frontiers | Frontiers in Marine Science

TYPE Original Research
PUBLISHED 04 July 2024
DOI 10.3389/fmars.2024.1429781

OPEN ACCESS

EDITED BY
Yen-Chiang Chang,
Dalian Maritime University, China

REVIEWED BY
Shih-Ming Kao,
National Sun Yat-sen University, Taiwan
Mehran Idris Khan,
University of International Business and Economics, China
Maruf M.,
Dalian Maritime University, China
Hongyun Huang,
Shandong University, China

*CORRESPONDENCE
Yinxiao Xu
761011309@qq.com

RECEIVED 08 May 2024
ACCEPTED 17 June 2024
PUBLISHED 04 July 2024

CITATION
Mao S and Xu Y (2024) Manufacturing maritime firms' environmental behaviors: theory and practice.
Front. Mar. Sci. 11:1429781.
doi: 10.3389/fmars.2024.1429781

Manufacturing maritime firms' environmental behaviors: theory and practice

Shuling Mao[1] and Yinxiao Xu[2]*

[1]School of Law and Politics, Liaoning Normal University, Dalian, China, [2]Law School, East China University of Political Science and Law, Shanghai, China

Analyzing the factors that influence maritime manufacturing firms' environmental behavior is of significant theoretical and practical importance, particularly from a managerial cognition perspective. This study applies the regulatory focus theory to examine the complex relationship between environmental quality, regulation, and firms' environmental actions. Our findings reveal a U-shaped relationship between regional environmental quality and local firms' environmental consciousness. In regions with either better or poorer environmental conditions, firms demonstrate higher environmental consciousness. Specifically, firms in regions with better environmental quality exhibit a "promotion focus" on environmental issues, leading to proactive engagement in green innovation. Conversely, firms in regions with poor environmental quality adopt a "prevention focus" by pursuing ISO 14001 certification to maintain legitimacy and mitigate penalties. Moreover, we find that incentive regulations are more effective at stimulating green innovation among firms operating in regions with good environmental quality. In contrast, mandatory regulations drive higher ISO 14001 certification rates among firms located in areas with poor environmental quality. This study offers insights into the internal and external motivators of firms' environmental behavior, contributing to the literature on corporate environmental responsibility. Additionally, it provides policy recommendations to encourage active participation in environmental initiatives among maritime manufacturing firms.

KEYWORDS

manufacturing maritime firms, environmental quality, marine environmental consciousness, Environmental behavior, environmental regulation, regulatory focus theory

1 Introduction

Currently, approximately 97% of international trade is conducted via sea (Chang and Khan, 2023), implying that the shipping industry significantly contributes to carbon emissions and environmental pollution. Over the past decade, as global warming and climate change have accelerated, there has been a growing focus on environmental

management. This has led to increased interest in Green Supply Chain Management (GSCM) among businesses, governments, and consumers (Shang et al., 2010; Wu et al., 2012). Similarly, growing pressure for sustainable socio-economic development has led to increased attention from various sectors regarding environmental protection and sustainable development. Shipping firms are confronting new opportunities and challenges in the contemporary global economy. Specifically, there is a growing public awareness and concern about environmental issues such as resource depletion and pollution associated with shipping activities, spurred by the globalization of business operations (Lai et al., 2011). Business and political leaders have extensively deliberated on the topics of environmental conservation and sustainable resource management (Obama, 2009). In 2020, China committed to global climate and ecological preservation by announcing its goal to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060. Strengthening management and control at the "emission source" is essential to achieving this goal. Firms, acting as emission entities, play a pivotal role in achieving the "30–60 dual carbon goals."

Currently, environmental pollution and ecological destruction resulting from production and daily activities are still at a high level. In addition to factors such as delayed legislation and funding challenges, a crucial factor is the perception of ecological resources as free public goods in the traditional mindset of individuals, particularly profit-driven entrepreneurs. Moreover, the impact on the marine environment is particularly significant. Marine ecosystems face unique challenges due to pollution, overfishing, habitat destruction, and climate change. The degradation of marine resources not only threatens biodiversity but also affects industries reliant on healthy oceans, such as fisheries, tourism, and maritime transportation. Many top managers in enterprises lack a sense of responsibility and willingness to foster an ecological civilization, resulting in their reluctance to allocate resources to environmental protection. Consequently, understanding the complicated antecedents of firms' environmental consciousness is a crucial direction for analyzing their environmental behaviors (Bansal and Roth, 2000; Bianchi et al., 2022).

In assessing environmental consciousness within business contexts, it is important to analyze the specific behaviors and attitudes of maritime manufacturing firms towards ecological civilization and environmental protection (Chen and Zheng, 2020; Nazir et al., 2024). The maritime sector, encompassing industries such as shipbuilding, marine equipment manufacturing, and shipping logistics, faces unique challenges and opportunities related to environmental sustainability. Maritime manufacturing firms play a significant role in global trade and transportation, but they also have a substantial impact on marine ecosystems and coastal environments (Chen and Zheng, 2020; Tan et al., 2022). Despite growing awareness of environmental issues, studies suggest that many maritime manufacturing firms still face obstacles in adopting environmentally friendly practices due to factors such as cost concerns, regulatory complexities, and perceived conflicts between profitability and sustainability goals (Tan et al., 2022; Li et al., 2023).

It is crucial to recognize that the external environment, encompassing natural and institutional aspects, plays a significant role in shaping corporate environmental consciousness. However, prior research frequently treats executive environmental consciousness as a predetermined factor, focusing on its impact on firm behavior and performance (Chang, 2011), but neglects the process of environmental consciousness formation. The natural development of environmental consciousness is inherently challenging, and individuals' perception and appreciation of the natural environment are significantly influenced by the feedback they receive from both natural and social realms. Furthermore, while certain studies have observed changes in individual environmental consciousness influenced by a combination of natural and social factors (Franzen and Meyer, 2010), they have not thoroughly examined or deconstructed the concept of "environmental consciousness." There is an important dimension of consciousness — the regulatory focus.

Significantly, there are divergent focuses in terms of environmental consciousness. Specifically, some firms prioritize the "costs of pollution," while others prioritize the "benefits of green initiatives" (Wright and Nyberg, 2017). Various external environmental factors catalyze the emergence of different focuses, which in turn cause firms to prioritize environmental behavior in varying ways. Therefore, a comprehensive understanding of the notable differences in specific environmental behaviors among firms is elusive unless a specific analysis of the causes of environmental consciousness is conducted, and the regulatory focus of environmental consciousness is classified and discussed. Furthermore, enterprises are increasingly opting to implement environmental initiatives voluntarily, based on the belief that these actions will enhance environmental conditions and support economic growth (Lai et al., 2010). However, a recent study investigating green practices across various industrial sectors discovered that firms often do not align closely with this "win-win" mindset (Zhu et al., 2008). One prominent reason underlying this discrepancy is the absence of compelling incentives to justify the investment of time and resources required to embrace green practices.

Second, research on environmental consciousness often establishes a direct, linear relationship between environmental consciousness and behavior (Harris, 2008). Most studies assume that firms will engage in more environmental behaviors if their top managers have environmental consciousness. However, it is often observed that heavily polluting firms, despite having greater sensitivity and understanding of pollution emissions and environmental information than others, often lack the motivation to engage in environmental behavior proactively. Therefore, what is the true relationship between firms' environmental consciousness and their environmental behavior? The paper argues that there is currently no convincing answer to this question due to two key factors. One reason is that previous studies failed to consider varying dimensions of environmental consciousness specially in maritime manufacturing sector. The other is the absence of an examination of how managers' environmental consciousness impacts corporate environmental behavior across various situations such as marine manufacturing sector.

Third, existing research also indicates that firms' environmental behavior depends on the intervention of environmental regulations. The relationship between environmental regulations and maritime firms' environmental behavior has consistently been a crucial research topic (Reid and Toffel, 2009; Rennings and Rammer, 2011). Although, firm's policy and procedure (FPP) involves a corporate dedication to a sustainability vision or culture within a shipping firm. This includes commitments from senior managers to GSPs, backing for GSPs from mid-level managers, collaboration across departments for green initiatives, environmental compliance and auditing programs, ISO 14001 certification, environmental policy establishment, and system implementation. For example, Maersk prioritizes environmental protection and integrates this commitment into its business management. Maersk's environmental policy emphasizes minimizing environmental impact through resource conservation, operational optimization, and waste management, while continuously striving to enhance environmental performance and prevent pollution across all activities (Lai et al., 2011). Similarly, from a regulatory perspective, the adoption of Environmental Compliance (2007) developed by the International Chamber of Shipping and International Shipping Federation (available at www.marisec.org/environmental-compliance) imposes pressure on shipping companies to embrace GSPs.

Furthermore, the "Porter hypothesis" posits that while strict environmental policies may increase costs in the short term, they can stimulate firms to pursue technological innovations, leading to the adoption of more efficient production technologies and ultimately enhancing industrial competitiveness in the long run (Wubben, 2000; Chygryn et al., 2021). Since the Porter hypothesis was proposed, scholars have been involved in vigorous debates about its validity (Andersson and Börjesson, 2021). However, these debates have resulted in inconsistent research conclusions (Ford et al., 2014; Currie and Walker, 2019).

Although these studies have presented evidence for or against the Porter hypothesis from their respective perspectives, they have overlooked a crucial premise: the significance of well-designed environmental regulations. Environmental regulations can be classified into different types, including mandatory regulations and incentive regulations. The reasonable combination and design of different types of environmental regulations can often lead to favorable outcomes. Therefore, this study posits that selecting appropriate environmental regulations is vital for effectively guiding maritime firms' environmental behavior.

In the context of maritime ecosystems, the impact of environmental regulations is particularly important. Marine ecosystems face significant threats from pollution, overfishing, habitat destruction, and climate change, which can disrupt the delicate balance of marine life. Likewise, within maritime manufacturing, environmental behavior plays a critical role in minimizing the ecological footprint of shipbuilding, marine equipment manufacturing, and shipping logistics. By aligning environmental regulations with the unique challenges of maritime ecosystems and the environmental behavior of maritime manufacturing firms, policymakers can foster sustainable practices that promote the health and resilience of marine environments while supporting responsible industrial activities. Effective incentivization of firms' environmental efforts occurs when environmental regulations are tailored to the specific needs and focus of maritime stakeholders, promoting positive environmental outcomes across the maritime sector.

Hence, Firms that adopt a long-term orientation prioritize future-oriented strategies and investments, as opposed to short-term oriented firms that aim for immediate low-cost returns. Long-term oriented firms are more inclined to prioritize reducing their greenhouse gas (GHG) emissions, as they tend to allocate resources towards environmental efforts even when the benefits are not immediate or directly advantageous to the firm (Wang, 2016; Sternad and Kennelly, 2017).

To sum up, the existing literature has laid a foundation for studying the antecedents of maritime firms' environmental behavior, yet certain gaps remain. This study aims to address the following three research questions: First, what is the relationship between regional environmental quality and firms' environmental consciousness, particularly within the context of maritime manufacturing firms and their interactions with the marine environment? Second, how does the environmental consciousness of maritime manufacturing firms influence their environmental behaviors, especially concerning marine ecosystem sustainability? Third, how can the alignment of environmental regulations and the regulatory focus of environmental consciousness better incentivize maritime manufacturing firms' environmental behaviors towards marine ecosystem protection and sustainability?

This study aims to conduct an empirical analysis of maritime manufacturing firms, utilizing regulatory focus theory to explore how managers' orientations towards environmental issues impact their firms' environmental behaviors, particularly in relation to the marine environment. By examining the influence of managers' regulatory focus—whether promotion-focused, which emphasizes aspirations and accomplishments, or prevention-focused, which prioritizes safety and responsibility—the study seeks to understand how these orientations shape environmental practices within these firms. Additionally, the research investigates the effects of various types of environmental regulations, including command-and-control, market-based, and voluntary approaches, on the environmental behaviors of maritime manufacturing firms. By identifying the incentives created by different regulatory frameworks, the study aims to align these frameworks with the environmental consciousness of maritime manufacturing firms to promote sustainable practices. Ultimately, the objective is to provide insights into effective regulatory strategies that foster responsible stewardship of the marine environment and advance environmental sustainability in the maritime manufacturing sector.

2 Literature review

2.1 Environmental quality and maritime firms' environmental consciousness

Sustainable development is defined as the process of fulfilling current needs without jeopardizing the ability of future generations

to satisfy their own requirements. This concept has garnered universal endorsement and has progressively been enshrined in national and international legal frameworks and policies, such as the 1992 Rio Declaration, Agenda 21, and the Johannesburg Declaration. A fundamental aim of sustainable development is to reconcile resource utilization with environmental stewardship, ensuring that they are neither contradictory nor antagonistic, but rather mutually reinforcing. Environmental preservation is imperative for achieving sustainable resource exploitation, while the economic gains derived from resource use can create the conditions most conducive to effective environmental protection (Zou and Chang, 2021).

Environmental consciousness encompasses societal concern, attention, and understanding of environmental knowledge. Only when people have awareness and concern about environmental problems will they engage in environmental protection behaviors (Franzen and Meyer, 2010). Likewise, within firms, active guidance towards environmental protection activities is only possible when managers possess environmental responsibility, environmental consciousness, or environmentalist beliefs (Chang, 2011). Consequently, numerous studies grounded in environmental psychology have thoroughly examined the environmental consciousness of executives (Boiral et al., 2018). However, existing research often treats individual environmental consciousness as a static factor, focusing on its impact on firm behavior and performance while overlooking the complex antecedents that shape it. This oversight makes it challenging to fully understand the factors contributing to the variations in specific environmental behaviors observed among maritime firms.

Therefore, it is crucial to explore the environments in which individuals within the maritime sector exhibit heightened environmental consciousness and prioritize environmental issues. Drawing from a synthesis of existing research and practical experience in the maritime industry, this study emphasizes that individuals in maritime contexts tend to exhibit heightened environmental consciousness in environments characterized by distinct environmental qualities. As the International Maritime Organization (IMO) confronts governance challenges in today's context—exacerbated by climate change and technological advancements, such as artificial intelligence—initiatives like scoping exercises, the Sulphur 2020 regulations, and GHG emissions controls represent ambitious measures. These efforts are aimed at integrating new technologies and mitigating air pollution from ships, thereby navigating the complexities of contemporary maritime environmental management (Mukherjee et al., 2020; Khan et al., 2023).

The first situation follows the "pollution driving hypothesis," indicating that in regions with compromised environmental quality and escalated pollution levels, pollution will have significant adverse impacts on regional productivity and livelihoods (Franzen and Meyer, 2010). Thus, public environmental consciousness will be enhanced. For example, severe air pollution has had detrimental effects on residents' health. Additionally, water pollution and soil degradation have caused a scarcity of resources crucial for supporting regional economic development. In this situation, residents will gradually prioritize environmental protection and pollution control, fostering the motivation of individuals to bring about favorable changes in the environment. This effect influences managers in the region by directly altering their attitudes. Besides, it affects the attitudes of local stakeholders, such as the government, the community, and employees. Stakeholders' heightened demands on the environment compel managers to prioritize environmental protection and strive for energy conservation and emission reduction. Consequently, shipping materials (SM) focuses on recovering and repurposing used shipping resources to reduce costs and enhance operational efficiency. This includes activities such as selling surplus equipment and facilities, marketing used shipping materials like packaging and cartons, and collecting and reselling used oil. For instance, Maersk has implemented a thorough company policy regarding vessel recycling. This policy necessitates rigorous inspections of vessels prior to delivery to a recycling yard. These inspections ensure that recycled ships are free from oil spills, toxic water discharge, and other harmful environmental impacts associated with shipping material disposal. The procedures involve conducting radiation surveys and auditing hazardous materials to minimize environmental impacts during vessel recycling. Additionally, Maersk prioritizes designing and constructing new vessels with a high recycling ratio in mind (Lai et al., 2011).

However, the "pollution-driven hypothesis" suggests a positive linear relationship between pollution levels and public environmental consciousness. In fact, this research overlooks another situation: residents' value environmental protection in areas with high environmental quality. They are sensitive to non-compliant pollution emissions and environmental damage. They have higher demands and are concerned about potential environmental pollution (Bickerstaff and Walker, 2001), resulting in a positive response to environmental issues. Additionally, given the rising awareness of environmental issues across society, residents in areas with better environmental quality perceive "greenness" as a valuable resource for local socio-economic development (Porter and Kramer, 2019), representing a highly significant development advantage compared to other areas affected by pollution. Likewise, this will directly and indirectly affect the level of environmental concern among managers and shape firms' environmental consciousness.

In contrast, environmental issues may not attract significant attention from residents in maritime areas with relatively moderate environmental quality. Stakeholders in these regions may also place relatively low emphasis on environmental protection and pollution control. Therefore, environmental issues within the maritime sector may go unnoticed by managers whose primary goal is to maximize profits. Based on the above analysis within the maritime context, this study presents the baseline hypothesis: There is a U-shaped relationship between regional environmental quality and maritime firms' environmental consciousness. However, shipping design and compliance (SDC) entails sophisticated strategies aimed at minimizing the environmental impact of shipping activities throughout their lifecycle while ensuring compliance with regulatory standards. This involves implementing innovative approaches such as designing shipping activities and equipment to optimize material and energy usage, integrating practices that promote reuse, recycling, and material recovery, and developing

advanced equipment that reduces reliance on polluting energy sources (Lai et al., 2011). One key aspect of SDC is optimized voyage planning, which plays a crucial role in achieving fuel savings and environmental efficiency. For instance, Maersk has introduced the Voyage Efficiency System (VES), a sophisticated tool designed to identify the most fuel-efficient routes and implement a just-in-time steady running strategy. Additionally, initiatives like the Los Angeles Harbor Commission's Vessel Speed Reduction (VSR) Program, which encourages vessels to voluntarily reduce speed to a 12-knot limit within specific zones, demonstrate the commitment to environmental stewardship. Maersk actively participates in such programs, like the Ports of Los Angeles/Long Beach Vessel Speed Reduction Program, contributing to sustainable shipping practices (Lai et al., 2011).

Furthermore, Borja and colleagues explore the definition of Good Environmental Status (GES) as outlined by the European Union (EU) Marine Strategy Framework Directive (MSFD). GES is defined as the condition where marine waters provide ecologically diverse and dynamic oceans and seas which are clean, healthy, and productive. They emphasize the importance of operationalizing this concept by establishing clear, measurable indicators and targets. They discuss the 11 descriptors provided by the MSFD, which include biodiversity, fish populations, eutrophication, sea floor integrity, and contaminants, among others. They underscore the challenges in achieving GES, particularly due to the complexity and variability of marine ecosystems and the pressures exerted by human activities (Borja et al., 2013). Similarly, Cochrane and colleagues focus on the biological diversity descriptor of the MSFD. It details the criteria and methodological standards necessary for assessing biodiversity to achieve GES. They provide a comprehensive approach to monitoring and assessing marine biodiversity, including species, habitats, and ecosystems. They highlight the importance of maintaining ecosystem structure and functions and stress the need for coordinated monitoring efforts across EU member states. The report serves as a guideline for implementing biodiversity assessments and emphasizes the role of scientific research in informing policy decisions (Cochrane et al., 2010).

In addition, the foundational legal document of the MSFD outlines its objectives to protect and preserve the marine environment, prevent its deterioration, and, where practicable, restore marine ecosystems in areas where they have been adversely affected. The directive aims to achieve GES of the EU's marine waters by 2020 and ensure the sustainable use of marine goods and services. It mandates member states to develop Marine Strategies that include an initial assessment of their marine waters, determination of GES, establishment of environmental targets and monitoring programs, and the implementation of measures designed to achieve or maintain GES (European Commission, 2008). Likewise, Mee and colleagues examine the human values underlying the concept of GES and the implications for the MSFD. They discuss the difficulty of defining "good" environmental status due to the subjective nature of human values and perceptions. They argue that achieving GES requires balancing ecological, economic, and social objectives, which can sometimes be conflicting. The authors advocate for a participatory approach in the decision-making process, involving stakeholders from various sectors to ensure that the measures taken are equitable and reflect societal values (Mee et al., 2008).

2.2 Regulatory focus theory and maritime firms' environmental consciousness

Emerging issues in ocean governance encompass a wide range of concerns, including plastic pollution, blue carbon, ocean acidification, deep-sea mining, large marine protected areas, biodiversity conservation in international waters, aquaculture, and small-scale fisheries (Chang, 2023). Addressing these issues, alongside other scientific endeavors, necessitates the development of appropriate rules and regulations to manage their impacts while upholding the rule of law. Consequently, it is crucial to establish a timely and robust link between marine sciences, ocean governance, and the rule of law (Chang, 2023). Similarly, the complexities surrounding fuel supply, safety, regulation, and climate governance while exploring implications of low-Sulphur oil and alternative fuels (Chang, 2023). Furthermore, this paper aims to deconstruct the concept of "environmental consciousness" and analyze the different regulatory focus of firms' environmental consciousness based on the regulatory focus theory.

The basic assumption of psychology regarding the motivation of human behavior has been "the pursuit of pleasure and the avoidance of pain" (Sprigge, 1999). This principle suggests that seeking benefits and avoiding harm are inherent in human nature and explain the source and essence of human behavioral decision motivation. Building on this foundation, Higgins argued that "seeking benefits" and "avoiding harm" are two distinct motivational orientations that require further differentiation (Higgins, 1997). In his study, Higgins proposed the concept of two regulatory foci that individuals possess and explained how these foci are formed and achieved through distinct means. The regulatory focus theory, proposed by Higgins and further discussed by Higgins and Pinelli, suggests that individuals exhibit diverse goal orientations and pursue objectives through varying approaches (Higgins, 1998; Higgins and Pinelli, 2020). They commonly demonstrate two distinctive self-regulatory tendencies, referred to as "regulatory focus". One is promotion focus, which emphasizes positive outcomes, growth, progress, achievement, and long-term development. It entails a focus on higher levels of performance and an expectation of greater rewards and returns. The other is prevention focus, which emphasizes negative outcomes, the importance of fulfilling responsibilities and obligations, the pursuit of "legitimacy strategies," the avoidance of punishment and the achievement of security. An individual's regulatory focus can manifest as a stable, long-term personal trait or as a temporary state influenced by diverse external factors (Manczak et al., 2014).

In strategic management research, this perspective is often used to analyze how managers' different regulatory focuses influence their strategic decision-making (Ma et al., 2022). Moreover, this perspective has found application in the corporate environmental and green strategy literature. For example, in the context of

corporate sustainable transformation, managers driven by a promotion focus will emphasize the positive effects of environmental behavior and actively seek solutions to improve and enhance environmental governance throughout all industries and especially maritime sector. Conversely, managers with a prevention focus will primarily concentrate on avoiding punishment from the government and stakeholders due to non-compliance with environmental standards, as their primary motivation for decision-making is to enhance legitimacy.

Furthermore, an increasing body of literature has highlighted that a limited emphasis on individuals' regulatory focus and the application of this focus to anticipate decision outcomes often fail to yield consistent research findings (Neubert et al., 2008; De Cremer et al., 2009). Therefore, Higgins proposed the regulatory fit theory (Higgins, 2000), suggesting that individual regulatory focus should align with the decision situation to have its desired effects. This perspective can also be extended to analyzing organizational strategic behaviors within the maritime sector: managers are more likely to make sound strategic decisions when the external environment aligns with their regulatory focus (Lee et al., 2019; Huang and Zheng, 2022). Therefore, in addition to analyzing how different regulatory focuses influence maritime firms' environmental behaviors, it is also important to discuss how the institutional context (such as environmental regulations) aligns with the regulatory focus of managers (Lee et al., 2019; Huang and Zheng, 2022). Understanding this alignment can shed light on how managers navigate and respond to regulatory frameworks within the maritime sector, influencing strategic decisions that impact environmental outcomes and sustainability initiatives within maritime operations (Lee et al., 2019). This holistic approach considers both the internal cognitive factors of managers and the external institutional factors shaping environmental behaviors and strategic orientations in the maritime industry.

Building upon the regulatory focus theory, we aim to further analyze and explore the concept of "environmental consciousness" by examining the variations in managerial focus. We have noted that firms in regions characterized by both good and poor environmental quality have a certain level of environmental consciousness. However, is there a distinction in the regulatory focus of these firms between regions with good or poor environmental quality? We suggest that under conditions of poor environmental quality within the maritime sector, managers of maritime manufacturing firms are more likely to adopt a prevention focus when facing environmental issues. This means they have little incentive or willingness to proactively respond to environmental problems or make investments in green technologies (Aragòn-Correa et al., 2020; Wang et al., 2020, 2023). Their primary goal is to avoid punishment and maintain legitimacy in the face of regulatory pressures (Vourdachas, 2018; Wang et al., 2023). Although high pollution levels compel maritime firms to become environmentally conscious and recognize the urgency of addressing environmental issues, firms in highly polluted maritime areas may not always consider their emissions as "significant" compared to more severely affected regions. This mindset can lead to a reactive approach to environmental challenges rather than proactive initiatives aimed at improving environmental performance and sustainability within the maritime sector (Wang et al., 2023).

Consequently, understanding these dynamics is essential for developing targeted interventions and policies that encourage maritime firms to adopt more sustainable practices and contribute to environmental quality improvement. Instead, what they need to do is to ensure that their emissions are not significantly higher than those of other firms in order to avoid penalties, maintain legitimacy, and fulfill their environmental responsibilities and obligations appropriately (Bansal and Clelland, 2004; Shu et al., 2016). Therefore, when it comes to environmental issues, firms mainly emphasize legitimacy and obligations, making it easier for them to adopt a prevention focus.

In contrast, within the maritime sector and among maritime manufacturing firms operating in regions with better environmental quality, managers are more likely to adopt a promotion focus when addressing environmental issues. They proactively seek solutions to improve environmental performance, reduce emissions, employ technological advancements to address environmental problems, and emphasize the positive impacts of environmental protection (Li et al., 2020; Mulaessa and Lin, 2021). Residents in low-pollution maritime areas are highly sensitive to environmental and ecological damage, considering any pollution resulting from production and daily activities as "significant" and drawing the attention of the local community. Consequently, regional maritime firms should strive to improve and optimize their production methods, prioritize energy conservation, and focus on emission reduction to uphold environmental quality standards (Li et al., 2020; Mulaessa and Lin, 2021). This proactive approach not only helps in maintaining the ecological balance but also aligns with the local community's expectations and regulatory frameworks, fostering a culture of sustainability and responsible environmental stewardship within the maritime industry.

Moreover, in regions with higher environmental quality within the maritime sector, regional maritime manufacturing firms facing environmental issues still pay attention to maintaining their legitimacy. However, compared to firms in regions with poorer environmental quality, these maritime firms can leverage the region's overall "green advantage" to attain better growth. They view "green" practices not only as a means to avoid penalties but also as a strategic resource and pathway to gain a competitive advantage within the maritime industry (Li et al., 2020; Mulaessa and Lin, 2021). This strategic mindset underscores the importance of sustainable practices and environmental consciousness among maritime manufacturing firms operating in regions with varying environmental conditions.

3 Hypotheses

3.1 Firms' environmental behavior under varying regulatory focus in the maritime sector

This study aims to discuss whether and how environmental consciousness stimulates firms' environmental behavior

(Harris, 2008). Prior research usually neglects the gap between "consciousness" and "behavior," assuming a straightforward linear association between environmental consciousness and environmental behavior. This study posits that despite sharing similar levels of environmental consciousness, firms may have varying regulatory focuses on environmental issues, which changes their motivations for environmental behaviors. Therefore, based on regulatory focus theory, this study investigates the different environmental behaviors that firms may engage in under diverse regulatory focuses of their environmental consciousness.

In general, four types of environmental behavior have gained significant attention across various sectors. The first is environmental information disclosure. In March 2008, with the establishment of China's Ministry of Environmental Protection, firms' environmental behavior received further guidance and regulation at the policy level (Wang et al., 2018). Subsequently, Chinese listed firms have been progressively obligated to disclose their environmental actions and fulfill environmental responsibilities in their annual reports, corporate social responsibility reports, environmental reports, and other relevant documents. The implementation of the "Guidelines for the Preparation of Corporate Environmental Reports" on October 1, 2011, further standardized the process of preparing corporate environmental reports and clarified the obligation of firms to disclose environmental information. While the current regulatory requirements for environmental information disclosure are already well-defined and strict, firms have maneuverable space regarding how and when to disclose, along with the authenticity, accuracy, and completeness of the disclosed information (Reid and Toffel, 2009; Li et al., 2018, p. 100).

The second is firms' environmental investment. It encompasses investments in purchasing and operating environmental equipment and facilities, treating pollution and wastewater, emitting waste gases and solid waste, ecological shipbuilding, and organizing social activities related to the environment (Wang et al., 2018). However, because such investment does not always result in direct economic output, traditional corporate social responsibility research typically regards this investment as either a social responsibility investment or a cost to society.

The third is adopting and implementing environmental management systems (EMS) and associated management practices, as exemplified by ISO 14001 certification. Firms seeking ISO 14001 certification must obtain a "certificate of compliance" from the environmental protection department, adhere to national standards for environmental labeling of their products or technical requirements, maintain emissions within specified limits, and keep their environmental performance at a high level. Wuisan, van Leeuwen, and van Koppen investigated the Clean Shipping Project (CSP) and proposed that a key strategy to promote environmental awareness in the shipping industry is to encourage cargo owners or shippers to demand that their shipping suppliers or carriers adopt green practices (Wuisan et al., 2012). ISO 14001 mandates rigorous subcontractor management, encompassing adherence to green transport supplier criteria. Additionally, the CSP advocates for the use of the Clean Shipping Index as a supportive tool in the procurement process (Lirn et al., 2014). At present, ISO 14001 certification has established itself as a mature environmental management approach for firms and plays a crucial role in demonstrating their environmental legitimacy and responsibility to external stakeholders. Apart from ISO 14001, certain industries also have their own certification standards. For example, in the construction industry, Leadership in Energy and Environmental Design (LEED) is a green shipbuilding certification program (York et al., 2018).

The fourth is green innovation - Green innovation is a more proactive environmental action, providing more environmental and economic benefits. Developing an environmental policy – green policy is essential for establishing an effective environmental management system (Roy et al., 2001). The concept of a greener policy involves the adoption of environmental policies to cultivate a culture or vision of environmental protection (Lai et al., 2011). In the maritime sector, green innovation encompasses the development and adoption of new technologies, processes, or products aimed at reducing environmental pollution and minimizing the use of raw materials and energy. This includes innovations such as green product design tailored for maritime applications, advancements in environmentally friendly manufacturing processes specific to maritime operations, and the implementation of green management practices within maritime firms. Green innovation in the maritime sector plays a crucial role in promoting sustainability, enhancing resource efficiency, and mitigating the environmental impact of maritime activities on marine ecosystems. By fostering green innovation across these domains, the maritime industry can contribute to a more sustainable and environmentally responsible approach to maritime operations and marine resource management.

Green product innovation directly reflects the progress of green technology and has profound implications for the environment and ecology (Rehfeld et al., 2007). It helps firms optimize production methods, improve efficiency, and reduce the environmental burden caused by production (Chen and Chang, 2013). Moreover, green innovation brings long-term competitive advantages to firms (Frempong et al., 2021; Dai and Xue, 2022). Firms can not only gain a "green premium" by selling their green products and technologies but also occupy the green market, seize green opportunities, and establish unique green competitive advantages (Chen et al., 2006). However, it should be noted that green product innovation requires significant financial resources and exhibits dual externalities (Rennings, 2000) with high research and development costs. Therefore, strong motivation and incentives are often necessary for firms to engage in green innovation.

We focus on two types of environmental behaviors within maritime manufacturing firms: the certification of the environmental management system (ISO 14001) and green product innovation. On the one hand, these two types of environmental behaviors are driven by voluntary and proactive motivations of maritime firms, rather than passive responses to policies or pressures from stakeholders. On the other hand, these environmental behaviors substantially change maritime firms' overall management practices and production operations. Embracing ISO 14001 certification and engaging in green product innovation reflect a strategic commitment to sustainability within the

maritime sector, leading to improvements in environmental performance and the adoption of eco-friendly practices throughout maritime manufacturing processes and product development cycles.

As previously mentioned, individuals make different decisions and exhibit different behaviors based on varying regulatory focuses. In our research context, managers in areas with good or poor environmental quality possess a high level of environmental consciousness, which implies that they have a specific regulatory focus on environmental issues. However, their regulatory focus differs in these two types of areas. Consequently, their environmental behaviors will be different. Firms driven by a prevention focus are more inclined to adopt mature environmental management methods and obtain certification standards to maintain legitimacy and prevent penalties resulting from "illegitimacy." Hence, firms in areas with poorer environmental quality are more prone to adopting and certifying ISO14001 standards. Conversely, in areas with better environmental quality, firms are more inclined to embrace proactive green production practices, implement technological innovations, and engage in additional green product innovations, aiming to gain distinct competitive advantages through green innovation.

However, for firms located in areas with relatively moderate environmental quality, due to their insufficient environmental consciousness, managers cannot develop a regulatory focus on environmental protection and, therefore, will not engage in further protective behaviors.

Based on this, we propose the following hypotheses:

Hypothesis 1: Compared to firms in other regions, firms located in regions with better environmental quality initiate more green innovation.

Hypothesis 2: Compared to firms in other regions, firms located in regions with poorer environmental quality have higher ISO14001 certification rates. The relationship of "environmental quality-environmental consciousness-regulatory focus-environmental behavior" is summarized in Table 1.

TABLE 1 Relationship between environmental quality, environmental consciousness, regulatory focus, and environmental behavior.

Environmental Quality	Good	Moderate	Poor
Environmental consciousness	High	Low	High
Regulatory Focus	Promotion Focus	No Focus	Prevention Focus
Environmental behavior	Green product innovation	× ×	Certified ISO14001 standard

3.2 The moderating effect of environmental regulations

Moreover, firms' environmental behaviors heavily depend on the incentives offered by environmental regulations. In emerging economies like China, the institutional environment strongly influences the strategic choices made by firms. Nevertheless, environmental regulations may not always achieve the desired effectiveness. The regulatory fit theory posits that to optimize the impact of individual regulatory focus, it should be aligned with the decision-making context. This study posits that effective environmental regulations should align with the varying environmental consciousness influenced by different regulatory focuses of firms. Environmental behaviors of firms are effectively incentivized only when the objectives and means of environmental regulations align with the regulatory focus of managers.

Overall, environmental regulations can be divided into two types. The first is mandatory regulation, which focuses on enforcing firms' environmental actions and binding firms through administrative laws and regulations. The underlying rationale behind mandatory regulation is to deter firms from causing environmental harm by imposing penalties for such actions (Dowell and Muthulingam, 2017). This approach aims to urge firms to adopt specific environmental standards in their production practices. The second type is incentive regulation, which focuses on utilizing market incentives to encourage firms to invest in environmental activities. Incentive regulations stimulate firms' environmental behaviors through supporting and optimizing the development of green markets (Huang et al., 2019). Mandatory regulation emphasizes punishing environmental destruction, whereas incentive regulation emphasizes supporting the benefits derived from environmental protection.

Based on the framework of the regulatory focus theory and the regulatory fit theory, when a specific regulatory context emphasizes the benefits of environmental protection and provides increased encouragement and support for positive aspects of environmental behaviors, it aligns with the logic of a promotion focus. This alignment further reinforces the promotion focus of managers. Consequently, for maritime firms located in regions with better environmental quality, incentive regulations are more effective in stimulating environmental behaviors and promoting green innovation.

Conversely, for maritime firms situated in high-pollution areas with a prevention focus, mandatory regulations are more effective. This is because mandatory regulations align with the basic logic of the prevention focus, given their emphasis on the costs incurred by non-compliance. As a result, maritime firms might opt to adopt ISO 14001 standards to maintain legitimacy and avoid being penalized by environmental regulations. This nuanced understanding of regulatory focus and fit helps elucidate how different types of environmental regulations can influence maritime firms' behavior and strategic decision-making within varying environmental contexts.

This study derives the 2x2 matching framework depicted in Figure 1 and posits the subsequent hypotheses:

Hypothesis 3: For firms in regions with better environmental quality, incentive regulations can enhance their level of green innovation more effectively than mandatory regulations.

Hypothesis 4: For firms in regions with poorer environmental quality, mandatory regulations can increase the certification rate of ISO 14001 more effectively than incentive regulations.

Our theoretical framework is summarized in Figure 2.

	Mandatory regulation	Incentive Regulation
Prevention Focus	√	×
Promotion Focus	×	√

FIGURE 1
Matching of regulatory focus and environmental regulation.

4 Research design

4.1 Data

We constructed our sample with all publicly listed manufacturing firms on China's Shanghai and Shenzhen Stock Exchanges from 2010 to 2019. In 2007, the China Green Companies Public Welfare Project was officially launched, marking that Chinese firms have put "green" on the agenda. With the establishment of the Chinese Ministry of Environmental Protection (formerly known as the State Environmental Protection Administration) in March 2008, enterprises received specific guidance and regulations for their environmental protection activities in terms of policy. Subsequently, Chinese listed firms have been progressively required to disclose their environmental behavior and fulfill their environmental responsibilities through reports such as annual reports, corporate social responsibility reports, and environmental reports. The implementation of the Guidelines for the Compilation of Corporate Environmental Reports on October 1, 2011, played a significant role in standardizing the preparation of these reports. Therefore, starting from 2010 as the initial year, it is possible to observe the activities of firms in environmental protection more comprehensively and in-depth.

The firm-level data utilized in this study are sourced from the China Stock Market and Accounting Research Database (CSMAR) (available at: https://data.csmar.com/), incoPat Shared Global Patent Literature Database available at: https://www.incopat.com/login?locale=en), and annual reports of listed firms. Data on regional air quality, particularly the PM2.5 index, is obtained from the report data provided by the Atmospheric Composition Analysis Group at Dalhousie University in Canada (ResourceWatch, 2024). Information on regional environmental regulations is obtained from various sources, including Peking University Law Information, the China Statistical Yearbook published by the National Bureau of Statistics (NBSC, 2022), Provincial Statistical Yearbooks, and the China Insurance Yearbook.

We match the data obtained from these sources. For observations with incomplete or ambiguous records, additional information is obtained and verified through websites such as "QiChaCha" (available at: https://www.qcc.com/). Ultimately, a total of 17,245 observations were collected from 2,806 manufacturing firms between 2010 and 2019.

4.2 Measurement

(1) Environmental quality and environmental consciousness. Regional environmental quality is typically indicated by the level of pollution in the area. Specifically, air pollution is closely related to the activities of residents and local production. Research has shown that PM2.5, which refers to fine particulate matter with an aerodynamic equivalent diameter of 2.5 micrometers or less in the ambient air, stands out among air pollutants such as PM10, SO2, CO, O3, and API. It is considered the primary pollutant responsible for air pollution and draws significant attention across different sectors of society. Additionally, PM2.5 concentration provides a more accurate and objective measurement of the atmospheric pollution in a region compared to indicators like industrial "three wastes" emissions. Hence, we employ the annual average PM2.5 concentration as a metric to assess regional environmental quality. Using ArcGIS software, this article extracts the layer information of NC from grid data (in NetCDF format) provided by the Atmospheric Composition Analysis Group at Dalhousie University in Canada (available at: sites.wustl.edu/acag/datasets/surface-pm2–5/). Subsequently, the data is matched with China's administrative divisions through zoning statistics to obtain the annual average PM2.5 concentration data at the provincial level.

According to our theoretical framework, we also need to group different environmental qualities (good/poor/average). The specific

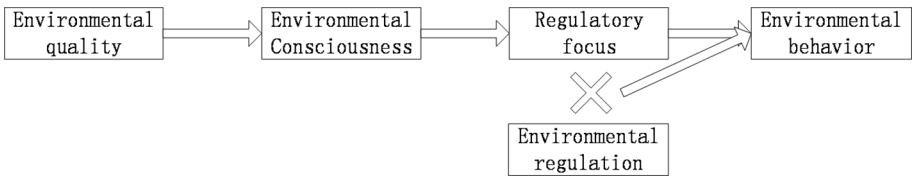

FIGURE 2
Theoretical framework.

grouping method is as follows: "Poor environmental quality" group (1 = the average annual concentration of PM2.5 in the province where the firm is located is the highest 25% among all provinces, 0 = others); "Good environmental quality" group (1 = the average annual concentration of PM2.5 in the province where the firm is located is the lowest 25% among all provinces, 0 = others).

For the construction of environmental consciousness indicators, this study chooses to use text analysis (Graf-Vlachy et al., 2020). We use Python to conduct text mining on the annual reports of listed firms. Based on the environmentally related keywords identified in previous studies (Wang et al., 2018), we counted the word frequency of the following keywords in the firms' annual reports: "ecology," "environmental protection," "green," "pollution," "emission," "energy consumption," "emission reduction," and "low carbon." This study selects and calculates the word frequency of these keywords from the financial reports of firms each year and calculates their proportion in the total word count of the financial reports to measure the focal firm's "environmental consciousness." Most importantly, In the context of improving environmental practices within maritime manufacturing firms and their supply chains, the adoption of ISO 14001 certification emerges as a critical factor. ISO 14001 is an international standard that provides a framework for establishing, implementing, maintaining, and improving environmental management systems. This certification signifies a firm's commitment to managing its environmental impact in a systematic and effective manner.

For instance, Ford Motor Company requires its suppliers, including those in maritime manufacturing, to utilize manufacturing facilities certified to ISO 14001 standards, demonstrating a proactive approach to environmental management (Sroufe and Curkovic, 2008). This requirement not only ensures compliance with environmental regulations but also promotes continuous improvement in environmental performance throughout the supply chain, including maritime manufacturing activities. In the shipbuilding industry, where shipowners increasingly demand environmentally friendly ships and sustainable production processes, ISO 14001 certification can play a crucial role. Maritime manufacturing firms can leverage ISO 14001 to enhance their environmental management practices and demonstrate their commitment to meeting regulatory requirements and customer expectations in the maritime sector. The integration of ISO 14001 into supply chain practices within maritime manufacturing underscores the importance of environmental considerations in modern business operations. By encouraging maritime manufacturing suppliers to adopt ISO 14001 and other green initiatives, lead firms promote sustainability throughout the value chain and mitigate environmental risks associated with maritime manufacturing activities. This proactive approach not only enhances environmental performance but also contributes to the overall competitiveness and reputation of maritime manufacturing firms in environmentally conscious industries.

(2) Green product innovation and ISO 14001 certification. Drawing on Flammer, Hong, and Minor's measurement (Flammer et al., 2019) for green patents and green innovation, this study first identifies green patents from the patents that firms apply for each year. In 2010, the World Intellectual Property Organization (WIPO) launched an online tool called the "International Patent Classification Green Inventory" (available at: www.wipo.int/classifications/ipc/green-inventory), which aims to facilitate the retrieval of environmentally friendly technology-related patent information. Based on the United Nations Framework Convention on Climate Change, this retrieval system classified green patents into seven categories: transportation, waste management, energy conservation, alternative energy production, administrative regulatory or design aspects, agriculture or forestry, and nuclear power generation. Following this classification standard, this article identifies and calculates the number of green patents obtained by firms each year based on the green patent IPC categories provided in the inventory. Finally, we measure firms' green innovation using the number of green patents applied for by firms in a given year (natural logarithm). In addition, the concept of green innovation was evaluated using three items that reflect a firm's innovative actions in relation to green or environmental processes, solutions, and products. These items were adapted from innovation metrics developed by Bell (Bell, 2005) and Wang (Wang, 2008). An example item from this assessment is: "Our firm is at the forefront of adopting new green technologies compared to our competitors." Similarly, following the adoption of the Maritime Labor Convention, 2006 by the ILO, which has become the fourth pillar of the international maritime legal regime, shipping firms should also adhere to the convention's requirements concerning the safety of human resources and the protection of the marine ecosystem (Khan et al., 2024).

For the certification of ISO 14001 in firms, this study measures it by setting a dummy variable (1 = focal firm has obtained ISO 14001 certification; 0 = focal firm has not obtained ISO 14001 certification). The data are obtained from the CSMAR Environmental Research Database.

Incentive regulation: We measure incentive regulation through the green finance index of the province where the company is located. Drawing on related research, the green finance index is calculated using the entropy method based on four dimensions: green credit (interest expenses of the six major high-energy-consuming industries/total industrial interest expenses), green investment (investment in environmental pollution control/GDP), green insurance (agricultural insurance income/total agricultural output value), and government support (environmental protection expenditure/total general budget expenditure).

(4) Control Variables: This study also controls for firm age, firm size (total number of employees in the current year), firm research and development intensity (proportion of R&D investment to total sales), as well as the firm's financial performance in the current year (difference between Tobin's Q value of the firm and the industry average). Additionally, we believe that the motivation for environmental efforts in heavily polluting industries differs from that of clean industries in manufacturing firms, and their sensitivity to environmental regulations is higher. Therefore, based on the 16 categories of heavily polluting industries summarized in the "Guidelines for Environmental Information Disclosure of Listed Firms" published by the Ministry of Environmental Protection in

2010, this study classifies the samples and controls for heavily polluting industries. At the same time, this study also controls for regional factors. First, we control for the level of industrial pollution control in each province, which was measured by the proportion of investment in industrial pollution control to the value added by the secondary industry. Second, we control for the original value of pollution levels in each province (in the model of grouped regression). Finally, this study sets year and industry fixed effects and controls for them.

In order to maintain the consistency of variable dimensions, this study standardized all variables (except for dummy variables).

4.3 Sampling: propensity score matching analysis (PSM)

It is important to note that the research design of this study is affected by a confounding factor, namely selection bias in sample selection. Specifically, the allocation of firms' locations is not random and is influenced by issues of self-selection and endogeneity in the choice of location. For instance, high energy-consuming and heavily polluting firms often cluster together to manipulate pollution levels to appear insignificant. Additionally, there is a close relationship between environmental quality and the level of industrial development in a region, leading to a larger accumulation of manufacturing firms in regions with higher levels of development. Despite the inclusion of some control variables at the regional level, this study does not fully address the aforementioned issues. To mitigate these issues, this study employs the one-to-one nearest neighbor method of propensity score matching [38] to better control for the selection bias. The goal is to achieve approximate equality among three groups of firms categorized as having good, medium, and poor environmental quality, by matching and controlling for individual-level heterogeneity based on important indicators.

This study conducts a two-step process to match three groups of samples based on their environmental quality, categorized as good, medium, and poor. Initially, this paper individually selects two groups of enterprises from the complete sample, specifically those categorized as having "poor environmental quality" and "good environmental quality". Subsequently, it considers various factors, including company size (revenue), age, research and development intensity, innovation ability (proportion of invention patents to total patents), financial performance (Tobin's Q), and industry (represented as an industry dummy variable). Utilizing these variables, the paper employs profit regression to calculate the propensity scores, which represent the likelihood of firms being situated in areas characterized by good or poor environmental quality. Following the acquisition of propensity scores, the paper utilizes a one-to-one nearest neighbor matching method to group observations with identical scores into the corresponding categories of good and poor environmental quality. Additionally, given that the samples are collected over multiple years, this study conducts the matching procedure on an annual basis. The specific econometric model is outlined as follows:

$$C(P_i) = \min_j \| P_i - P_j \|, j \in I_0$$

In this study, P_i and P_j represent propensity scores of participants in the intervention group (with poor environmental quality) and the control group (with good environmental quality), respectively. I_0 refers to the set of participants in the control group, where j is a participant in the control group. C (P_i) represents a set of "neighbor" relationships. When a match between j and i is found, j is removed from I_0 and not returned. Since a one-to-one matching approach is used, for each i, only a single j is found that falls into C P_i).

After the aforementioned matching process, we achieved no significant differences among each observation on important individual factors between the two groups of samples, namely "poor environmental quality" and "good environmental quality." Moving on, the second step is carried out, where the matched groups of "good and poor environmental quality" are matched with the two groups of samples from the original data on "moderate environmental quality." The matching process is consistent with the previous step. After completing this matching step, the complete sample for subsequent analysis is obtained in this study. In this sample, the number of observations in the three groups is also effectively controlled, with each group representing 25% of the total sample for "good environmental quality" and "poor environmental quality," and the "moderate environmental quality" observations accounting for 50% of the total sample. This further facilitates a better comparison of the behaviors of firms in different areas with varying environmental qualities in this research.

After PSM analysis and matching, and excluding observations with missing values in relevant variables, the final sample size used for the subsequent empirical analysis in this study is 7,118 observations from 2,075 manufacturing firms from 2010 to 2019. To evaluate the quality of matching, this study further tested whether there are significant differences between the "poor environmental quality" group and the "good environmental quality" group in terms of relevant variables. Table 2 shows the statistical characteristics of each group of firms before and after matching on important variables. Descriptive statistical analysis and correlation coefficient analysis of each variable in the matched sample are presented in Tables 3, 4, respectively.

5 Results

5.1 Regression results

Before conducting empirical analysis, we first perform Variance Inflation Factor (VIF) diagnostics on all explanatory variables and control variables included in the model. The results show that all VIF values are below 10, indicating no multicollinearity issues. Table 5 presents the regression results. Different regression models are used for different dependent variables. Specifically, for models (1–4) with environmental consciousness and green innovation (in natural logarithm) as the dependent variables, panel data OLS regression is employed. For models (5–7) with ISO 14001 certification as the dependent variable, panel data logit regression is used. We conduct our analyses using Stata 15.0.

In the regression results of Table 5, Model (1) tests the basic hypothesis of this study: there is a U-shaped relationship between

TABLE 2 Basic statistical characteristics of the two groups of observations of poor/good environmental quality before and after matching.

Before PSM matching					
	Poor environmental quality group (N=5784)		Good environmental quality group (N=4100)		
Variable	Average value	Standard deviation	Average value	Standard deviation	T-test for the difference between the two
Tobin's Q	-0.057	2.922	0.063	2.959	1.961**
Operating income	1.42e+10	1.16e+11	6.83e+09	2.14e+10	-3.991***
Heavy polluting industries	0.326	0.469	0.293	0.455	-3.531***
After PSM matching					
	Poor environmental quality group (N=2195)		Good environmental quality group (N=2174)		
Variable	Average value	Standard deviation	Average value	Standard deviation	T-test for the difference between the two
Tobin's Q	-0.082	1.110	-0.051	1.121	0.920
Operating income	6.13e+09	1.45e+10	6.65e+09	1.95e+10	1.015
Heavy polluting industries	0.391	0.488	0.352	0.478	-2.668***

*p< 0.1, **p< 0.05, ***p< 0.01.

regional environmental quality and firms' environmental consciousness. The results of Model (1) show that the coefficient of the first-order term for regional environmental quality (pollution level) (PM2.5) is significantly negative (β=-0.259, p<0.01), and the coefficient of the second-order term for regional environmental quality (pollution level) (PM2.52) is significantly positive (β=0.135, p<0.05). Moreover, the turning point of the U-shape (PM2.5 = 0.959) falls within the range of PM2.5 values (PM2.5 has been standardized), thus supporting the basic hypothesis of this study, that regional environmental quality and firms' environmental consciousness have a U-shaped relationship.

Model (2) is used to test hypothesis 1: firms located in regions with better environmental quality have higher levels of green innovation compared to firms in other regions. Model (2) shows that the coefficient for good regional environmental quality (low PM2.5) is positively significant (β=0.190, p<0.01), thus supporting hypothesis 1. Hypothesis 2 suggests that firms located in regions with poorer environmental quality have higher ISO14001

TABLE 3 Descriptive statistics of main variables.

Variable	Average value	Standard deviation	Maximum value	Minimum value
green innov.	0.320	0.737	6.026	0
ISO14001	0.287	0.452	1	0
PM2.5	39.362	12.123	85.629	9.566
PM2.5 high	0.254	0.436	1	0
PM2.5 low	0.240	0.427	1	0
env. penalty	2647.993	3674.678	17449	0
green finance	0.265	0.135	0.793	0.071
size	5082.854	10219.21	229154	50
age	9.248	6.958	28	0
RDintensity	4.179	3.700	76.35	0
tobin	-0.087	1.144	-3.023	12.843
dirty industry	0.582	0.493	1	0
prov. govern.	0.002	0.002	0.025	0.000

TABLE 4 Correlation matrix of main variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1.*PM2.5*													
2.*size*	-0.004												
3.*age*	0.001	0.258***											
4.*RDintensity*	-0.047***	-0.120***	-0.216***										
5.*tobin*	-0.034***	-0.107***	-0.027**	0.133***									
6.*dirty industry*	0.030**	0.022*	0.082***	-0.291***	-0.018								
7.*prov. govern.*	0.231***	0.037***	0.067***	-0.124***	-0.032***	0.106***							
8.*env. penalty*	-0.256***	0.045***	-0.071***	0.119***	0.025**	-0.111***	-0.212***						
9.*green finance*	-0.008	0.022*	-0.068***	0.164***	0.023*	-0.121***	-0.281***	0.396***					
10.*PM2.5 low*	-0.579***	0.051***	-0.028**	0.034***	0.016	-0.051***	-0.082***	0.171***	-0.103***				
11.*PM2.5 high*	0.695***	-0.009	-0.018	-0.010	0.003	0.007	0.087***	-0.002	0.024**	-0.328***			
12.*green innov.*	0.063***	0.299***	0.051***	0.022*	-0.060***	-0.145***	0.007	-0.049***	-0.009	0.045***	0.004		
13.*ISO14001*	-0.028**	0.044***	0.023**	-0.018	-0.027**	-0.015	-0.013	0.049***	0.023*	-0.002	0.007	0.043***	

N=7118; *p< 0.1, **p< 0.05, ***p< 0.01.

TABLE 5 Regression results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	full sample	full sample	full sample	poor regional environmental quality subsample	full sample	full sample	good regional environmental quality subsample
	env. orientation	green innov.	green innov.	green innov.	ISO14001	ISO14001	ISO14001
size	0.009	0.183***	0.183***	0.201***	0.083	0.088	0.589***
	(0.014)	(0.011)	(0.011)	(0.018)	(0.064)	(0.064)	(0.206)
age	0.025***	-0.002	-0.001	-0.001	0.001	-0.000	-0.018
	(0.002)	(0.002)	(0.002)	(0.004)	(0.011)	(0.011)	(0.025)
RDintensity	-0.003	-0.000	-0.000	-0.003	-0.033*	-0.033*	-0.061
	(0.003)	(0.003)	(0.003)	(0.005)	(0.019)	(0.019)	(0.048)
tobin	-0.020**	-0.015**	-0.015**	-0.023	-0.088*	-0.087*	0.091
	(0.008)	(0.007)	(0.007)	(0.017)	(0.049)	(0.049)	(0.110)
dirty industry	0.506***	-0.199***	-0.196***	-0.110	-0.327	-0.319	-0.287
	(0.058)	(0.042)	(0.042)	(0.097)	(0.264)	(0.264)	(0.546)
prov. govern.	-0.042***	0.012	0.015*	0.034*	0.060	0.055	-0.055
	(0.010)	(0.009)	(0.009)	(0.019)	(0.056)	(0.056)	(0.194)
industry FE	YES	YES	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES	YES	YES
env. penalty	0.022**	-0.059***	-0.048***	-0.100***	0.112**	0.090*	0.562**
	(0.009)	(0.008)	(0.013)	(0.020)	(0.049)	(0.050)	(0.230)

(Continued)

TABLE 5 Continued

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	full sample	full sample	full sample	poor regional environmental quality subsample	full sample	full sample	good regional environmental quality subsample
green finance	0.039**	0.001	-0.008	0.166***	0.060	0.050	-0.076
	(0.018)	(0.013)	(0.014)	(0.064)	(0.081)	(0.082)	(0.206)
PM2.5	-0.259***	0.113***	0.107***	0.129**	-0.268***	-0.227**	-0.103
	(0.060)	(0.013)	(0.013)	(0.062)	(0.093)	(0.096)	(0.287)
$PM2.5^2$	0.135**						
	(0.058)						
PM2.5 low		0.190***	0.214***				
		(0.026)	(0.028)				
low*penalty			-0.043**				
			(0.019)				
low*greenfin			0.128***				
			(0.042)				
PM2.5 high					0.344**	0.245	
					(0.174)	(0.180)	
high*penalty						0.296**	
						(0.140)	
high*greenfin						0.102	
						(0.133)	
_cons	-0.506***	0.305***	0.302***	0.507***	-1.568***	-1.561***	-1.508**
	(0.058)	(0.044)	(0.044)	(0.112)	(0.285)	(0.285)	(0.661)
N	7114	7118	7118	1709	7118	7118	1798
Wald chi2	1 630.92***	957.77***	969.27***	330.84***	98.78***	103.77***	46.42***

Standard errors are shown in parentheses. *p< 0.1, **p< 0.05, ***p< 0.01.

certification rates compared to firms in other regions. The results of Model (5) show that the coefficient for poor regional environmental quality (high PM2.5) is positively significant (β=0.344, p<0.05), thus providing support for hypothesis 2.

Next, we analyze how different types of environmental regulations influence the environmental behaviors of firms in regions with different environmental quality. First, models (3) and (4) are used to test hypothesis 3: for firms in regions with poor environmental quality, incentive regulations are more effective in improving their level of green innovation compared to mandatory regulations. Next, we test the moderating role of environmental regulations by introducing interaction terms. In model (3), the interaction term (*lowpenalty*) between good regional environmental quality (PM2.5 low) and mandatory regulations (env. penalty) is significantly negative (β=-0.043, p<0.05), indicating that mandatory regulations not only fail to promote green innovation among firms in regions with better environmental quality but also inhibit their green innovation. Conversely, the interaction term (*lowgreenfin*) between good regional environmental quality (PM2.5 low) and incentive regulations (green finance) is significantly positive (β=0.128, p<0.01), indicating that incentive regulations can promote green innovation among firms in regions with better environmental quality, supporting hypothesis 3. Second, we conduct separate regression analysis for all firms in regions with good environmental quality. The results of model (4) show that, under the sample of good regional environmental quality, the coefficient of mandatory regulations (env. penalty) is significantly negative (β=-0.100, p<0.01), while the coefficient of incentive regulations (green finance) is significantly positive (β=0.166, p<0.01), further indicating that only incentive regulations stimulate green innovation among firms in regions with better environmental quality, whereas mandatory regulations only have an inhibitory effect. Therefore, hypothesis 3 is supported.

Based on the same logic, this study tests Hypothesis 4: For businesses in regions with poor environmental quality, mandatory regulation is more effective in improving the certification rate of ISO 14001 than incentive regulation. First, this study sets up an interaction term to test the moderating effect of environmental regulation. In Model (6), the interaction term (*highpenalty*) between poor environmental quality (PM2.5 high) and mandatory regulation (env. penalty) is positively significant (β=0.296, $p<0.05$), indicating that mandatory regulation can indeed increase the ISO 14001 certification rate in regions with poor environmental quality. Conversely, the interaction term (*highpenalty*) between poor environmental quality (PM2.5 high) and incentive regulation (green finance) is not significant (β=0.102, $p>0.1$), suggesting that incentive regulation does not incentivize firms in regions with poor environmental quality to obtain ISO 14001 certification, which is consistent with Hypothesis 4. Similarly, this study conducts a separate regression analysis for all firms in regions with poor environmental quality. The results of Model (7) show that under the sample of poor environmental quality, the coefficient of mandatory regulation (env. penalty) is positively significant (β=0.562, $p<0.05$), while the coefficient of incentive regulation (green finance) is not significant (β=-0.076, $p>0.1$). This further indicates that only mandatory regulation can increase the ISO 14001 certification rate for firms in regions with poor environmental quality, while incentive regulation does not have an effect. Therefore, Hypothesis 4 is supported.

5.2 Robustness check

We tested the robustness of our results. First, we changed the measurement and grouping methods of environmental quality. In the previous model, the grouping of environmental quality was based on the mean concentration of PM2.5 in the province where the company is located, which was either the highest or lowest 25% among all provinces in the same year. In this study, two additional criteria, 20% and 30%, were used for grouping, and the regression analysis was performed with these criteria substituted into the original model. The results were consistent with the previous findings, indicating the robustness of the research results. Furthermore, another air pollution index (API index) was used as a proxy variable to measure environmental quality, and the results were still consistent with the previous findings.

Moreover, this study also changed the measurement of firms' environmental consciousness. In the previous model, this study used text analysis to measure the ratio of keyword frequencies related to "environmental protection/environment" in firms' financial reports. To eliminate ambiguity and subjectivity that may exist in text analysis and enhance the accuracy and objectivity of the research, we replaced it with two dummy variables (whether the firm disclosed environmental targets in its current annual report and whether the firm disclosed environmental protection concepts in its current annual report) to measure firms' "environmental consciousness". The new regression results remain consistent with the previous ones, further confirming the robustness of our research findings.

5.3 Supplementary analysis

Eco-innovation encompasses the creation of novel products and processes that serve the dual purpose of benefitting the environment while promoting environmental sustainability (Rennings and Zwick, 2002). Strategic investments in eco-innovation activities have been shown to optimize resource utilization within firms, ultimately leading to significant cost savings (Triguero et al., 2013). This proactive approach not only drives environmental progress but also enhances economic efficiency, underscoring the business case for embracing eco-innovation within organizational strategies. The previous analysis did not discuss the specific situation of the "medium environmental quality" group of firms but directly compared it with the other two groups as a control group. In order to make the research conclusions clearer, we need to supplement the analysis of this group, that is, to discuss whether the firms in the "medium environmental quality" area lag behind the other two groups of firms in terms of environmental consciousness and environmental behavior. Therefore, we set a new dummy variable "PM2.5 middle" for this group of firms, which takes the value 1 when the company does not belong to the poor environmental quality group or the good environmental quality group, and 0 otherwise. The regression results are shown in Table 6. The results show that in the model with environmental consciousness as the dependent variable (Model 1), the coefficient of medium environmental quality (PM2.5 middle) is negatively significant (β=-0.045, $p<0.1$), indicating that firms in the medium environmental quality areas indeed have weaker environmental consciousness. In the model with green innovation as the dependent variable (Model 2), the coefficient of medium environmental quality (PM2.5 middle) is still negatively significant (β=-0.041, $p<0.05$), indicating that firms in the medium environmental quality areas also have lower levels of green innovation. Finally, in the model with ISO14001 certification as the dependent variable (Model 3), the coefficient of medium environmental quality (PM2.5 middle) is not significant (β=0.109, $p>0.1$), indicating that firms in the medium environmental quality areas do not have higher ISO14001 certification rates. In summary, we further confirm that firms in the medium environmental quality areas are relatively lagging behind in terms of environmental consciousness and environmental behavior compared to the other two groups of firms.

6 Discussion

This study presents a meticulous examination of the intricate interplay among environmental quality, regulatory frameworks, and corporate environmental behavior, focusing on Chinese listed manufacturing firms. Grounded in both theoretical analysis and empirical investigation, it aims to illuminate the multifaceted relationships between these pivotal elements. The research embarks on a thorough theoretical inquiry, meticulously scrutinizing existing frameworks and theories to cultivate a nuanced comprehension of how environmental quality interfaces with corporate behavior. This theoretical foundation lays the groundwork for a rigorous empirical

TABLE 6 Regression results for the medium pollution level group.

	(1)	(2)	(3)
	env. orientation	green innov.	ISO14001
size	0.009	0.186***	0.082
	(0.014)	(0.011)	(0.064)
age	0.026***	-0.003*	0.002
	(0.002)	(0.002)	(0.011)
RDintensity	-0.003	-0.000	-0.032*
	(0.003)	(0.003)	(0.019)
tobin	-0.020**	-0.015**	-0.084*
	(0.008)	(0.007)	(0.049)
dirty industry	0.506***	-0.194***	-0.325
	(0.058)	(0.042)	(0.264)
prov. govern.	-0.044***	0.015*	0.040
	(0.010)	(0.009)	(0.055)
industry FE	YES	YES	YES
year FE	YES	YES	YES
PM2.5	-0.129***	0.072***	-0.148*
	(0.016)	(0.012)	(0.077)
env. penalty	0.021**	-0.054***	0.137***
	(0.009)	(0.008)	(0.050)
green finance	0.040**	-0.012	0.039
	(0.018)	(0.013)	(0.083)
PM2.5 middle	-0.045*	-0.041**	0.109
	(0.023)	(0.019)	(0.119)
_cons	-0.485***	0.366***	-1.530***
	(0.059)	(0.045)	(0.288)
N	7114	7118	7118
Wald chi2	1 628.94***	898.47***	95.65***

Standard errors are shown in parentheses. *p< 0.1, **p< 0.05, ***p< 0.01.

exploration. Drawing from comprehensive empirical findings, the study discerns the profound impact of environmental quality on firms' environmental consciousness. It delineates how variations in environmental conditions catalyze differential levels of environmental awareness and commitment among firms.

Moreover, the research delves into the consequential role of this environmental consciousness in shaping firms' regulatory orientation. It elucidates how firms prioritize compliance and adaptation to environmental regulations commensurate with their degree of environmental consciousness. Furthermore, the study probes into the nuanced responses of firms to diverse environmental regulations, elucidating how their regulatory behavior is intricately linked to their internal environmental priorities. It scrutinizes firms' proactive engagement with regulations, their propensity for innovation to meet compliance standards, and their propensity to exploit regulatory loopholes, all contingent upon their environmental consciousness.

Key findings from this research include:

U-Shaped Relationship Between Regional Environmental Quality and Firms' Environmental Consciousness: The analysis conducted in this study unveils a nuanced U-shaped relationship between regional environmental quality and firms' environmental consciousness, adding depth to our understanding of the complex interplay between environmental contexts and corporate behaviors. Remarkably, our findings suggest that firms located in regions characterized by either poor or excellent environmental quality exhibit heightened levels of environmental consciousness. This phenomenon underscores the significance of extreme environmental conditions in catalyzing a proactive environmental stance among corporations. Specifically, firms situated in regions with subpar environmental quality demonstrate a pronounced inclination towards environmental consciousness. Such adverse conditions likely necessitate heightened awareness and proactive measures to mitigate environmental risks and sustain business operations. Conversely, firms operating in regions renowned for their pristine environmental conditions exhibit a similar propensity towards environmental consciousness. Here, the imperative may lie in preserving the environmental integrity of the area, aligning with broader societal expectations and regulatory frameworks.

Intriguingly, our analysis also reveals a contrasting trend among firms situated in regions characterized by moderate environmental quality. Surprisingly, these firms exhibit comparatively lower levels of environmental awareness. These finding challenges conventional assumptions and suggests that moderate environmental conditions may not exert a sufficiently compelling influence to stimulate robust environmental consciousness among corporations. The observed U-shaped relationship underscores the nuanced nature of environmental responsiveness within the corporate landscape. It highlights the critical role of environmental extremities—whether detrimental or advantageous—in prompting firms to prioritize environmental concerns. Moreover, it raises pertinent questions regarding the efficacy of regulatory interventions and industry initiatives in fostering environmental stewardship amidst moderate environmental contexts.

Regulatory Focus Based on Environmental Quality: In dissecting the regulatory comportment of firms *vis-à-vis* the backdrop of varying regional environmental qualities, our research unveils a subtle interplay of strategic orientations nuanced by environmental contexts. Specifically, firms situated in regions endowed with superior environmental quality exhibit a discernible "promotion focus" in their environmental endeavors. This proactive stance manifests through deliberate investments in green innovation initiatives, leveraging their favorable environmental milieu to augment their ecological footprint positively. Such strategic positioning not only underscores a commitment to advancing environmental stewardship but also serves as a strategic lever to harness competitive advantage amidst

a landscape increasingly attuned to sustainability imperatives. Conversely, an intriguing departure emerges among firms navigating regions marked by ecological adversity. Here, a pronounced "prevention focus" takes root, steering organizational imperatives towards the preservation of legitimacy and reputational integrity amidst challenging environmental terrains. In lieu of pioneering innovation, these firms prioritize defensive maneuvers, with a pronounced emphasis on regulatory compliance and legitimacy-seeking behaviors. Notably, the pursuit of ISO 14001 certification emerges as a salient manifestation of this regulatory orientation, symbolizing a concerted effort to fortify organizational resilience against environmental exigencies.

This dichotomous regulatory orientation underscores the adaptive ingenuity of firms in tailoring strategic responses to the idiosyncratic demands of their environmental contexts. While firms in regions of environmental abundance leverage their advantageous position to spearhead proactive environmental initiatives, counterparts contending with ecological constraints pivot towards defensive strategies aimed at mitigating operational vulnerabilities. By unraveling these divergent trajectories, our study offers nuanced insights into the intricate interplay between environmental quality and corporate regulatory postures.

Effectiveness of Incentive Versus Mandatory Regulations: Our study delves into the comparative effectiveness of incentive-based and mandatory regulations in driving environmental compliance and innovation across regions characterized by varying environmental qualities. Our findings reveal a nuanced interplay between regulatory approaches and firms' strategic orientations, shedding light on differential responses shaped by environmental contexts. In regions boasting high environmental quality, incentive-based regulations emerge as potent catalysts for fostering green innovation among firms. Aligned with the promotion-focused mindset prevalent in such environments, these regulations leverage rewards and positive reinforcement to motivate firms towards enhancing their environmental practices. By offering tangible incentives for eco-friendly initiatives, such regulations not only stimulate proactive engagement but also cultivate a culture of continuous improvement, wherein firms strive to capitalize on their environmental advantages to gain competitive edge through innovation.

Conversely, in regions grappling with lower environmental quality, mandatory regulations exhibit greater efficacy, particularly in driving ISO 14001 certification rates among firms. This resonance with the prevention-focused ethos prevalent in such contexts underscores the significance of compulsory measures in ensuring compliance and bolstering legitimacy. Faced with environmental challenges, firms prioritize adherence to regulatory mandates as a means to fortify their organizational image and navigate reputational risks associated with environmental non-compliance. Mandatory regulations, characterized by their enforceability, serve as pivotal instruments for instilling discipline and ensuring conformity to prescribed environmental standards, thereby mitigating operational vulnerabilities and safeguarding organizational standing. This dichotomy in regulatory effectiveness underscores the importance of tailoring regulatory strategies to suit the specific environmental conditions and strategic orientations of firms. While incentive-based regulations thrive in stimulating innovation and proactive environmental engagement in regions endowed with favorable environmental conditions, mandatory regulations emerge as pragmatic tools for promoting compliance and legitimacy in regions confronting environmental adversities. By elucidating these differential dynamics, our research contributes valuable insights to policy formulation and strategic decision-making aimed at fostering enduring environmental sustainability and corporate responsibility across diverse environmental landscapes.

Further to explain, these insights underscore the imperative for managers within the manufacturing maritime sector to adopt a forward-thinking orientation. Such an orientation is crucial as it directly impacts their firms' environmental initiatives, particularly in green innovation and strategy. This is especially significant in the maritime sector, which faces unique and pressing sustainability challenges. While a long-term perspective indirectly supports the prioritization of emission reduction, the research suggests that managers can effectively achieve emission reductions through strategic green initiatives, even in the absence of a strong long-term outlook. The findings highlight that merely possessing a long-term perspective is insufficient for achieving emission reduction goals within the manufacturing maritime context. Instead, the cultivation of robust green strategies and innovation capabilities is paramount. This necessity underscores the need to prioritize these capabilities irrespective of temporal orientation, particularly in industries like maritime manufacturing that require sustained investments for substantial environmental impact.

Moreover, the analysis reveals a positive correlation between green strategy and green innovation within the maritime manufacturing sector. Firms that implement proactive green strategies are more likely to foster innovation in environmental practices. This suggests that organizations embracing sustainability are better equipped to develop and adopt innovative solutions tailored to the specific challenges of maritime manufacturing. While our model underscores the pivotal role of green innovation in emission reduction, it cautions against a narrow focus on innovation alone. Instead, we advocate for a comprehensive approach that integrates green strategy with innovative environmental initiatives, finely attuned to the complexities of maritime manufacturing operations.

Last but not least, the research provides significant policy implications for encouraging firms to proactively engage in environmental behaviors and implementing suitable environmental regulations. Effective environmental governance necessitates a sophisticated understanding of how regional environmental quality influences corporate environmental consciousness and behavior. Policy mechanisms must be designed to align with these insights, ensuring that both incentive-based and mandatory regulations are deployed strategically to maximize their impact on fostering sustainable practices within the manufacturing maritime sector. Furthermore, these findings underscore the importance of coordinated policy efforts and collaborative governance to achieve regional green and high-quality development, aligning the environmental efforts of both policymakers and firms to ensure genuine improvements in environmental performance.

7 Conclusion

The research offers significant policy implications for encouraging firms to proactively engage in environmental behaviors and implementing suitable environmental regulations:

Cultivating Firms' Environmental Consciousness: It is essential to help manufacturing firms understand the significance of environmental behavior. Effective allocation of limited resources to maximize benefits has always been a primary concern for managers. However, investing in environmental behavior is often perceived as a social cost that may conflict with managers' economic benefits, hindering many firms from engaging in such behaviors. This study suggests that, beyond considerations of corporate image, reputation, and stakeholder relationships, firms' perspectives on environmental issues may involve proactive engagement in green technological innovation to attain greater environmental benefits within relevant environmental and institutional contexts. Hence, cultivating and guiding environmental consciousness among firms is vital. This would enable managers to reassess the strategic significance of environmental protection and emphasize the technological value of environmental practices, ultimately facilitating firms in acquiring and accumulating green technologies and knowledge.

Targeted Environmental Regulation: Effective environmental regulation should be more targeted and "prescribe the right medicine." This study suggests that proper guidance of firms' environmental behavior through environmental regulation depends on selecting the appropriate regulations. Government environmental regulation should align with firms' understanding of environmental issues to enhance their motivation to protect the environment. For instance, incentive regulations can reward and support firms that proactively engage in environmental management, strive to optimize production processes, and improve production technology, thereby significantly enhancing environmental performance. Such regulations can further encourage increased investments in research and development of green technologies. Differentiated and targeted environmental regulation is more effective than a one-size-fits-all approach across all regions, as it fosters environmentally friendly and high-quality development of firms in different sectors, thereby enhancing the overall effectiveness of environmental regulation.

Effective and Collaborative Governance: Establishing effective and collaborative governance between policies and firms is crucial for addressing environmental issues, necessitating a careful balance between incentive and mandatory regulations. The research indicates that regional green and high-quality development can be achieved through the joint efforts of policy and firms. On the one hand, it is essential to identify the factors influencing corporate environmental consciousness. A comprehensive understanding of how managers' environmental consciousness influences firms' environmental strategies, particularly in varying contexts, can shed light on the mechanisms that motivate firms to proactively participate in environmental actions. On the other hand, analyzing the alignment between various types of environmental regulations and the motivation and consciousness of firms' environmental behavior is crucial for ensuring the effectiveness of the regulations. Genuine improvement in the region's environmental performance is only possible when the environmental efforts of policymakers and firms are effectively aligned and coordinated.

Furthermore, policy mechanisms such as technology push through public development contracts and market pull via public procurement play vital roles in accelerating sustainability within manufacturing maritime firms. These mechanisms are crucial for transitioning towards lower emission levels at sea, aligning with broader efforts to promote environmental responsibility in maritime operations. While firms should be encouraged to actively participate in this transition, effective policy changes are essential to inspire and incentivize innovative projects and the adoption of green strategies at organizational levels. Stakeholder involvement and coordinated actions across government and industry are crucial for successful policy implementation. In addition to these policy measures, the implementation of environmental management systems such as ISO 14001 within firms can significantly enhance their environmental behaviors. ISO 14001 is an internationally recognized standard that provides a framework for establishing, implementing, maintaining, and improving environmental management systems. By adopting ISO 14001, manufacturing maritime firms can systematically manage their environmental impact, improve resource efficiency, and demonstrate a commitment to sustainability to stakeholders and regulatory bodies. Achieving considerable sector-wide reductions requires a multifaceted approach with various policies and regulations. A transition to more sustainable business operations at sea demands clear and concise policy regulations from governments at both national and international levels. While sector ambition is a positive step forward, sustained long-term support from policymakers is essential for driving technology and market development that leads to significant emission reductions over time (Bouman et al., 2017).

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

SM: Writing – review & editing, Writing – original draft. YX: Writing – review & editing, Formal Analysis, Data curation.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Andersson, Ö., and Börjesson, P. (2021). The greenhouse gas emissions of an electrified vehicle combined with renewable fuels: Life cycle assessment and policy implications. *Appl. Energy* 289, 116621. doi: 10.1016/j.apenergy.2021.116621

Aragòn-Correa, J. A., Marcus, A. A., and Vogel, D. (2020). The effects of mandatory and voluntary regulatory pressures on firms' Environmental strategies: A review and recommendations for future research. *Acad. Manage. Ann.* 14, 339–365. doi: 10.5465/annals.2018.0014

Bansal, P., and Clelland, I. (2004). Talking trash: legitimacy, impression management, and unsystematic risk in the context of the natural environment. *Acad. Manage. J.* 47, 93–103. doi: 10.5465/20159562

Bansal, P., and Roth, K. (2000). Why companies go green: A model of ecological responsiveness. *Acad. Manage. J.* 43, 717–736. doi: 10.5465/1556363

Bell, G. G. (2005). Clusters, networks, and firm innovativeness. *Strateg. Manage. J.* 26, 287–295. doi: 10.1002/(ISSN)1097-0266

Bianchi, G., Testa, F., Boiral, O., and Iraldo, F. (2022). Organizational learning for environmental sustainability: internalizing lifecycle management. *Organ. Environ.* 35, 103–129. doi: 10.1177/1086026621998744

Bickerstaff, K., and Walker, G. (2001). Public understandings of air pollution: the 'localisation' of environmental risk. *Glob. Environ. Change* 11, 133–145. doi: 10.1016/S0959-3780(00)00063-7

Boiral, O., Raineri, N., and Talbot, D. (2018). Managers' Citizenship behaviors for the environment: A developmental perspective. *J. Bus. Ethics* 149, 395–409. doi: 10.1007/s10551-016-3098-6

Borja, A., Elliott, M., H. Anderson, J., C. Cardoso, A., Carstensen, J., G. Ferreira, J., et al. (2013). Good Environmental Status of marine ecosystems: What is it and how do we know when we have attained it? *Mar. pollut. Bull.* 76, 16–27. doi: 10.1016/j.marpolbul.2013.08.042

Bouman, E. A., Lindstad, E., Rialland, A. I., and Strømman, A. H. (2017). State-of-the-art technologies, measures, and potential for reducing GHG emissions from shipping – A review. *Transp. Res. Part Transp. Environ.* 52, 408–421. doi: 10.1016/j.trd.2017.03.022

Chang, C.-H. (2011). The influence of corporate environmental ethics on competitive advantage: the mediation role of green innovation. *J. Bus. Ethics* 104, 361–370. doi: 10.1007/s10551-011-0914-x

Chang, Y.-C. (2023). Editorial: Rule of law in the governance of new frontiers of the marine environment. *Front. Mar. Sci.* 10. doi: 10.3389/fmars.2023.1277409

Chang, Y.-C., and Khan, M. (2023). The Maritime Labour Convention 2006 in human rights context: An appraisal. *Mar. Policy* 154, 105688. doi: 10.1016/j.marpol.2023.105688

Chen, Y.-S., and Chang, C.-H. (2013). The determinants of green product development performance: green dynamic capabilities, green transformational leadership, and green creativity. *J. Bus. Ethics* 116, 107–119. doi: 10.1007/s10551-012-1452-x

Chen, Y.-S., Lai, S.-B., and Wen, C.-T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *J. Bus. Ethics* 67, 331–339. doi: 10.1007/s10551-006-9025-5

Chen, X., and Zheng, J. (2020). Countermeasures for marine environmental pollution governance: an ecological civilization perspective. *J. Coast. Res.* 106, 355–358. doi: 10.2112/SI106-082.1

Chygryn, O., Rosokhata, A., Rybina, O., and Stoyanets, N. (2021). Green competitiveness: the evolution of concept formation. *E3S Web Conf.* 234, 4. doi: 10.1051/e3sconf/202123400004

Cochrane, S., Connor, D., Nilsson, P., Mitchell, I., Reker, J., Franco, J., et al. (2010). Marine strategy framework directive - task group 1 report biological diversity. *JRC Publ. Repos.* doi: 10.2788/86653

Currie, J., and Walker, R. (2019). What Do Economists Have to Say about the Clean Air Act 50 Years after the Establishment of the Environmental Protection Agency? *J. Econ. Perspect.* 33, 3–26. doi: 10.1257/jep.33.4.3

Dai, D., and Xue, Y. (2022). The impact of green innovation on a firm's value from the perspective of enterprise life cycles. *Sustainability* 14, 1226. doi: 10.3390/su14031226

De Cremer, D., Mayer, D. M., van Dijke, M., Schouten, B. C., and Bardes, M. (2009). When does self-sacrificial leadership motivate prosocial behavior? It depends on followers' prevention focus. *J. Appl. Psychol.* 94, 887–899. doi: 10.1037/a0014782

Dowell, G. W. S., and Muthulingam, S. (2017). Will firms go green if it pays? The impact of disruption, cost, and external factors on the adoption of environmental initiatives. *Strateg. Manage. J.* 38, 1287–1304. doi: 10.1002/smj.2603

European Commission (2008). Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance). Available online at: https://eur-lex.europa.eu/eli/dir/2008/56/oj (Accessed June 9, 2024).

Flammer, C., Hong, B., and Minor, D. (2019). Corporate governance and the rise of integrating corporate social responsibility criteria in executive compensation: Effectiveness and implications for firm outcomes. *Strateg. Manage. J.* 40, 1097–1122. doi: 10.1002/smj.3018

Ford, J. A., Steen, J., and Verreynne, M.-L. (2014). How environmental regulations affect innovation in the Australian oil and gas industry: going beyond the Porter Hypothesis. *J. Clean. Prod.* 84, 204–213. doi: 10.1016/j.jclepro.2013.12.062

Franzen, A., and Meyer, R. (2010). Environmental attitudes in cross-national perspective: A multilevel analysis of the ISSP 1993 and 2000. *Eur. Sociol. Rev.* 26, 219–234. doi: 10.1093/esr/jcp018

Frempong, M. F., Mu, Y., Adu-Yeboah, S. S., Hossin, M. A., and Adu-Gyamfi, M. (2021). Corporate sustainability and firm performance: the role of green innovation capabilities and sustainability-oriented supplier–buyer relationship. *Sustainability* 13, 10414. doi: 10.3390/su131810414

Graf-Vlachy, L., Bundy, J., and Hambrick, D. C. (2020). Effects of an advancing tenure on CEO cognitive complexity. *Organ. Sci.* 31, 936–959. doi: 10.1287/orsc.2019.1336

Harris, P. G. (2008). Green or brown? Environmental attitudes and governance in greater China. *Nat. Cult.* 3, 151–182. doi: 10.3167/nc.2008.030202

Higgins, E. T. (1997). Beyond pleasure and pain. *Am. Psychol.* 52, 1280–1300. doi: 10.1037/0003-066X.52.12.1280

Higgins, E. T. (1998). "Promotion and Prevention: Regulatory Focus as A Motivational Principle," in *Advances in Experimental Social Psychology*. Ed. M. P. Zanna (Academic Press, Elsevier), 1–46. doi: 10.1016/S0065-2601(08)60381-0

Higgins, E. T. (2000). Making a good decision: Value from fit. *Am. Psychol.* 55, 1217–1230. doi: 10.1037/0003-066X.55.11.1217

Higgins, E. T., and Pinelli, F. (2020). Regulatory focus and fit effects in organizations. *Annu. Rev. Organ. Psychol. Organ. Behav.* 7, 25–48. doi: 10.1146/annurev-orgpsych-012119-045404

Huang, Z., Liao, G., and Li, Z. (2019). Loaning scale and government subsidy for promoting green innovation. *Technol. Forecast. Soc Change* 144, 148–156. doi: 10.1016/j.techfore.2019.04.023

Huang, C., and Zheng, W. (2022). CEO regulatory focus, analysts' Optimism bias, and firm strategic change: evidence from Chinese-listed companies. *Front. Psychol.* 13. doi: 10.3389/fpsyg.2022.813920

Khan, M., Butt, M. J., and Chang, Y.-C. (2023). Maritime Law in Motion: Book Review. *China Oceans Law Rev.* Available online at: https://heinonline.org/HOL/LandingPage?handle=hein.journals/cholr2023&div=29&id=&page.

Khan, M., Chang, Y.-C., and Bibi, A. (2024). Navigating Pakistan's Maritime Industry potential in context of blue economy: An analysis of the necessity for ratification of maritime labour convention 2006. *Mar. Policy* 165, 106150. doi: 10.1016/j.marpol.2024.106150

Lai, K.-H., Cheng, T. C. E., and Tang, A. K. Y. (2010). Green retailing: factors for success. *Calif. Manage. Rev.* 52, 6–31. doi: 10.1525/cmr.2010.52.2.6

Lai, K.-H., Lun, V. Y. H., Wong, C. W. Y., and Cheng, T. C. E. (2011). Green shipping practices in the shipping industry: Conceptualization, adoption, and implications. *Resour. Conserv. Recycl.* 55, 631–638. doi: 10.1016/j.resconrec.2010.12.004

Lee, P. T.-W., Kwon, O. K., and Ruan, X. (2019). Sustainability challenges in maritime transport and logistics industry and its way ahead. *Sustainability* 11, 1331. doi: 10.3390/su11051331

Li, D., Huang, M., Ren, S., Chen, X., and Ning, L. (2018). Environmental legitimacy, green innovation, and corporate carbon disclosure: evidence from CDP China 100. *J. Bus. Ethics* 150, 1089–1104. doi: 10.1007/s10551-016-3187-6

Li, S., Qiao, J., Cui, H., and Wang, S. (2020). Realizing the environmental benefits of proactive environmental strategy: the roles of green supply chain integration and relational capability. *Sustainability* 12, 2907. doi: 10.3390/su12072907

Li, Y., Tang, Y.-T., Tan-Mullins, M., and Ives, C. D. (2023). Exploring the potential opportunities of China's environmental agenda, ecological civilization, on global sustainable development. *Sustainability* 15, 5135. doi: 10.3390/su15065135

Lirn, T.-C., Lin, H.-W., and Shang, K.-C. (2014). Green shipping management capability and firm performance in the container shipping industry. *Marit. Policy Manage.* 41, 159–175. doi: 10.1080/03088839.2013.819132

Ma, R., Hou, W., Priem, R., and Wright, P. (2022). Does restricted stock turn CEOs into risk-averse managers? Insights from the regulatory focus theory. *Long Range Plann.* 55, 102165. doi: 10.1016/j.lrp.2021.102165

Manczak, E. M., Zapata-Gietl, C., and McAdams, D. P. (2014). Regulatory focus in the life story: Prevention and promotion as expressed in three layers of personality. *J. Pers. Soc Psychol.* 106, 169–181. doi: 10.1037/a0034951

Mee, L. D., Jefferson, R. L., Laffoley, D.d'A., and Elliott, M. (2008). How good is good? Human values and Europe's proposed Marine Strategy Directive. *Mar. pollut. Bull.* 56, 187–204. doi: 10.1016/j.marpolbul.2007.09.038

P. K. Mukherjee, M. Q. Mejia and J. Xu (Eds.) (2020). *Maritime law in motion* (Cham: Springer International Publishing). doi: 10.1007/978–3-030–31749-2

Mulaessa, N., and Lin, L. (2021). How do proactive environmental strategies affect green innovation? The moderating role of environmental regulations and firm performance. *Int. J. Environ. Res. Public. Health* 18, 9083. doi: 10.3390/ijerph18179083

Nazir, S., Zhaolei, L., Mehmood, S., and Nazir, Z. (2024). Impact of green supply chain management practices on the environmental performance of manufacturing firms considering institutional pressure as a moderator. *Sustainability* 16, 2278. doi: 10.3390/su16062278

NBSC (2022). China Statistical Yearbook. Available online at: https://www.stats.gov.cn/sj/ndsj/2022/indexeh.htm (Accessed June 6, 2024).

Neubert, M. J., Kacmar, K. M., Carlson, D. S., Chonko, L. B., and Roberts, J. A. (2008). Regulatory focus as a mediator of the influence of initiating structure and servant leadership on employee behavior. *J. Appl. Psychol.* 93, 1220–1233. doi: 10.1037/a0012695

Obama, B. (2009). President Barack Obama at UN Climate Change Summit. Available online at: https://www.osti.gov/sciencecinema/biblio/1045440 (Accessed May 6, 2024).

Porter, M. E., and Kramer, M. R. (2019). ""Creating Shared Value,"," in *Managing Sustainable Business: An Executive Education Case and Textbook*. Eds. G. G. Lenssen and N. C. Smith (Springer Netherlands, Dordrecht), 323–346. doi: 10.1007/978–94-024–1144-7_16

Rehfeld, K.-M., Rennings, K., and Ziegler, A. (2007). Integrated product policy and environmental product innovations: An empirical analysis. *Ecol. Econ.* 61, 91–100. doi: 10.1016/j.ecolecon.2006.02.003

Reid, E. M., and Toffel, M. W. (2009). Responding to public and private politics: corporate disclosure of climate change strategies. *Strateg. Manage. J.* 30, 1157–1178. doi: 10.1002/smj.796

Rennings, K. (2000). Redefining innovation — eco-innovation research and the contribution from ecological economics. *Ecol. Econ.* 32, 319–332. doi: 10.1016/S0921-8009(99)00112-3

Rennings, K., and Rammer, C. (2011). The impact of regulation-driven environmental innovation on innovation success and firm performance. *Ind. Innov.* 18, 255–283. doi: 10.1080/13662716.2011.561027

Rennings, K., and Zwick, T. (2002). Employment impact of cleaner production on the firm level: empirical evidence from a survey in five european countries. *Int. J. Innov. Manage.* 06, 319–342. doi: 10.1142/S1363919602000604

ResourceWatch Air Quality: Surface Fine Particulate Matter (PM2.5) Concentrations (RESSOURCEWATCH). (2024). Available online at: https://resourcewatch.org/data/explore/cit031rw1-Air-Quality-Surface-Fine-Particulate-Matter-PM25-Concentrations (Accessed June 6, 2024).

Roy, M.-J., Boiral, O., and Lagacé, D. (2001). Environmental commitment and manufacturing excellence: a comparative study within Canadian industry. *Bus. Strategy Environ.* 10, 257–268. doi: 10.1002/bse.304

Shang, K.-C., Lu, C.-S., and Li, S. (2010). A taxonomy of green supply chain management capability among electronics-related manufacturing firms in Taiwan. *J. Environ. Manage.* 91, 1218–1226. doi: 10.1016/j.jenvman.2010.01.016

Shu, C., Zhou, K. Z., Xiao, Y., and Gao, S. (2016). How green management influences product innovation in China: the role of institutional benefits. *J. Bus. Ethics* 133, 471–485. doi: 10.1007/s10551-014-2401-7

Sprigge, T. L. S. (1999). The relation between jeremy bentham's psychological, and his ethical, hedonism. *Utilitas* 11, 296–319. doi: 10.1017/S0953820800002521

Sroufe, R., and Curkovic, S. (2008). An examination of ISO 9000:2000 and supply chain quality assurance. *J. Oper. Manage.* 26, 503–520. doi: 10.1016/j.jom.2007.06.006

Sternad, D., and Kennelly, J. J. (2017). The sustainable executive: antecedents of managerial long-term orientation. *J. Glob. Responsib.* 8, 179–195. doi: 10.1108/JGR-04-2017-0026

Tan, K., Siddik, A. B., Sobhani, F. A., Hamayun, M., and Masukujjaman, M. (2022). Do environmental strategy and awareness improve firms' Environmental and financial performance? The role of competitive advantage. *Sustainability* 14, 10600. doi: 10.3390/su141710600

Triguero, A., Moreno-Mondéjar, L., and Davia, M. A. (2013). Drivers of different types of eco-innovation in European SMEs. *Ecol. Econ.* 92, 25–33. doi: 10.1016/j.ecolecon.2013.04.009

Vourdachas, A. (2018). Overview of the recent regulatory framework in maritime industry (SAFETY4SEA). Available online at: https://safety4sea.com/overview-of-the-recent-regulatory-framework-in-maritime-industry/ (Accessed June 6, 2024).

Wang, C. L. (2008). Entrepreneurial orientation, learning orientation, and firm performance. *Entrep. Theory Pract.* 32, 635–657. doi: 10.1111/j.1540-6520.2008.00246.x

Wang, T. (2016). Long-term orientation, marketing and technological capabilities, and social responsibility in new ventures. *World Scientific. World Scientific*. 249–273. doi: 10.1142/9789813220614_0010

Wang, L., Li, W., and Qi, L. (2020). Stakeholder pressures and corporate environmental strategies: A meta-analysis. *Sustainability* 12, 1172. doi: 10.3390/su12031172

Wang, R., Wijen, F., and Heugens, P. P. M. A. R. (2018). Government's green grip: Multifaceted state influence on corporate environmental actions in China. *Strateg. Manage. J.* 39, 403–428. doi: 10.1002/smj.2714

Wang, L., Yao, J., Zhang, H., Pang, Q., and Fang, M. (2023). A sustainable shipping management framework in the marine environment: Institutional pressure, eco-design, and cross-functional perspectives. *Front. Mar. Sci.* 9. doi: 10.3389/fmars.2022.1070078

Wright, C., and Nyberg, D. (2017). An inconvenient truth: how organizations translate climate change into business as usual. *Acad. Manage. J.* 60, 1633–1661. doi: 10.5465/amj.2015.0718

Wu, G.-C., Ding, J.-H., and Chen, P.-S. (2012). The effects of GSCM drivers and institutional pressures on GSCM practices in Taiwan's textile and apparel industry. *Int. J. Prod. Econ.* 135, 618–636. doi: 10.1016/j.ijpe.2011.05.023

Wubben, E. F. M. (2000). *The Dynamics of the Eco-efficient Economy: Environmental Regulation and Competitive Advantage* (UK: Edward Elgar Publishing, Glos). doi: 10.4337/9781782543978

Wuisan, L., van Leeuwen, J., and Kris) van Koppen, C. S. A. (2012). Greening international shipping through private governance: A case study of the Clean Shipping Project. *Mar. Policy* 36, 165–173. doi: 10.1016/j.marpol.2011.04.009

York, J. G., Vedula, S., and Lenox, M. J. (2018). It's not easy building green: the impact of public policy, private actors, and regional logics on voluntary standards adoption. *Acad. Manage. J.* 61, 1492–1523. doi: 10.5465/amj.2015.0769

Zhu, Q., Sarkis, J., and Lai, K. (2008). Confirmation of a measurement model for green supply chain management practices implementation. *Int. J. Prod. Econ.* 111, 261–273. doi: 10.1016/j.ijpe.2006.11.029

Zou, K., and Chang, Y.-C. (Eds.). (2021) "Climate Change and Fisheries Regulation: What We Should Consider for the Future?," in *Preserving Community Interests in Ocean Governance towards Sustainability*, vol. 2 (MDPI, Basel, Switzerland). Available at: https://core.ac.uk/download/pdf/520262239.pdf.