role in fostering a company's innovative green capabilities and competitive position. Concurrently, GKM positively affects GC and GCA, emphasizing the importance of effectively using and leveraging green knowledge within businesses. Furthermore, we observe the mediating role of GC in the relationships between GMO and GCA, as well as GKM and GCA. This finding underscores the need to promote GC to maximize the advantages of market orientation and knowledge management in attaining a green competitive advantage. These results not only add to the existing KBV theoretical framework, but they also have important implications for managers because they show how important it is to fully incorporate green practices into an organization's strategy in order to gain a sustainable competitive advantage.

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Introduction

Growing environmental concerns have made achieving a green competitive advantage (GCA) a crucial goal for businesses on a global scale (Zameer et al. 2020; Zhu et al. 2023). This advantage signifies a company's dedication to environmental sustainability and its capacity to leverage green practices to outperform competitors (Chen and Liu 2018; Purwanti et al. 2019). Within this framework, two factors emerge as crucial. First, green market orientation (GMO) refers to a company's proactive adaptation to cater to the market's environmentally conscious preferences, indicating alignment with both existing and expected environmental standards (Du and Wang 2022; Purcărea et al. 2022). This perspective guarantees that organizations maintain relevance and competitive advantage in a progressively more attuned marketplace to green concerns (Li et al. 2018). Furthermore, the significance of green knowledge management (GKM) cannot be underestimated (Riva et al. 2021; Sahoo et al. 2022). In the face of the intricate challenges posed by sustainable practices, firms that can effectively obtain, integrate, and utilize environmental knowledge are more favorably situated to foster innovation and adjust to the green framework, consequently enhancing their competitive position (Yahya et al. 2022). However, the specific effects of GMOs and GKM on GCA, although crucial, may not be straightforward. Developing a comprehensive understanding of the complex internal mechanisms that underpin these interactions is crucial in order to fully grasp the interplay between green orientation, knowledge, and competitiveness.

Although the direct connections between GMO, GKM, and GCA offer valuable insights, it is plausible to propose the existence of intermediate mechanisms that can provide more clarification on these relationships. Such mediators can provide a comprehensive understanding of how companies convert green market and environmental knowledge into meaningful competitive advantages. In this context, green creativity (GC) emerges as a potential intermediate, referring to an organization's ability to provide innovative and effective environmental solutions (Maitlo et al. 2022). GC encapsulates the creative endeavors and solutions focused on addressing environmental challenges, often catalyzing green knowledge into actionable and profitable strategies (Kalyar et al. 2021; Maitlo et al. 2022). Moreover, the role of green creativity as a mediator in this interrelation offers a rich tapestry of insights into how eco-innovation can fill the gap between market orientation, information management, and competitive prowess (Aeknarajindawat and Jermsittiparsert 2019; Lartey et al. 2020). Hence, a notable research gap persists in understanding the nuanced dynamics between GMO, GKM, and GCA, especially in the presence of the potential mediating effect of GC. Previous studies have shown how important GMOs and GKM are for creating long-term business plans (Dangelico and Pujari 2010; Yu and Chen 2021). However, there is still a strong need to understand how these two concepts work together to affect GCA, mainly from the point of view of GC.

This study addresses the current research gap by demonstrating the complex interactions between GMO, GKM, GCA, and GC. Recent literature emphasizes the criticality of adopting a market-oriented approach and effectively managing information to attain a sustained competitive advantage (Ha et al. 2016; Santos-Vijande et al. 2016; Zack et al. 2009). Furthermore, the importance of fostering innovation and adaptability in the face of swift environmental and technological transformations has elevated the significance of GC as a powerful intermediary (de Medeiros et al. 2018; Zhang et al. 2020). However, a compelling yet underexplored link exists between GMO and GKM in augmenting GCA, especially with GC as a mediating factor. This research explores how companies can align their market orientation with their knowledge resources to carve a unique green competitive edge in addressing this gap. Emphasizing the transformative role of GC in converting orientation and knowledge into effective competitive strategies (Zheng et al. 2010), this paper aims to dissect the interdependence of these constructs. It aims to broaden academic insight and uncover essential elements that foster durable competitive advantages.

Additionally, this study acknowledges the practical challenges of promoting green products across various countries, which is a critical backdrop for this research. Regulatory hurdles, consumer perception, and market readiness are pivotal in shaping green strategies (Johnson et al. 2017; Smith and Brower 2012). These challenges are especially pronounced in emerging economies, where environmental concerns are often secondary to economic growth (Patel et al. 2014). Tumpa et al. (2019) reported that green market knowledge, lack of government incentives, financial constraints, an unskilled workforce, regulations and legislative frameworks, and technological constraints are the crucial barriers to green practices in developing countries like Bangladesh. This research, therefore, extends beyond theoretical exploration, offering insights into the practical challenges and opportunities in the green market. Through a comprehensive empirical assessment across multiple sectors, the study aims to deepen our understanding of integrating these elements and contribute substantially to the discourse on environmentally conscious strategic priorities in varying market conditions.

This study signals a crucial progression in the domain of strategic management and knowledge management, particularly from the knowledge-based view (KBV) perspective. Through an in-depth exploration of the relationships among GMO, GKM, GCA, and GC, this research extends the KBV framework to offer a fresh perspective on how knowledge management practices can be tailored to foster green market orientation and thereby obtain a green competitive advantage (Valmohammadi et al. 2019). This research integrates the concept of GC, highlighting how innovative green solutions can be developed through effective knowledge management (Begum, Ashfaq et al. 2022). The incorporation of GKM as a vital enabler in this framework emphasizes the pivotal role knowledge plays in ensuring sustainability at the core of a firm's strategic initiatives, reinforcing the principles laid out in the KBV (Issa and Jabbouri 2022; Kong et al. 2020). Green creativity mediates this novel connection between green market orientation and knowledge management, underscoring the crucial need for firms to continuously innovate and adapt in a dynamically shifting green market landscape (Dhir et al. 2023). Moreover, elucidating GC as a mediator underscores the intricate complexities of transforming green knowledge into tangible competitive advantages (Baah et al. 2023; Uwem et al. 2021). By bridging existing theoretical gaps and offering a comprehensive understanding of the interactions between the variables under study, this research provides invaluable insights for firms looking to position themselves in green markets strategically. In essence, this research enhances the theoretical discourse in the KBV domain and clarifies the role of knowledge in driving environmental competitive advantage in modern business ecosystems.

Theoretical framework

Knowledge-based view (KBV). The knowledge-based view (KBV) has emerged as a pivotal framework in strategic management, particularly in the domain of environmental sustainability. This perspective argues that knowledge, particularly specialized 'green' knowledge, is critical for competitive differentiation. According to Grant (2021), KBV emphasizes the

strategic importance of knowledge integration and application, which is paramount in the contemporary environmental context. Rooted in the foundational works of Kogut and Zander (1992), KBV postulates that the intrinsic competitiveness of firms is primarily a function of their capability to integrate, amplify, and apply their reservoir of knowledge in ways that distinguish them from competitors (Nonaka and von Krogh 2009). In the modern era, where environmental sustainability has become a cornerstone of organizational strategy, KBV accentuates the need for firms not just to accumulate but also adeptly harness, deploy, and refresh their green knowledge assets to navigate the intricacies of sustainable practices (Bansal and Song 2017). Green Market Orientation (GMO) extends the KBV framework to include a firm's comprehension and response to environmental market dynamics. This concept encapsulates the ability to discern and adapt to changes in ecological preferences, regulations, and consumer expectations. Hartmann and Apaolaza-Ibáñez (2012) articulate that GMO necessitates a symbiotic relationship between market intelligence and green knowledge. This intersection is crucial for firms to remain responsive and relevant in the evolving landscape of environmental sustainability. Within the KBV paradigm, green knowledge management (GKM) pertains to the organizational mechanisms and processes dedicated to cultivating, disseminating, and renewing green knowledge.

According to Antunes and Pinheiro (2020), GKM involves more than just knowledge acquisition; it involves the establishment of a dynamic system that continuously develops and applies this knowledge. This aspect of KBV underscores the importance of a learning-oriented organizational culture in fostering sustainable practices. The KBV framework posits green creativity (GC) as the transformative phase, where green knowledge converges with innovation. Aragón-Correa et al. (2008) describe GC as converting environmental knowledge into innovative and sustainable outputs, whether in products, services, or processes. This concept illustrates the critical role of creativity in leveraging green knowledge for competitive advantage. Green Competitive Advantage (GCA) represents the culmination of effectively synergizing GMO, GKM, and GC. Teece (2018) highlights this as the strategic integration of green knowledge and creativity, culminating in a superior market position. GCA is thus the endpoint in the KBV journey, where applying specialized knowledge and innovation establishes a firm's dominance in the green marketplace. This research adopts the KBV as its core theoretical lens, intricately interlinking GMO, GKM, GCA, and GC. The framework presents a comprehensive perspective in which these elements, rather than existing in isolation, actively contribute to enhancing a firm's green competitive advantage.

This interconnected framework offers a nuanced understanding of how environmental knowledge and market orientation, through creativity, can be strategically harnessed for competitive advantage. While our research, grounded in the KBV, primarily assesses the direct impact of GMO and GKM on GC and subsequently GCA, some studies, such as Hurley and Hult (1998), alongside recent studies by Borah et al. (2023) and Gao et al. (2023), indicate the possibility of these relationships being bidirectional. For example, GC might potentially impact a company's market orientation and knowledge management strategies. This viewpoint emphasizes the dynamic and interconnected relationship between these concepts, indicating that the influence among them is not exclusively one-way but perhaps cyclical, with one construct impacting and being impacted by the others. However, it is crucial to emphasize that our research primarily focuses on investigating the positive impacts of GMOs and GKMs on GC and GCA. Although we acknowledge the theoretical importance of bidirectional impacts in achieving a thorough understanding of strategic management in environmental sustainability, this study does not investigate reverse avenues because of its distinctive focus.

Development of hypothesis

Green market orientation and green competitive advantage. Green market orientation (GMO) refers to a firm's deliberate and strategic allegiance to comprehending and fulfilling particular environmental preferences and the requirements of its consumer base. Green marketing is defined as the strategic alignment of a company's marketing efforts with sustainable and environmentally friendly practices. This approach highlights the importance of delivering sustainable customer value and adopting green product positioning (Grant 2009). This proactive, market-driven approach ensures better environmental performance and meets consumers' increasing demand for sustainable products (Cronin et al. 2011). In contrast, green competitive advantage (GCA) pertains to a company's ability to distinguish itself from rivals through sustainable business strategies, resulting in enhanced market positioning, improved brand perception, and increased profitability (Chen et al. 2009). It is when companies successfully integrate sustainability into their core business policies and practices that they gain a competitive advantage.

Previous research has shed considerable light on the connection between GMOs and GCAs. According to the proposition by Cherian and Jacob (2012), companies that possess a robust GMO tend to create distinctive environmentally friendly product offers, setting themselves apart in the marketplace and gaining a competitive edge. Mohammad and Wasiuzzaman (2021) also supported this view, suggesting that green market-oriented firms often have superior brand reputation, consumer loyalty, and sales performance. This is because a GMO allows businesses to anticipate and align with shifts in consumer preferences toward green products (Papadas et al. 2019). Wang et al. (2016) observed that a robust GMO fosters a firm's ability to tap into innovative sustainable business opportunities, consequently bolstering its green competitive positioning. These firms reacted to market changes and led and shaped the market through green initiatives.

Furthermore, Singh et al. (2019) noted that a strong GMO provides companies with the agility to quickly adapt to environmental regulations and consumer demands, directly enhancing their green competitiveness in the market. Nevertheless, while the predominant evidence suggests a positive correlation, it is imperative to acknowledge that a strong GMO does not always equate to a clear GCA. Firms might have a comprehensive understanding of the green market but lack the operational capacity or agility to translate that understanding into tangible competitive practices (Hansen et al. 2009). While companies may have a focus on the green market, the saturation of similar initiatives in the competitive environment could dilute any potential advantage (Peattie 2016). Considering the discussions above, we posit that:

Hypothesis 1 (H1): *GMO positively impacts firms' GCA*.

Green market orientation and green creativity. GMO denotes a firm's strategic emphasis on identifying and responding to the environmentally sustainable preferences of its target market. This framework is about more than just adapting to green consumer demands; it is about foreseeing and shaping them. In this vein, firms prioritize understanding the rising environmental consciousness of consumers and shape their product or service offerings accordingly (Cronin et al. 2011). Conversely, green creativity (GC) relates to the innovative capabilities of organizations in creating eco-friendly solutions, products, or services. This kind of creativity is not just limited to the final product or service but includes the entire design and production process that

emphasizes minimal environmental impact, effective utilization of resources, and fostering a culture of sustainable innovation (Chen et al. 2006).

A burgeoning body of evidence elucidates the correlation between GMOs and GC. A study by Chen et al. (2006) illustrated how GMOs can foster GC by providing insights into evolving customer demands for green products, thereby guiding R&D departments to innovate sustainably. Additionally, Montabon et al. (2007) provided evidence that firms with a robust GMO are better equipped to encourage creativity in sustainability, resulting in groundbreaking green products and solutions. This is attributable to the enhanced understanding of market demands, which invariably challenge firms to think creatively. Furthermore, Singh et al. (2014) highlighted that a strong market orientation towards sustainability is foundational for nurturing creativity in the development of green goods and services. Understanding the nuances of the green market spurs firms to innovate, leading to enhanced GC. The integration of GMOs with GC is considered essential within the framework of sustainable business practices. Li et al. (2020) elaborated on this relationship, noting that firms that actively seek insights from their green market are invariably more successful in channeling these insights into creative green outcomes. However, a pertinent consideration is that the strength of the GMO-GC relationship could be contingent on other variables like organizational culture, leadership orientation, and the availability of resources. While a strong GMO provides direction, converting it into creative solutions may depend on other enablers within the firm (Aragón-Correa et al. 2007). Aboelmaged and Hashem (2019) concluded that this sustainable capability can be a powerful determinant of firms' green creativity. Given the previously discussed interplay between GMO and GC, we present the following hypothesis:

Hypothesis 2 (H2): *GMO positively affects firms' GC.*

Green knowledge management and green competitive advantage. The systematic processes of capturing, organizing, and disseminating knowledge about environmental sustainability throughout an organization are known as green knowledge management (GKM). This knowledge aids firms in recognizing the significance of green practices, understanding their implications, and strategizing their business processes accordingly (Tseng 2010). It embodies an integrated approach, highlighting the effective utilization and management of green information resources to enhance environmental performance and reduce adverse ecological impacts. Conversely, green competitive advantage (GCA) encapsulates a company's capability to leverage green practices, technologies, and strategies to outperform competitors, enhancing market position, profitability, and stakeholder trust (Chen 2011). GCA enables organizations to differentiate their offerings and project a strong image of environmental friendliness, appealing to an increasing segment of eco-conscious consumers.

The current body of literature offers valuable insights into the correlation between GKM and GCA. Specifically, Shalley et al. (2000) found that effective GKM practices promote environmental responsibility and increase market competitiveness. Their study revealed that knowledge-based ecological initiatives could provide real, quantifiable competitive benefits. Similarly, Wu and Pagell (2011) claimed that businesses must effectively manage their green knowledge resources to achieve a GCA. This view aligns with Singh et al. (2014), which underscores GKM's positive influence on achieving GCA, highlighting the necessity for businesses to incorporate and implement green knowledge in their strategic operations. Integrating GKM practices can lead to innovative solutions, optimized processes, and differentiated product offerings, thus enhancing a firm's GCA (Dangelico and Pujari 2010). However, it is essential to note the contextual factors influencing this relationship. While GKM can provide the requisite knowledge and understanding, converting this knowledge into a competitive advantage requires strategic direction, a conducive organizational culture, and other enablers (Huang and Rust 2011). Moreover, merely possessing green knowledge does not automatically translate to a competitive advantage; applying and integrating this knowledge into the firm's core operations generates tangible benefits (Chen 2011). Given the literature's insights and emerging trends in sustainable business practices, we postulate:

Hypothesis 3 (H3): *GKM positively impacts firms' GCA.*

Green knowledge management and green creativity. GKM entails the structured coordination and dissemination of environmentally sensitive knowledge and practices within an enterprise (Chen et al. 2009). This framework ensures that organizations harness, refine, and leverage knowledge to support sustainability and minimize environmental degradation (Lee & Kim, 2011). Through knowledge sharing, GKM aims to cultivate a culture that respects the environment and integrates sustainable practices into day-to-day operations. Conversely, green creativity (GC) relates to an organization's innovative approaches and ideas to tackle environmental challenges and promote sustainability (Begum et al. 2022). It is a fusion of environmental awareness and the ability to ideate and innovate for the betterment of our ecosystem. Such creativity is vital in today's competitive landscape, where customers and stakeholders demand greener products and services (Hart et al. 2003).

Examining the relationship between GKM and GC, Koberg and Longoni (2019) revealed that organizations with well-established GKM frameworks tend to demonstrate higher levels of green creativity. This could be attributed to the seamless flow of green knowledge, spurring innovative thoughts and actions. Ma et al. (2022) found in another study that companies prioritizing GKM are better positioned to generate green solutions, indicating a direct connection between information management and green creativity. Tseng et al. (2013) observed that cultivating and disseminating green knowledge within firms positively influenced the ideation and execution of creative green solutions, further supporting this notion. GKM cultivates an environment that values and shares green knowledge, thereby fostering innovation and nurturing green culture (Weina and Yanling 2022). Furthermore, GKM equips employees with the necessary tools and knowledge to think creatively about sustainability, enhancing the company's innovative ability to respond to environmental struggles (Abbas and Sağsan, 2019). Therefore, it stands to reason that:

Hypothesis 4 (H4): *GKM positively affects GC.*

Green creativity and green competitive advantage. Green creativity (GC) encompasses the innovative strategies and solutions companies adopt to address environmental concerns and promote sustainable business practices (Dey et al. 2020; Yang et al. 2011). It signifies a firm's capability to ideate, innovate, and carry out eco-friendly initiatives. Approaches like this respond to environmental challenges and fulfill consumers' and stakeholders' increasing necessity for sustainable solutions (Hart et al. 2003). Conversely, green competitive advantage (GCA) indicates the strategic edge companies acquire when they integrate and prioritize sustainable and green initiatives in their operational and strategic pursuits (Chen et al. 2006). By doing so, companies can differentiate themselves in the marketplace, leading to improved market position, better stakeholder relationships, and potential financial benefits.

Examining the dynamics between GC and GCA, Lin et al. (2013) illustrated that companies that invested in green creative strategies experienced enhanced competitive advantage in their respective markets. This observation stems from the belief that consumers are becoming more environmentally conscious, and as a result, they lean towards brands committed to sustainability. Uddin and Islam (2020) highlighted that green innovation, a key component of GCA, directly influences GCA by fostering consumer trust and loyalty and efficiently meeting regulatory compliance. Furthermore, firms that harness GC exhibit a forward-thinking approach, anticipating future environmental challenges and market demands. This proactive approach gives them a head start in market positioning, making them pioneers in green innovation and subsequently offering them a significant competitive advantage (Zhou et al. 2005). A longitudinal study by Mudgal et al. (2009) emphasized that GC, over time, has a cumulative effect on GCA. Companies that consistently demonstrate green creativity in their products, services, and operations find it easier to penetrate new markets, retain loyal customers, and even command premium pricing because of their established green reputation. This reinforces the notion that GC is not just a short-term investment but has long-term ramifications for a company's competitive positioning. Consequently, we postulate that:

Hypothesis 5 (H5): *GC positively affects GCA*.

The mediating role of green creativity. In this contemporary business ecosystem, there is an increasing emphasis on green market orientation (GMO). This orientation signifies firms' focus on understanding and responding to environmentally conscious market demands and dynamics (Papadas et al. 2017; Shang et al. 2022). By emphasizing a sustainable market approach, firms aim to align their offerings with the evolving demands of eco-aware consumers and stakeholders. However, there has been extensive debate on the empirical relationship between GMOs and green competitive advantage (GCA). While studies like those by Bai and Chang (2015) posit that firms with a pronounced GMO are likelier to enjoy a competitive advantage due to aligning with green market demands, others present a more nuanced perspective. For instance, the findings of Vilkaite-Vaitone and Skackauskiene (2019) suggest no significant direct relationship between GMO and GCA, attributing such anomalies to potential market complexities and varying consumer perceptions. Moreover, Liu et al. (2016) suggest a negative link, pointing out situations in which focusing too much on green market strategies could cause businesses to ignore other important factors, resulting in losing their competitive edge. These divergent empirical outcomes suggest an underlying complexity in the GMO-GCA relationship, which might be contingent on intermediary factors. GC epitomizes companies' innovative and creative strategies to address environmental challenges and craft green solutions (Chen et al. 2023). While GMO provides insights into market demands, GC acts as the mechanism to transform these insights into innovative products, services, and processes. The presence or absence of GC could potentially elucidate the conflicting results seen in GMO-GCA studies. For instance, while a firm may possess strong green market insights, without the creative prowess to actualize these insights, it may fail to establish a competitive edge. Conversely, companies that can innovatively implement their GMO through GC may witness a more pronounced GCA, thereby consolidating their market positioning (Borazon et al. 2022; Chow and Chen 2012). In this context, GC serves as a crucial mediating construct, facilitating the innovative execution of market insights to establish a competitive advantage.

Similarly, in the ever-changing realm of green business operations, green knowledge management (GKM) is a cornerstone for organizations aiming to leverage environmentally conscious insights for competitive prowess. GKM facilitates the cultivation and dissemination of green knowledge, fostering a sense of ecological responsibility and strategic acumen (Guo 2022; Yu et al. 2022). While one would posit that effective GKM invariably leads to a pronounced green competitive advantage (GCA), empirical studies present a more nuanced narrative. Some research asserts that there is not always a significant direct relationship between GKM and GCA (Rahimli 2012). Furthermore, a few studies suggest a potential negative relationship, arguing that over-emphasizing green knowledge could detract from other competitive factors and strain resources (Hung et al. 2014; Polas et al. 2023). Such divergent findings signal the existence of potential moderating or mediating variables that shape the trajectory between GKM and GCA. Green creativity (GC) represents the innovative application of green knowledge, transforming abstract ecological insights into actionable and differentiated business strategies (Lin and Chen 2017; Zameer et al. 2020). While GKM provides a knowledge base, it is through the lens of GC that firms can actualize this knowledge, ideate sustainable products, or craft eco-centric services that confer a distinct competitive advantage (d'Orville 2019). When organizations fail to translate their GKM into a tangible GCA, it may be due to a deficiency in cultivating or leveraging GC. Without the creative impetus, the knowledge remains dormant and does not effectively contribute to a company's competitive stance. Contrarily, organizations proficient in GC can bridge the divide, converting their green knowledge reservoirs into unique offerings, processes, or market positioning, granting them an unmistakable green competitive edge (Exton and Totterdill 2009). Therefore, it becomes imperative to consider:

Hypothesis 6 (H6): *GC mediates the interrelation between GMO and GCA*.

Hypothesis 7 (H7): *GC mediates the interrelation between GKM and GCA*.

Figure 1 illustrates the conceptual model of this research.

Research methods

Data collection and sample. We targeted companies that prominently focus on the green market across various sectors in China due to the country's significant attempt to establish sustainable business practices and eco-innovation. We made this strategic choice because it aligns with China's commitment to sustainable practices and innovation, providing a crucial context for our study. China, with one of the world's largest and fastest-growing economies, has a significant impact on global sustainability practices. The Chinese market is an especially pertinent subject for the investigation of green market orientation and green knowledge management owing to its distinct combination of robust industrial growth, escalating environmental awareness, and a dynamic regulatory environment. The sectors chosen for this study have a significant impact on China's economy and play a critical role in shaping its green market dynamics. These industries include green tech solutions, sustainable transportation, eco-tourism, sustainable forestry, and bio-based industries. These sectors were carefully selected to ensure that our research captures a diverse range of green market activities, providing a comprehensive view of the topic. These businesses are leading China's green transition; thus, their strategic choices and inventive activities are crucial to guaranteeing a competitive and environmentally friendly region. While selecting our sample firms for this study, we focused on small and medium enterprises (SMEs) within the private sector, recognizing their crucial role in leading green initiatives in many industries in China. Understanding that

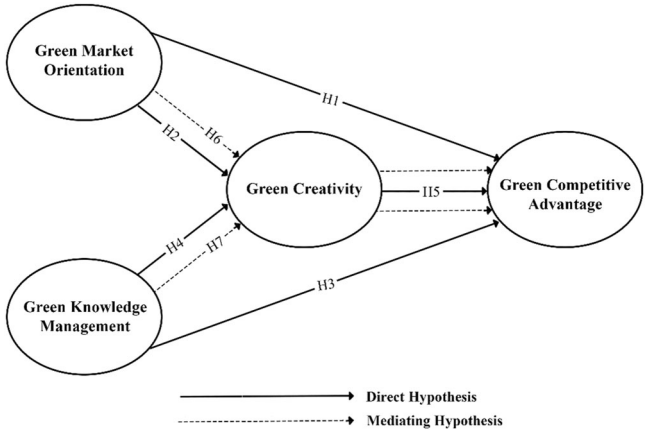

Fig. 1 Conceptual Model.

SMEs, especially those under private ownership, possess unique characteristics in adopting green initiatives due to their operational flexibility, innovation capabilities, and unique challenges, sets them apart from larger enterprises or state-owned entities. We decided to select a sample of SMEs that are geographically spread across China, as well as between urban and rural areas, to account for the high variability of environmental challenges and opportunities that the local context entails. Furthermore, we equally divide the sample among five groups of SMEs specializing in green tech solutions, sustainable transportation, eco-tourism, sustainable forestry, and bio-based industries. The choice of sector was determined by two main factors: the importance of each sector for China's green economy and the diversity of approaches to sustainability pursued by SMEs within each of the sectors. We carefully stratified the sample based on the size of the SME group's companies and their ownership structure to ensure generalization of the study's results to the Chinese SMEs population.

We developed a self-administered structured questionnaire to collect data on the influences of GMO, GKM, and GC on GCA. We meticulously designed the questionnaire to assess the specific factors under investigation, ensuring the accuracy and relevance of the collected data. Following the initial formation, we made minor changes based on feedback from a primary test group consisting of academic scholars and green business experts. This iterative feedback process ensured the questionnaire's validity and comprehensibility. We then distributed the final questionnaire to 510 Chinese firms, accompanied by a letter outlining the study's objective and emphasizing the voluntary nature of their participation. Participants received affirmation regarding the utmost confidentiality of their responses and their exclusive purpose for academic research. The emphasis on confidentiality and the voluntary nature of participation aimed to establish trust and encourage candid responses. A second reminder helped to receive 325 complete and credible surveys, resulting in a response rate of 63.72%. This response rate underscores the willingness of the participating firms to contribute to the research, reflecting the relevance and importance of our study in their context. Table 1 outlines the demographic characteristics and organizational profiles of the participants and firms involved in our research. According to the table, the respondents were educated, experienced, and participated in training programs offered by their employers to improve their managerial and interpersonal skills. These demographic details provide insights into the qualifications and skills of our survey participants, reinforcing the reliability of the collected data. The findings illustrate the employee knowledge, skills, and strategies Chinese firms implement to attain a green competitive advantage. The data collection for this research spanned from January to May 2023.

Table 1 Background of the respondents and firms.

Respondent's Profile	Frequency	Percentage (%)
Education		
Bachelor	168	51.69%
Master	137	42.15%
PhD	20	6.15%
Years of experience		
1 to 5 years	64	19.69%
5 to 10 years	149	45.85%
More than 10 years	112	34.46%
Firms' age		
1–5 years	42	12.92%
6–10 years	98	30.15%
More than 10 years	185	56.92%
Number of employees		
Less than 100	116	35.69%
100 to 250	117	36.00%
251 to 500	68	20.92%
More than 500	24	7.38%

Survey instrument development. We used several questionnaire items influenced by prior research to evaluate the study's hypotheses. We revised several items to align with the current investigation. We used a seven-point Likert scale to assess the exogenous variables. We generated the survey instrument before collecting the primary data, in accordance with Hair Jr. et al. (2019). We provided a copy of the research findings to six academic experts and seven industry professionals. Their goal was to ascertain the accuracy of these items in relation to the intended concepts. On a 3-point Likert scale, "3" indicated a high level, "2" indicated a moderate level, and "1" indicated a low level. The survey instrument only contained items graded a "3" by two or more experts and not a "1" by any. By employing an iterative process of feedback and modification, we ensured that our survey instruments were both thorough and relevant to the intricacies of the relationships we attempted to examine. We sourced the measuring instruments for this research from relevant literature. We measured GMO by adopting eight items inspired by the research of Du and Wang (2022) and Narver and Slater (1990). These items focused on assessing how firms align their market approaches with sustainability and eco-friendly strategies. We used five items, rooted in the research of Mao et al. (2016) and Soto-Acosta et al. (2018), to assess GKM, exploring how businesses manage and leverage eco-centric knowledge. We utilized GC's mediating constructs based on six items from the insights of Barczak et al. (2010) and Chen and Chang (2013), using sustainable business as the context. We assessed GCA by using four items from Chen and Chang's (2013) fundamental work to explore the ways in which sustainability-oriented initiatives provide firms with competitive leverage.

Data analysis techniques. We used Partial Least Squares Structural Equation Modeling (PLS-SEM) to test the hypotheses for this research. We selected PLS-SEM due to its ability to evaluate intricate relationships among variables and produce valid findings even with small sample sizes (Afum et al. 2023; Hair et al. 2011). This structural equation modeling (SEM) method focuses on causal explanations and predictive capabilities (Pratono et al. 2019). SmartPLS Version 4.0 was used for the analysis, and the model formulation highlighted a causal viewpoint (Wagner et al.

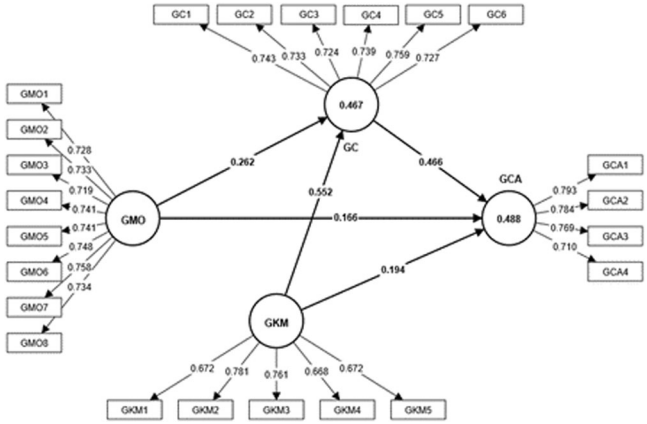

Fig. 2 Measurement model.

2018). As is the case with our research, PLS-SEM is particularly effective at handling complex models involving multiple constructs and connections. This approach is known for being robust in exploratory research settings where the main objective is to expand upon established theories and reveal significant relationships among constructs (Hair et al. 2019). Furthermore, its suitability for smaller sample sizes and less reliance on normal distribution assumptions make PLS-SEM an ideal method for the data that we collected (Hair et al. 2022). We utilized advanced techniques in PLS-SEM, including bootstrapping with 5000 subsamples, to ensure the reliability of our hypothesis testing. Using SEM, both measurement and structural models were constructed (Al-Hakimi et al. 2021). The measurement model's objective was to develop connections between observed variables and the latent constructs of interest, and the structural model inspected connections among these latent constructs. The structural model's validity was evaluated through the convergent and divergent validity criteria (Al-Hakimi et al. 2021).

To enhance the robustness of our PLS-SEM application, we used several different techniques in addition to bootstrapping. For example, we employed the latest techniques for testing discriminant validity, such as the heterotrait-monotrait (HTMT) ratio, to ensure that our constructs are different and evaluate distinctive aspects of the green business strategies under consideration. Recognizing the possible limitations of PLS-SEM, such as its variance-based nature, which may favor variance explanation above the study of latent construct associations, we carefully designed our model to address these issues. This includes taking a methodical approach to picking indicators for each construct based on theoretical relevance and empirical robustness, which improved the interpretability and relevance of our findings. We conducted a non-response bias analysis by comparing the responses of early respondents (the first 75% who returned the surveys) with late respondents (the remaining 25%) across all variables. We failed to find any significant differences in the comparisons made, indicating that response bias was not a major problem (Armstrong and Overton 1977). As suggested by Podsakoff et al. (2003), we conducted further statistical analysis using Harman's single-factor testing approach to investigate the potential common method bias (CMB). All exploratory factors underwent an analysis, and the findings suggested no substantial method bias because one single factor only explained 33.49% of the variance; this is less than the 50% threshold. The next section presents the research findings in detail.

Findings

The measuring model was assessed to ascertain the reliability and validity of the constructs employed in this study (Fig. 2). The constructs' reliability was evaluated using Cronbach's alpha (α) and composite reliability (CR). All constructs demonstrated satisfactory internal consistency, as the results for Cronbach's alpha were above the suggested level of 0.7 (Hair et al. 2022). The results indicate that green market orientation (GMO) exhibited a Cronbach's alpha coefficient of 0.882, green knowledge management (GKM) displayed an alpha coefficient of 0.760, green creativity (GC) yielded an alpha of 0.832, and green competitive advantage (GCA) manifested an alpha of 0.763. In addition to Cronbach's alpha, CR was also employed to assess the internal consistency of the constructs. The CR value for all constructs surpassed the recommended benchmark of 0.7 (Hair et al. 2019) (Table 2).

We assessed convergent validity by extracting the average variance (AVE) from each construct. The AVE values for all constructs were above the recommended threshold of 0.5, suggesting adequate convergent validity (Hair et al. 2011; Siddik et al. 2023). The AVE for the GMO, GKM, GC, and GCA were 0.544, 0.508, 0.544, and 0.585, respectively. Every item was found to be relevant to its corresponding construct since its loadings were all found to be higher than the suggested value of 0.6. The item GKM4 exhibited the lowest observed loading, with a loading value of 0.668 (Table 2).

We used the heterotrait-monotrait (HTMT) ratio to assess the discriminant validity. The range of recorded HTMT values is 0.372 to 0.823, with 0.823 being the highest value. Table 3 shows that the observed values are below the set threshold of 0.85, indicating that the elements have adequate discriminant validity (Henseler et al. 2015). The Fornell-Larcker criterion was also applied to confirm the discriminant's validity. This criterion states that each construct's square root of the average variance extracted (AVE) must be greater than the correlation of that construct with any other construct (Fornell and Larcker, 1981). Our study's results met this particular requirement, adding to the evidence supporting the variables' discriminant validity (Table 3). As a result, the measurement model demonstrated adequate levels of discriminant validity, convergent validity, and reliability, making it suitable for further examination in the structural model.

The variance inflation factor (VIF) was calculated for each construct to ensure the model did not exhibit multicollinearity. The VIF values for all constructs were significantly lower than the commonly accepted threshold of 5, suggesting that multicollinearity is not an issue in this study (Hair et al. 2012; Yan et al. 2022). The GCA had a VIF value of 1.877, while the GC had a value of 1.117. In this study, the R-square value for GCA was 0.488%, suggesting that its predictors account for approximately 48.8% of the variance in GCA (Siddik et al. 2023). Similarly, Table 4 shows that the predictors of GC explain about 46.7% of its variance, with an R-square value of 0.467. We evaluated the Q-square values to determine the predictive accuracy of the model (Huang et al. 2023). A Q-square value greater than zero reveals the model's predictive value for a specific construct. In our paper, the Q-square values for GCA and GC were 0.488 and 0.467, supporting the predictive reliability of the model for these constructs (Table 4).

Finally, the effect sizes of the relationships between the constructs were measured using the f-square values. According to the standards, F-square values of 0.02, 0.15, and 0.35 correspond to small, medium, and large effect sizes, respectively. Therefore, the association between GKM and GC exhibited a large effect size, but the association between GC and GCA had a moderate effect (Table 5). All the remaining associations had small effect sizes.

Table 6 provides an extensive analysis of model factors' direct and indirect impacts. The initial results suggest that GMOs positively affect enterprises' GCA. This is supported by the

Table 2 Results of the measurement model.

Construct	Items	Scale Items	Loading
Green Market Orientation (GMO) (AVE = 0.544, CR = 0.905, α = 0.882)	GMO1	Our firm continuously seeks to increase the environmental value that is provided to customers.	0.728
	GMO2	Our firm periodically revises environmental-friendly products to match customers' needs.	0.733
	GMO3	Our firm supplies customers with environmental protection information in order to enable them to get the best from our firm.	0.719
	GMO4	Our firm's competitive advantage is based on a better understanding of customers' demands for environmental protection.	0.741
	GMO5	Our firm's salespeople often share information about competitors' environmental operations and strategies.	0.741
	GMO6	Our firm responds quickly to competitors' environmental operations and strategies.	0.748
	GMO7	In our firm, top managers regularly discuss the strengths and weaknesses of competitors' environmental operations and strategies.	0.758
	GMO8	Top managers quickly share information about competitors' important environmental operations and strategies.	0.734
Green Knowledge Management (GKM) (AVE = 0.508, CR = 0.837, α = 0.760)	GKM1	Employees and partners at our organization have easy access to information on best-in-class environmentally friendly practices.	0.672
	GKM2	Our organization has procedures in place to gain knowledge about the environmental practices of our competitors, suppliers, clients, and strategic partners.	0.781
	GKM3	Our organization has structured mechanisms in place to exchange best practices across multiple disciplines of business operations.	0.761
	GKM4	Our organization develops initiatives (such as seminars, periodic meetings, and collaborative projects) that promote green information exchange across divisions/stakeholders.	0.668
	GKM5	Our organization actively engages in processes that apply knowledge to solve new challenges across organizational departments and beyond departmental boundaries.	0.672
Green Creativity (GC) (AVE = 0.544, CR = 0.877, α = 0.832)	GC1	Employees suggest new ways to achieve environmental goals.	0.743
	GC2	proposes new green ideas to improve environmental performance.	0.733
	GC3	promote and champion new green ideas to others.	0.724
	GC4	develop adequate plans for the implementation of new green ideas.	0.739
	GC5	would rethink new green ideas.	0.759
	GC6	would find creative solutions to environmental problems.	0.727
Green Competitive Advantage (GCA) (AVE = 0.585, CR = 0.849, α = 0.763)	GCA1	The company has the competitive advantage of the low cost of environmental management or green innovation compared to its major competitors.	0.793
	GCA2	The quality of the green products or services that the company offers is better than that of its major competitors.	0.784
	GCA3	The company is more capable of environmental R&D and green innovation than its major competitors.	0.769
	GCA4	The company is more capable of environmental management than its major competitors.	0.71

α Cronbach's Alpha, *CR* composite reliability, *AVE* average variance extracted.

Table 3 Discriminant validity.

	HTMT Criterion			
	GKM	**GMO**	**GC**	
GMO	0.372			
GC	0.779	0.496		
GCA	0.697	0.497	0.823	
	Fornell Larcker Criterion			
	GMO	GKM	GC	GCA
GMO	0.738			
GKM	0.324	0.713		
GC	0.441	0.637	0.738	
GCA	0.435	0.545	0.664	0.765

Table 4 The predictive power of the model.

Constructs	R^2	Q^2
Green creativity	0.467	0.25
Green competitive advantage	0.488	0.274

statistically significant beta coefficient (β1 = 0.166), *t*-value (*t* = 3.550), and *p*-value (*p* = 0.000), hence confirming hypothesis H1. In addition, the GMO of companies has a significant impact on their corporate GC (β2 = 0.262, *t* = 6.047, *p* = 0.000), hence providing evidence for hypothesis 2. It has been shown that there is a positive association between GKM and businesses' GCA, as indicated by the statistically significant coefficient β3 (0.194) with a *t*-value of 3.695 and a p-value of 0.000. This finding provides empirical support for hypothesis H3. Additionally, we discover that the GKM substantially influences firms' GCA (β4 = 0.552, *t* = 16.405, *p* =0.000), thus confirming hypothesis 4. The final analysis results demonstrate a significant relationship between GC and businesses' GCA (β5 = 0.468, *t* = 8.326, *p* = 0.000), supporting Hypothesis 5.

The mediation analysis (β6 = 0.123, *t* = 4.928, *p* = 0.000) also shows that the GC is a key part of the connection between GMO

Table 5 Effect sizes for the structural model relationships.

Effect size (f^2)		
	GCA	GC
GMO	0.043	0.116
GKM	0.044	0.511
GC	0.226	

Table 6 Results of structural equation modeling.

Hypotheses	Coefficients	SE	T statistics	Remarks
Direct effects				
H1: GMO → GCA	0.166***	0.047	3.550	Supported
H2: GMO → GC	0.262***	0.043	6.047	Supported
H3: GKM → GCA	0.194***	0.052	3.695	Supported
H4: GKM → GC	0.552***	0.034	16.405	Supported
H5: GC → GCA	0.468***	0.056	8.326	Supported
Indirect effects				
H6: GMO → GC → GCA	0.123***	0.025	4.928	Supported
H7: GKM → GC → GCA	0.258***	0.035	7.396	Supported

***Significant at the 1% level.

and GCA, which supports the sixth hypothesis. Furthermore, we found that GC is a mediator in the relationship between a company's GKM and GCA ($\beta 7 = 0.258$, $t = 7.396$, $p = 0.000$), confirming H7. Figure 3 illustrates the structural model of our research.

After presenting our SEM analysis results, it is critical to contextualize these findings in the broader methodological context of our research. Applying the SEM approach has enabled a detailed examination of the intricate connections between GMO, GKM, GC, and GCA. This analysis has effectively recognized the possibility of endogeneity by taking into account the multi-directional influences among the constructs. However, we acknowledge that SEM, despite its strong ability to represent these connections, may not completely address issues like simultaneous causality and omitted variable bias. To address these limitations, we developed our model by thoroughly reviewing both theoretical and empirical literature. This approach ensures that our model adequately reflects the complex nature of these relationships.

Discussion

This research focuses primarily on the relationship between GMO, GKM, and GCA, as well as the intervening role of GC. Our findings, in conjunction with existing literature, delineate several essential observations. Our research's first hypothesis was that GMOs have a positive effect on GCA. Consistent with prior studies, our findings substantiate this linkage. GMOs are a testament to a firm's commitment to adapting its strategies harmoniously with environmental concerns, resonating with consumer shifts towards green products. However, it is critical to consider the balance between supply and consumer needs to address the limited demand for green products. As highlighted by Claudy (2011), despite growing environmental awareness, market demand for green products often lags behind due to higher pricing and limited availability. This environmental alignment is not merely a reactive stance but a proactive strategic move, responding to environmental imperatives and consumer demands (Testa et al. 2012). It is evident from our study, as well as from the work of Lin et al. (2020), that the capability of companies to

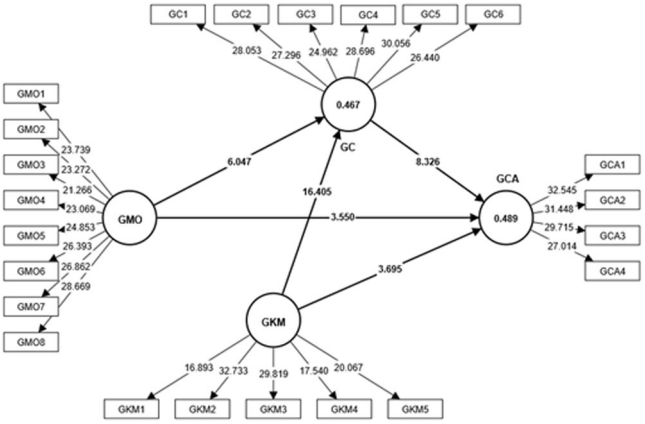

Fig. 3 Structural model.

infuse sustainable practices within their core strategies can lead to enhanced market positioning in understanding GCA. Additionally, we observed that firms deeply rooted in GMO tend to bring forth distinct green product offerings. Furthermore, the issue of greenwashing needs to be discussed, as it can undermine consumer trust and the perceived authenticity of green products. Ha (2022) noted that greenwashing practices can lead to skepticism among consumers, reducing the effectiveness of genuine green initiatives. This differentiation often results in a pronounced competitive advantage, reinforcing the findings of Ameer and Othman (2012) on the significance of green initiatives in shaping market dynamics. However, it is crucial to highlight that the positive correlation between GMOs and GCAs is not omnipresent. It is possible for firms to understand green markets deeply, but they must grapple with operational constraints that prevent translating this understanding into palpable competitive tactics (de Medeiros et al. 2016). In markets where green initiatives are abundant, even the most profound GMO may not yield a clear GCA advantage, particularly in contexts where greenwashing is prevalent (Ha 2022).

Hypothesis 2 illuminates the linkage between GMOs and GC. Our findings (Aboelmaged and Hashem 2019) solidify the positive association between these constructs, in line with existing scholarly work. GMOs are emblematic of a firm's commitment to proactively align with and shape the environmentally conscious demands of its consumers. This strategic alignment emphasizes reactive measures and the proactive identification of emergent green market trends (Porter and Kramer 2011). GC, by contrast, anchors itself in the innovative competencies of organizations. More than mere product innovation, GC encapsulates an eco-centric ethos spanning the complete lifecycle of a product—from conception to consumption. This approach guarantees a reduced environmental impact, optimizes resource use, and promotes a culture based on sustainable ideation (Hart and Milstein 2003). The synergy between GMOs and GC is both vital and transformative. Firms accentuating GMOs are, by design, equipped with nuanced market insights. When channeled through the crucible of GC, these insights yield avant-garde green products and solutions (Zhu et al. 2013). It is evident that GMOs do not merely guide a firm's innovative green pursuits—they propel them. Businesses adapt to the shifts in the green market and actively shape them, forging new paradigms in sustainable innovation with an entrenched GMO (Schaltegger and Wagner 2011). However, this narrative is layered. While GMOs provide navigational cues, the metamorphosis of these market insights into pioneering green solutions necessitates a confluence of myriad internal elements. Organizational culture, visionary leadership, and resource stewardship play cardinal roles in steering this

transformational odyssey from innovation insight (Aragón-Correa et al. 2008). Our findings resonate with broader academic discourse. Organizations must seamlessly integrate this orientation with their GC faculties to truly harness their GMO.

Our following hypothesis seeks to elucidate the relationship between GKM and GCA. The identification of a positive association between these constructs supports the perspectives found in contemporary literature. GCA denotes a company's capacity to harness green strategies, practices, and technologies to gain a competitive edge, distinguishing its market presence and solidifying stakeholder confidence (Chen 2011). This advantage resonates deeply with an ever-growing eco-aware customer base, emphasizing the necessity for businesses to adopt greener strategies. In this context, GKM is critical because it is an intricate process of accumulating, structuring, and proliferating environmental knowledge. There is a correlation between GKM and GCA, as well as a causative relationship. Firms adept at GKM are not just predisposed to attaining a GCA but rely on it to navigate the competitive landscape (Wu and Pagell, 2011). With their deep-rooted green knowledge reservoirs, such firms are poised to make informed strategic choices that enhance their competitiveness. This aligns with the assertion of Lee et al. (2014) that robust GKM processes do not just echo environmental responsibility but act as catalysts for market dominance. However, the dynamics are intricate. While GKM provides a vast knowledge repository, several factors influence the transition from possessing this knowledge to having a pronounced GCA. The application of green knowledge, its seamless integration into core business processes, and the enabling environment play crucial roles (Chen 2011; Huang and Rust 2011). Without these factors, GKM's immense potential might remain untapped. In light of these findings, it is evident that for firms to truly leverage their green knowledge assets, a strategic focus on translating this knowledge into competitive actions is paramount.

Hypothesis 4 explores the association between GKM and GC. In congruence with existing research, this study's findings affirm the positive linkage between these constructs. Ma et al. (2022) assert that GKM acts as a conduit, channeling environmentally conscious knowledge throughout the firm. Such an environment of enriched knowledge sharing becomes fertile ground for nurturing GC, as evidenced by heightened levels of innovation in green initiatives. Indeed, GC is a byproduct of the systematic implementation of GKM, as it infuses organizations with fresh, sustainable insights (Begum et al. 2022). Businesses adept at GKM practices are more agile in ideating green solutions, bolstering their competitive edge (Chang and Hung 2021). GKM facilitates the acquisition and dissemination of green knowledge, which in turn fosters a cognitive environment receptive to innovative, green-centric ideation. By ensuring that green knowledge is accessible and actionable, GKM is instrumental in nurturing a culture of green creativity. While GKM sets the stage, GC plays the pivotal role of spotlighting sustainable innovations (Turner 2011). A proactive approach to GKM could stifle the potential for GC. Therefore, the nexus between these constructs is not just correlative but also causative. Firms desiring to elevate their green creative endeavors should prioritize the seamless integration of GKM into their organizational fabric.

Our results reveal a strong correlation between GC and GCA. This result is consistent with earlier studies showing how crucial GC is to promoting an organization's GCA (Montabon et al. 2007; Yang et al. 2011). When organizations channel their creative energies toward environmentally sustainable initiatives, they are better positioned to meet the burgeoning consumer demand for eco-friendly solutions (Hart 2017; Testa and Iraldo 2010). This consumer-driven movement towards sustainability invariably enhances a firm's competitive stance in the market. The translation of GC into GCA can be witnessed in multiple facets. For instance, GC spurs the design and commercialization of green products and services, which resonate well with a growing segment of eco-conscious consumers (Liu et al. 2012). This results in an improved brand reputation and offers potential financial upsides as consumers are increasingly willing to spend more on eco-friendly options (Wong et al. 2012).

Moreover, GC acts as a catalyst for shaping a firm's external stakeholder relationships. Firms recognized for their green creativity tend to navigate regulatory landscapes more efficiently, given their proactive approach to environmental stewardship (Rao and Holt 2005). These firms also experience enhanced trust and credibility among investors, customers, and regulatory bodies (Hervani et al. 2005). Furthermore, the emphasis on GC encourages organizations to explore novel green supply chain practices, streamline operations for minimal environmental impact, and delve into strategic partnerships that emphasize sustainability (Carter and Rogers 2008). As firms progressively integrate these green creative strategies, they solidify their competitive footing, ensuring long-term GCA.

Examining GC's role as a mediator in the connection between GMOs and GCAs adds a new dimension to our understanding of green market dynamics. To address the existing supply demand gap in green products, it is crucial to consider limited market demand as a critical factor influencing this relationship (Heinemann et al. 2018). Findings from our research indicate that while GMO provides firms with insights into green market demands, actualizing these insights into competitive advantage requires innovative interventions facilitated by GC. While many researchers acknowledge the potential of GMOs to significantly drive competitive advantage in the marketplace (Bai and Chang 2015), there are contradictions and inconsistencies in these outcomes. GMOs might lead to a perceptible competitive advantage, particularly in sectors where consumers demonstrate high eco-consciousness (Rathore 2018). Yet, even if green, mere market orientation does not directly translate to competitive advantage (Tjahjadi et al. 2020). Furthermore, the challenge of greenwashing activities must be considered, as these can undermine the credibility of green marketing efforts (Heinemann et al. 2018). If businesses concentrate just on market insights, they risk losing sight of more important strategic objectives. In this complex backdrop, GC emerges as a compelling mediator. Creativity is the bridge that translates market insights into tangible products, services, or solutions. With its focus on innovative solutions to environmental challenges, GC becomes the transformative bridge for GMOs. Firms might comprehend the market demands through GMOs, but the capacity to innovate and capitalize on these demands via green creative strategies indeed ensures a solid GCA (Asiaei et al. 2022). The interplay between these elements becomes more critical when considering the limited demand for green products and the need to navigate the pitfalls of greenwashing (von Flüe et al. 2024). Additionally, organizational culture, regulatory pressures, and stakeholder expectations could further impact the dynamics between GMO and GCA, but a robust GC approach can effectively navigate these dynamics (Al-Swidi et al. 2021). Taking all of these points of view into account, it's clear that GC acts as a go-between and greatly improves the connection between GMO and GCA. It also gives businesses a way to make sure their market focus is carried out in the best and most creative way possible to gain the most competitive edge.

Similarly, we cannot overstate the pivotal role of GKM as an enabler for firms aiming to integrate environmental awareness into their competitive strategies. The notion that GKM can act as a catalyst, enhancing corporate ecological insights and augmenting strategic advantages, underlines this significance (Dangelico and Pujari 2010; Hart and Dowell 2011). Yet, while it is

tempting to perceive a direct correlation between GKM and GCA, empirical explorations suggest a more intricate interplay. Research has indicated that merely integrating green knowledge might not always directly foster competitive advantage (Porter and Van Der Linde 2017). Moreover, some studies highlight the risk of overprioritizing green knowledge, suggesting that it might inadvertently marginalize other competitive imperatives (Ambec and Lanoie, 2008). This multifaceted relationship signals the mediating influence of GC. GC serves as the mechanism that refines and applies green knowledge to actionable strategies, transforming abstract GKM into concrete, differentiated business tactics (Chen et al. 2006; Dangelico and Pujari 2010). The foundational premise is that while GKM forms the knowledge bedrock, GC operationalizes this knowledge, shaping eco-centric product innovations or service offerings that amplify a firm's competitive positioning (Sharma and Vredenburg 1998). Instances where GKM does not manifest into a palpable GCA might result from a firm's challenges in leveraging GC effectively. Conversely, companies proficient in GC can translate their green knowledge into unique market offerings, fortifying their competitive landscape (Darnall et al. 2010). Therefore, by integrating the abovementioned viewpoints, it becomes apparent that GC serves as a mediator and substantially influences the strengthening of the GKM and GCA's connection. This provides companies with a strategic pathway to successfully and innovatively implement their market orientation, maximizing their competitive advantage.

Conclusion and implications

This study investigated the interconnections between GMO, GKM, and GC, as well as how they collectively influence GCA. This study utilized dependable and robust statistical techniques to validate the proposed theoretical framework based on data from senior management at several companies. The main goal was to examine the complex interactions between these variables, focusing on GC as a mediator. The main focus of this study was the possible moderating effect of a firm's GKM and GMO on GCA growth. The findings firmly supported all the hypotheses, which revealed positive relationships among the exogenous variables, the endogenous variable, and the mediator variable's crucial mediating role. The research's conclusions emphasize the importance of a market perspective and knowledge management strategies' alignment with green initiatives, amplifying competitive advantage in an eco-conscious business landscape. The paper navigates the evolving realm of environmentally sustainable competitiveness by exploring the limitations, potential future research scopes, broad theoretical and practical prospects, and implications of this research.

Theoretical implications. Our study advances the field of sustainable business practices by conducting a thorough investigation of the interconnections among GMO, GKM, and GCA, as well as the mediating role of GC, which is one of its significant contributions. It aligns with previous research (León Bravo et al. 2022) by highlighting the importance of GMOs and their key focus on aligning a firm's strategies with eco-conscious consumer demands and sustainable product offerings. This study investigates GMO's ways of influencing a company's capability to achieve a competitive advantage within eco-conscious markets by advocating for eco-friendly innovation and aligning business practices with green consumer preferences (Du and Wang 2022). Additionally, incorporating GKM into the theoretical framework builds on the work of Chang and Chen (2013) and amplifies our grip on knowledge acquisition, dissemination, and application in a green business context. The effective management of eco-centric knowledge assets is pivotal in promoting sustainable business practices and improving competitiveness within green markets (Nagano and Iacono 2019). This paper also makes a significant contribution by intricately inspecting the mediating role of GC in the relationships between GMO, GKM, and GCA. This research inspects the roles played by creative thinking, specifically highlighting sustainable solutions, in mediating the interconnections between market orientation, knowledge management, and a company's GCA. This adds a layer of complexity to the comprehensive perspective and pathways that firms can follow to leverage their market orientation and acknowledge resources to nurture GC for achieving a competitive advantage in eco-conscious markets (Hao et al. 2022).

This study notably improves our theoretical understanding of the critical relationships among GMO, GKM, GCA, and GC, building upon prior research (Chang and Chen 2013; León Bravo et al. 2022). It provides an extensive theoretical framework that contributes to the discussion of green business strategies. Additionally, it offers valuable insights for academics and industry practitioners wanting to improve their environmental activities and competitive advantage in sustainable markets (Du and Wang 2022; Hao et al. 2022; Nagano and Iacono 2019).

Managerial implications. Our research empowers companies with managerial insights that help them excel in eco-conscious markets (Papadas et al. 2019). The paper provides actionable guidance to amplify sustainability strategies by investigating how GMO, GKM, and GCA interact while GC mediates (Chang and Hung 2021). The study shows the necessity of following GMO strategies that align products and services with eco-conscious consumer preferences (Chen et al. 2023). Given that the dynamic GMO approach can amplify a company's eco-competitive advantage, this study encourages managers to foster a corporate culture that cultivates environmentally oriented innovation and risk-taking (Orlando et al. 2022). A key finding demonstrates GMO and GKM's cooperative impact on GC, which, in turn, mediates the influence on GCA (Aeknarajindawat and Jermsittiparsert, 2019). This highlights the importance of encouraging creativity as a channel to turn market orientation and knowledge management into real competitive advantages in eco-conscious markets (Zameer et al. 2020). Acknowledging GC as a vital asset and assisting the effective integration of green practices can enable managers to focus on enhancing GC within their organizations (Riva et al. 2021). This study also discusses GC's mediating role in the connection between GMO and GCA, emphasizing GC's ability to turn market orientation into a competitive edge in sustainability-focused markets (Lin et al. 2020).

The study encourages managers to nurture a culture of eco-conscious innovation by highlighting how GKM crucially amplifies the workforce by providing necessary eco-centric skills and knowledge, thus facilitating green practices across organizations (Cardoni et al. 2020). Simultaneously, we should encourage a firm commitment to GMOs, as it validates and enhances the impact of these initiatives (Chahal et al. 2014). Managers can make well-informed decisions supporting their company's long-term viability and sustainability, creating a mutually beneficial effect that boosts their overall competitiveness in eco-conscious markets and green competitive advantage (Kaptanoglu et al. 2007). This holistic approach will orient their organizations toward a more sustainable and competitive future (Lopez-Torres et al. 2022). Management teams can utilize these insights to prioritize investments in sustainable initiatives, ensuring they are in line with market expectations and internal capabilities. By cultivating a culture of environmental innovation, companies

may not only fulfill regulatory requirements and meet customer demands, but also differentiate themselves in highly competitive industries.

In addition to these broader implications, our findings are particularly relevant to the small and medium enterprises (SMEs) sector, which plays a dominant role in developing countries. SMEs can significantly benefit from applying the principles of GMO, GKM, and GC. SMEs can achieve a competitive advantage in eco-conscious markets by tailoring these strategies to smaller-scale operations. For instance, SMEs can adopt flexible and adaptive GMO strategies, allowing quicker responsiveness to market shifts and consumer preferences for eco-friendly products and services (Seman et al. 2019). Furthermore, leveraging GKM in smaller organizations can lead to more efficient and innovative green practices, which are often less resource-intensive and more suited to the agile nature of SMEs (Arsawan et al. 2022). SMEs can also foster GC to develop unique, sustainable solutions that resonate with local markets and cultural contexts, enhancing their competitiveness (Baggia et al. 2019). This approach benefits SMEs in terms of market positioning and contributes to broader sustainability efforts in developing regions (Mady et al. 2023). Consequently, applying these strategies to SMEs can lead to a ripple effect, bolstering eco-consciousness and sustainable practices across various sectors and regions.

Firms can leverage our findings by first conducting an internal assessment of their existing green market orientation and knowledge management strategies. In addition, regular collaboration with external stakeholders such as suppliers, customers, and environmental specialists can provide novel perspectives and cultivate a more comprehensive understanding of green market trends. Ultimately, it is crucial for firms to develop quantifiable measures to assess the effectiveness of their green efforts, using these insights to continuously improve their strategies.

Limitations and future research directions. Even though this study helps shed light on the connections between GMO, GKM, GCA, and GC, it is essential to recognize their limitations and establish a trajectory for further research to improve our comprehension of green entrepreneurship and corporate strategies. One constraint of this study is its focus on larger organizations, which could potentially restrict the results' relevance to small and medium-sized enterprises (SMEs). Future research should delve deeper into the dynamics of GMO, GKM, GCA, and GC, keeping SMEs as the primary context, to obtain an expanded understanding of the field's knowledge. Future researchers can achieve a comprehensive understanding by incorporating longitudinal studies instead of cross-sectional data, which will emphasize the dynamic nature of these relationships over extended periods. Although SEM has been useful in studying the connections between our key constructs, it might be beneficial for future researchers to explore alternative methods that can more effectively address endogeneity. For instance, employing instrumental variable approaches or conducting longitudinal research might provide a more profound understanding of the causal dynamics in action. These methods would enhance the insights obtained from SEM and help in developing a more thorough comprehension of how companies may successfully manage the challenges of attaining a GCA.

Furthermore, even though we have made an effort to increase the representativeness of our sample by selecting SMEs across different sectors and geographic locations in China, we acknowledge that selection bias is a potential issue. Because our sampling procedure is voluntary, we selected a sample of SMEs who may, in principle, be more involved in green practices than average Chinese SMEs. This limitation is critical in the interpretation of the results, as well as in providing input for the development of policy-relevant information. We attempted to limit the potential selection bias by ensuring rigor in the sampling and stratification procedures. While our approach may be relatively effective in limiting selection bias, utilizing a voluntary sampling procedure does not solve the potential problem in absolute terms. One direct way to possibly lessen selection bias, endogeneity, or omitted variable bias is to try out and evaluate different strategies to deal with these issues in the context of green business and corporate strategy. Furthermore, we understand that conducting a longitudinal analysis of the evolution of green strategies and their impact on competitive advantage over time could enhance the design and create more testing opportunities. In addition, exploring both external and internal contextual factors that significantly influence these relationships would prove to be incredibly beneficial. Factors like regional environmental norms, entrepreneurial ecosystems, internal organizational culture, and ethos play a crucial role in shaping these dynamics, encouraging academics to explore relatively uncharted territories. Although this study's primary focus is the synergistic relationships between the factors, future studies should look into the hindrances, inconsistencies, and compromises businesses may encounter when incorporating GC into their operational frameworks. Academics can remarkably enhance our understanding of the intricate relationships among GMO, GKM, GCA, and GC if they address these limitations and conduct further research. This improved understanding will aid business owners and corporate executives in integrating environmental sustainability into their strategic endeavors. Companies will be better equipped to negotiate the difficulties and opportunities the green business landscape provides, enhancing their competitive standing.

Data availability

The data that support the findings of this study are attached as a supplementary data file and available from the corresponding authors upon reasonable request.

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Author contributions

Z.Z. confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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Competing interests

The authors declare no competing interests.

Ethics approval

This study is exempted in line with the Zhoukou Normal University ethical guidelines as per the Declaration of Helsinki, ensuring participant anonymity and avoiding sensitive topics. Informed consent was obtained during the data collection period of January to May 2023, detailing purpose, data use, and risks, emphasizing voluntary participation. This reflects our commitment to ethical standards, prioritizing participant rights and welfare. Since the study exempted and any procedures requiring ethical approval by an institutional review board, no specific ethical approval number was assigned.

Informed consent

Written and oral consent was obtained from all individuals involved in this study during the data collection period of January to May 2023.

Additional information

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