

When nationalism meets environmentalism: an inverted U-curve linking national sentiment to carbon emission intensity through an institutional lens

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Abstract

Against the backdrop of rising corporate carbon emissions, managerial attributes are garnering increasing scholarly scrutiny. Utilizing a panel dataset from China's A-share market between 2010 and 2023, this paper employs an institutional theory perspective to examine the relationship between national sentiment and carbon emission intensity. We reveal a significant inverted U-shaped relationship between national sentiment and carbon emission intensity. Meanwhile, we also find that market competition, emission reduction target constrains and environmental penalties positively moderate the relationship between national sentiment and carbon emission intensity. Moreover, corporate social responsibility and green investment act as significant mediating channels in this relationship. Furthermore, national sentiment significantly influences enterprises characterized by high pollution, low subsidies, or low R&D intensity, and its impact on green patent, encompassing both green invention and green utility models, still exhibits a significant inverted U-shaped relationship. We further analyzed the effect of macro-environmental changes on this inverted U-shaped relationship.

Introduction

Greenhouse gas emissions have exerted profound impacts on socio-economic systems and human well-being. According to the *IPCC Sixth Assessment Report*, human-induced drivers have elevated mean global temperatures by about 1.1 °C relative to pre-industrial times. This progression toward critical climate tipping points underscores an escalating existential threat to societal stability and survival. According to the World Wildlife Fund's *Living Planet Report 2024* (WWF, 2024), climate change has been directly responsible for a 73% decline in global wildlife populations over the past five decades. Simultaneously, rising extreme temperatures are constraining human habitable zones and instigating significant migration movements (Reichman, 2022). To solve these problems, governments worldwide have intensified their focus on climate issues and reinforced their commitments to enhancing policies aimed at emissions reduction. The implementation of corporate emission reduction strategies reflects not only managerial insight and strategic planning (López-Manuel et al., 2023) but also serves as a primary driver for mitigating emissions. Empirical research indicates that approximately two-thirds of global industrial CO₂ and CH₄ emissions originate from corporate activities (Ekwurzel et al., 2017). Consequently, investigating corporate emission reduction mechanisms is critical for alleviating global climate pressures.

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Companies are increasingly integrating carbon management into their strategic planning and operational processes to mitigate their carbon footprint effectively. This commitment to decarbonization is disseminated throughout the organization via managers' perceptual awareness, visionary foresight, and structured planning (Arruñada and Vázquez, 2013). Scholars find that institutional ownership (Benlemlih et al., 2023) and board diversity (Oussii and Jeriji, 2025) are associated with enhanced carbon management performance. Of course, advancements in the digital economy (Li et al., 2025a), digital finance (Lu et al., 2023), and environmental technologies (Şahin et al., 2025), as well as R&D and innovation activities (Zhu and Wang, 2025)—particularly those focused on green technology (Khan et al., 2025)—along with increased green investment (Zheng and Jin, 2023), industrial structure upgrading (Cheng et al., 2025), and more efficient technology factor markets (Zhou et al., 2025), have been shown to reduce carbon emission intensity. Moreover, institutional factors are also essential in carbon emission intensity. Including institutional quality (Khan et al., 2022), institutional openness (Guo and Wang, 2023), and stringency of environmental regulations (Liu et al., 2024), these formal institutions have been demonstrated to mitigate corporate carbon emissions effectively, acting as critical policy instruments for governments promoting emission reductions worldwide. Simultaneously, informal institutions warrant considerable attention, and national sentiment has emerged as a distinctive informal institutional force, garnering growing academic interest and increasingly being integrated into business practices (Wang and Li, 2025). National sentiment functions as a catalyst for corporate economic activities, affecting foreign direct investment (Li et al., 2019), facilitating trade flows (Dow and Cuypers, 2024), promoting green innovation (Wang et al., 2025a), and boosting corporate ESG performance (Tan et al., 2025).

Whereas it is managers who are instrumental in spearheading and integrating strategic carbon reduction initiatives within the corporate framework. Firms with greater CEO power (Luong et al., 2025), higher board independence, and dedicated environmental committees (Elsayih et al., 2021) are associated with reduced carbon emissions, but managerial myopia (Xie et al., 2025b) increases emission levels. While extant literature has widely investigated the influence of managerial characteristics on corporate carbon behavior, little attention has been paid to their role in emissions reduction through the lens of informal institutions, such as national sentiment. Given the importance of informal institutional forces in carbon reduction, this study explores the nonlinear effects of national sentiment on carbon emission intensity. Specifically, we analyze how managers, amid dual pressures for economic legitimacy and low-carbon legitimacy, shape their firms' emission reduction strategies in response to nuanced national sentiment impulses.

This study offers three contributions to the existing literature. Firstly, we introduce a new nonlinear institutional perspective for the study of national sentiment and corporate environmental performance. From the perspective of institutional theory, we present novel evidence for an inverted U-shaped relationship between national sentiment and carbon emission intensity, complementing the literature on how informal institutions and managerial cognition drive corporate environmental behaviors, and provide a new theoretical entry point for the study of corporate carbon emission drivers. Secondly, we reveal the complete mechanism chain behind the core relationship. Based on the dual logic of economic legitimacy and low-carbon legitimacy, we verify corporate social responsibility and green investment as two mediating paths. This not only provides a specific path for the transformation of the black box between national sentiment and carbon emission intensity, but also deepens the understanding of the internal mechanism between the two. Meanwhile, we refine the mechanism layer by layer from regulatory scenarios, normative systems, and coercive means and clarify the boundary conditions of national sentiment on carbon emission intensity. Thirdly, we fill the theoretical gap of micro managers' cognition on corporate environmental behavior, enrich the application of institutional theory in the field of environmental management, and also providing a multi-level and differentiated policy perspective for the low-carbon development of enterprises.

The remainder of this paper is structured as follows. Section "Background literature and hypotheses" reviews the background literature and develops hypotheses. Section "Data and methodology" describes the data and methodology. Section "Results" presents the empirical results and analysis. Section "Conclusions and discussion" concludes with discussions.

Background literature and hypotheses

Institutional theory

Institutional theory illuminates how organizational environments' institutionalization drives homogeneous practice adoption (Aronson and LaFont, 2020). With the study of institutional isomorphism and decoupling growing into a substantial body of research, how individual or institutional entrepreneurs initiate institutional change and devise strategies for transforming individual agency into collective agency is beginning to attract the attention of scholars (Eitrem et al., 2024). Furthermore, institutional embeddedness fundamentally shapes institutional entrepreneurship and strategic agency (Battilana et al., 2009), where the interplay of habitual and reflexive agency elucidates institutional change trajectories (Lounsbury et al., 2021). Especially, confronting governmental policy enforcement, market uncertainties, and developmental imperatives, scholars increasingly examine the causal nexus between environmental compliance, corporate environmental practices, and firm performance through institutional theoretical lenses (Gupta and Gupta, 2021). Moreover, scholarship increasingly applies institutional theory to new fields, such as corporate social responsibility (CSR), revealing how regulatory, normative, and cognitive institutional elements shape CSR practices (Brammer et al., 2012), which are the consequences of value-driven agent selection and institutional structure (Risi et al., 2023). Then, institutional contexts fundamentally determine the form and content of geographically bounded CSR practices (Matten and Moon, 2020), compelling firms to engage in such activities to address legitimacy expectations. The moral legitimacy of these CSR initiatives is contingent upon CEO-driven stakeholder considerations manifested through responsible business conduct (Castelló and Lozano, 2011). Scholars increasingly examine how individual and collective actors agentially respond to institutional contexts. Specific CSR activities—including charitable donations and certification standards—mitigate institutional pressures (Iatridis et al., 2016; Wang et al., 2015), with behavioral change trajectories shaped by institutional process diversity (Oliver, 1991). Concurrently, firms experience compelling institutional forces: internal commitments (top management ethos, organizational culture) and external pressures (regulatory imperatives, competitive mimicry), collectively driving enhanced ethical and social responsibility (Ng et al., 2022). Drawing on institutional theory, we examine how normative and moral legitimacy imperatives for corporate decarbonization conduct shape the strategic guidance derived from patriotic corporate ethos.

Institutions constitute a systemic framework of rules that constrain, guide, and coordinate human behavior (Ostrom, 2025), encompassing both formal institutions such as laws, property rights, and organizational regimes (Korol and Korol, 2025), and informal institutions including cultural norms, social conventions, and traditions (Gërzhani and Cichocki, 2023). As a core constituent of cultural heritage, national sentiment functions as an integral informal institutional mechanism within the broader institutionalism framework.

National sentiment and corporate carbon emission intensity

As an organization embedded in the institutional environment, the behavior of enterprises is subject to both formal and informal systems (Berrone et al., 2022). Although different from the rigid constraints of formal systems, informal systems can influence organizational behavior choices through cultural identity and social expectations (Zhao et al., 2024). The specific cultural system of the enterprise is the essence of the formation and evolution of informal institutions (Pejovich, 2006). National sentiment focuses on the cultural values of the interests of the national community (Hertz, 2022), and as an important part of the cultural system, it affects the carbon emission behavior of enterprises through the legitimacy transmission mechanism of the informal system (Xu et al., 2025a).

When national sentiment is at a low level, it mainly acts as a shallow collective identity for enterprises. Managers and employees take production expansion, market occupation and output growth as the main ways to express national identity and fulfill corporate patriotic obligations. At this stage, the institutional logic dominated by informal institutions mainly consists of market logic and economic performance logic. The core legitimacy pressure faced by enterprises is concentrated on economic legitimacy, that is, obtaining institutional recognition by expanding

production, improving efficiency and increasing profits. At this time, the company's pursuit of short-term economic gains may trigger short-sightedness or overconfidence at the executive level. They will ignore long-term environmental performance, and regard carbon reduction investment as a cost burden. Therefore, when the core of informal institutional pressures falls on economic legitimacy, corporate cultural values will prioritize economic benefits and production expansion, leading to increased carbon emissions (Rottner and von Graevenitz, 2024). From the perspective of balancing resource shortages and legality pressures, businesses at this stage face prominent resource constraints and low resource margins. In balancing economically driven legitimacy pressures and resource constraints, companies prioritize scale over low-carbon emissions reductions that require large investments in scarce resources. Thus, even if enterprises hold a certain degree of national sentiment, they may temporarily overlook carbon emissions due to resource constraints and the primacy of economic legitimacy.

With the continuous rise of national sentiment to a moderate critical level, the dual attributes of national sentiment begin to appear simultaneously, and corporate strategic decision-making falls into a state of tension. On the one hand, the strengthened collective identity continues to motivate enterprises to maintain production expansion, and even generates managerial overconfidence. Managers overestimate the sustainability of extensive growth and ignore the potential risks of high carbon emissions. On the other hand, the connotation of national sentiment gradually evolves into a higher level of national will closely linked to ecological civilization and green development. Public opinion, social norms and national strategic expectations begin to form strong normative pressure, and the single pursuit of economic legitimacy is gradually challenged. The coexistence of short-term expansion motivation and emerging low-carbon responsibility pressure forms the inflection point of the inverted U-shaped curve. At this critical point, the promoting effect of national sentiment on carbon emissions reaches its peak and begins to reverse.

When a certain critical value is broken, its connotation evolves into a higher level of national will, which is compatible with ecological civilization and green development. At this point, the shallow patriotic expression relying on production expansion is no longer recognized by social norms. The informal system will reconstruct the social consensus, and the dominant position of economic legitimacy will gradually be replaced. Corporate culture values will shift from economic legitimacy to low-carbon development and environmental legitimacy (Roh et al., 2025). Enterprises will gradually realize that emission reduction and green governance are crucial to achieving national strategic expectations and gaining long-term social recognition. Firms actively abandon extensive growth models, and reallocate idle resources accumulated in the early stage from scale expansion to green innovation (Sheng et al., 2026) and low-carbon transformation, thereby reducing carbon emissions. Strong national sentiment evolves into a deep collective identity and long-term value orientation, which becomes an internal driving force for enterprises to take the initiative to reduce emissions. At the same time, with the early economic development and expansion of the enterprise, a certain amount of idle resources has been accumulated, and the resource base for the implementation of emission reduction strategies has been obtained. At this time, enterprises carry out emission reduction activities, which not only meet the requirements of ecological civilization construction reflected in national emotions, but also obtain new legitimacy recognition, so as to achieve sustainable development of the organization. We argue that the core logic of the inflection point lies in the reconstruction of legitimacy pressure driven by the evolution of national sentiment and the expansion of corporate decision-making space brought about by increased resource slack. Therefore, we propose the following hypothesis:

H1: There is an inverted U-shaped relationship between national sentiment and corporate carbon emission intensity.

The moderating effect of the market competition

Enterprises perpetually competing for scarce market resources to drive their growth (Deng et al., 2024), market competition serves as the testing ground for this contest, intensifying the perception of resource scarcity and directly shaping the strategic choices and operational boundaries of firms as they vie for critical resources.

In the low national sentiment stage, fierce market competition amplifies enterprises' single pursuit of economic legitimacy, which steepens the rising segment of the inverted U-shaped curve. Intensified market competition

compresses profit margins and survival space of firms. At this time, enterprises face fierce competition for resources and survival pressure, and must prioritize the allocation of limited resources to areas that can quickly improve their core competitiveness (Sun et al., 2025). To seize market share and satisfy economic legitimacy, companies will further prioritize output scale and short-term profit growth. Those carbon reduction investment that brings no immediate economic returns are regarded as an additional competitive cost burden. Meanwhile, enterprises may prefer lower-cost symbolic compliance strategies rather than substantive green transformation. Therefore, market competition enlarges the positive correlation between national sentiment and carbon emission intensity in the low national sentiment stage, that is, it plays a positively moderating role in the ascending section of the inverted U-shaped curve.

When national sentiment exceeds the critical threshold, market competition accelerates the reversal of the promoting effect of national sentiment on carbon emission intensity, making the subsequent declining segment steeper. Enterprises have shifted from pursuing economic efficiency to institutional legitimacy. Fierce market competition makes enterprises pay more attention to long-term environmental legitimacy, green low-carbon transformation becomes a differentiated competitive tool (Qian and Cao, 2025). Enterprises with strong national sentiment can win unique environmental legitimacy, policy support and consumer preference through emission reduction governance, forming competitive barriers against peers. Even if resource slack is limited in the short run (Shi et al., 2025), driven by competitive incentives still urge firms to transfer resources from high-carbon scale expansion to green innovation and carbon reduction transformation. Therefore, market competition sharpens the negative correlation between national sentiment and carbon emission intensity in the high national sentiment stage, that is, it also plays a positive moderating role in the descending section of the inverted U-shaped curve. Therefore, we propose the following hypothesis:

H2: Market competition positively moderates the inverted U-shaped relationship between national sentiment and carbon emission intensity.

The moderating effect of the emission reduction target

Local government emission reduction targets, as a rigid institutional constraint, have changed the logic of enterprises balancing economic legitimacy and environmental legitimacy and their resource allocation decisions. This policy oversight will significantly amplify the nonlinear impact of national sentiment on corporate carbon emission intensity, making the overall curve steeper. At this stage, enterprises only hold superficial collective national identity, and corporate executives regard output expansion and profit growth as the core way to fulfill patriotic responsibilities. Government emission reduction targets are top-down mandatory formal regulations, overly high targets can prompt enterprises to adopt passive and opportunistic response strategies. Enterprises emission reduction targets are more reflected in symbolic commitments under external compliance pressures, and enterprises are still oriented towards growth first (Hrasky, 2011). In the absence of intrinsic emission reduction motivation, enterprises often adopt low-cost response methods such as terminal governance to meet the target requirements, or dilute the fixed cost of emission reduction inputs by increasing the output scale, so as to further push up carbon emission intensity in the pursuit of maximizing economic benefits. Worse still, some firms may choose to use excess economic benefits to offset potential costs triggered by failure to meet partial emission reduction targets. In this context, government emission reduction supervision fails to constrain corporate high-carbon behaviors effectively; instead, it intensifies enterprises' short-sighted economic-oriented decision-making. Thus, in the low national sentiment stage, the setting of emission reduction targets strengthens the positive correlation between corporate expansion behavior and carbon emissions in the early stage of national sentiment rise, that is, it plays a positive regulating role in the upward section of the inverted U-shaped curve.

When national sentiment exceeds the critical threshold, high national sentiment has formed enterprises' endogenous green patriotic value orientation, making enterprises voluntarily respond to national green development strategies. At this time, exogenous mandatory government emission reduction targets form a complementary governance force with endogenous national sentiment. Clear official carbon reduction assessment indicators restrict

enterprises' residual high-carbon production behaviors, and eliminate the possibility of enterprises adopting superficial green governance and greenwashing strategies (Kashif et al., 2026). Meanwhile, supporting government-supported policies such as emission reduction subsidies, green credit, and carbon market incentives helps companies achieve official emission reduction targets (Liu et al., 2026). Emission reduction targets are no longer symbolic commitments made passively by companies in response to external constraints, but are closely integrated with corporate strategy, becoming internal governance tools to drive green transformation (Du and Li, 2023). Therefore, when national sentiment is at a high level, the setting of emission reduction targets further strengthens the negative correlation between national sentiment and carbon emission intensity, that is, it also plays a positive regulating role in the descending section of the inverted U-shaped curve. Therefore, we put forward the following hypothesis:

H3: Emission reduction target constraints positively moderate the inverted U-shaped relationship between national sentiment and corporate carbon emission intensity.

The moderating effect of the environmental penalties

Environmental penalties, as a consequence of stringent environmental regulation, particularly for polluting enterprises, impose substantial financial costs and operational disruptions through fines and production suspensions (Guedhami et al., 2025). In the low state sentiment stage, the overall institutional constraints on environmental regulation are relatively weak, institutional pressure has not yet formed a strong constraint on enterprises, and environmental penalties are often strategically regarded as passable operating costs by enterprises (Shevchenko, 2021). Due to the profit-seeking nature of enterprises, companies tend to internalize fines as regular operating expenses, dilute the cost burden of penalties by scaling up production, or even view penalties as compliance costs rather than signals of improvement (Porteous et al., 2015). Besides, the overall cost for enterprises to carry out costs related to compliant and legal emission reduction is generally higher than the cost of environment penalties (Stafford, 2002). Based on the decision-making logic of minimizing costs, enterprises will tend to increase their carbon emission levels. In this scenario, environmental penalties not only fail to effectively curb carbon emissions (Yin et al., 2022), but may also form a dual expansion incentive with rising national sentiment. On the one hand, national emotions stimulate the economic nationalist tendencies of enterprises and strengthen their motivation to expand production and seize the market. On the other hand, the existence of environmental penalties further strengthens the strategic thinking of enterprises to ensure growth first and environmental protection later, prompting enterprises to pursue output expansion more aggressively to hedge compliance costs. This makes the carbon emission intensity of enterprises increase more sharply with the improvement of national sentiment. Therefore, when national sentiment is at a low level, environmental penalties enhance the positive correlation between national sentiment and carbon emission intensity, that is, it plays a positive moderating role in the ascending section of the inverted U-shaped curve.

In the high state sentiment stage, as external institutional pressure increasing, firms shift from pursuing economic efficiency to pursuing institutional legitimacy (Li et al., 2025b). At this stage, the nature of environmental penalties undergoes a fundamental change; they are no longer seen as internalizable operating costs but pose a substantial threat to the legitimacy of the enterprise. The increase in the amount of fines, the deterrent effect of production suspension and rectification, and the public disclosure of environmental penalty information together form the superposition effect of multi-source institutional pressure (Zhao et al., 2017). In order to avoid reputational damage and maintain social licensing and regulatory trust, enterprises are forced to shift from symbolic compliance to substantive improvements, and increase systematic investment in digital technology innovation (Zhang et al., 2026), environmental information disclosure quality, and emission reduction performance (Hu and Xu, 2025; Ma et al., 2025a). Studies have shown that severe environmental penalties can enhance the synergy of carbon reduction and drive companies to achieve fundamental improvements in environmental performance (Li et al., 2024). Therefore, when national sentiment is at a high level, environmental penalties reinforce the negative correlation between national sentiment and carbon emission intensity, that is, it positively adjusts the descending section of the inverted U-shaped curve. Based on this reasoning, we propose the following hypotheses:

H4: Environmental penalties positively moderate the inverted U-shaped relationship between national sentiment and carbon emission intensity.

The mediating effect of corporate social responsibility

Corporate social responsibility constitutes a strategic imperative (Ginder et al., 2025), embodying the integration of economic, social, and environmental performance within a triple bottom line framework (Dang et al., 2022), and emerges as an outcome shaped by the confluence of agent selection and institutional structure (Risi et al., 2023). Institutional theory points out that enterprise behavior is not only subject to the logic of market efficiency, but also deeply affected by social recognition and normative pressure. As an informal institutional force embedded in historical and cultural traditions and contemporary institutional frameworks, national emotion can influence the perception and response of enterprises to the expectations of stakeholders by building a sense of collective identity and moral legitimacy (Yashalova et al., 2021). However, the effect is not linear. When national sentiment is relatively low, enterprises are constrained by market-driven objectives. Although they have perceived the institutional expectations of social responsibility, due to cost control and short-term performance targets, they often put social responsibility practices on the back burner, manifesting as symbolic compliance rather than substantive investment, resulting in a decline in overall social responsibility performance. Then, CSR will squeeze operating profit because it is an additional cost expenditure. Tight resource constraints will force enterprises to cut non-profit-oriented CSR expenditures to guarantee core operational cash flow.

When national sentiment crosses a certain critical threshold, constraints from previously loose, informal institutions have steadily intensified. Combined with the cumulative pressure, enterprises will face intensified institutional pressure from regulatory and regulatory systems, forming strong constraints on the acquisition and maintenance of corporate legitimacy (Lee et al., 2024). At this time, in order to maintain social licensing and institutional legitimacy, enterprises upgrade social responsibility from marginal strategies to core strategies (Bice, 2017) and actively embed environmental and social goals into organizational decision-making. Meanwhile, public acceptance of the single profit-oriented enterprise model continues to decline, with more attention shifting toward enterprises implementing low-carbon development strategies, thereby promoting the level of corporate social responsibility from decreasing to rising. In view of this, there is a U-shaped relationship between national sentiment and corporate social responsibility.

Then, in the relationship between corporate social responsibility and carbon emissions, enterprises that actively fulfill social responsibility usually pay more attention to environmental compliance, resource efficiency, and green innovation (Xie et al., 2025a), thereby effectively reducing carbon emission intensity (Chen, 2023; Zhang et al., 2022). CSR not only reflects the adaptive response of enterprises to institutional pressures, but also internalizes it as an important part of their environmental strategy, continuously curbing carbon emission intensity through systematic green management and low-carbon operations. Therefore, when national sentiment is below the critical value, the level of corporate social responsibility is low, which fails to effectively suppress carbon emission intensity, resulting in an increase in carbon emission intensity with the increase of national sentiment. When national sentiment exceeds the critical value, the level of corporate social responsibility is significantly improved, forming a strong carbon emission constraint mechanism and promoting a decrease in carbon emission intensity. Based on the foregoing analysis, the following hypothesis is proposed:

H5: Corporate social responsibility mediates the inverted U-shaped relationship between national sentiment and carbon emission intensity.

The mediating effect of green investment

Green investment reflects the profound impact of the institutional environment on capital allocation, and is a strategic resource allocation behavior driven by institutional pressure to align financial goals with environmental and social responsibility goals (Alsagr and Ozturk, 2024). Institutional theory shows that the resource allocation decisions of

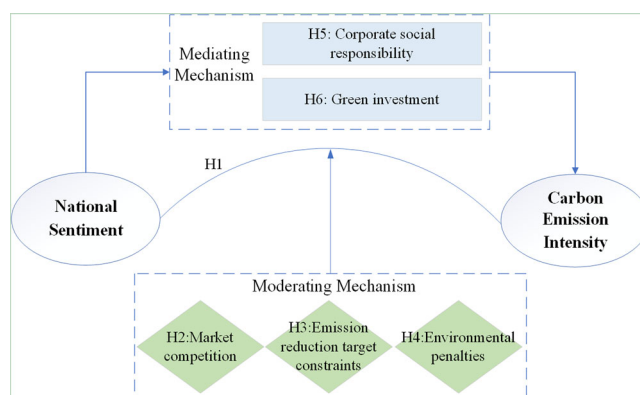


Fig. 1 Research mechanism.

enterprises are not only subject to the logic of market efficiency but also profoundly shaped by the legitimacy mechanism and institutional pressure (Zhao et al., 2017).

When national sentiment is low, the efficiency logic of market profit-seeking dominates corporate decision-making. National sentiment can shape corporate perception of environmental responsibility and resource allocation preferences by strengthening cultural identity and legitimacy expectations. Although they have perceived the institutional expectation of environmental responsibility, due to the characteristics of long investment cycle and uncertain short-term returns, enterprises often prioritize the allocation of resources to productive activities that can quickly improve economic benefits, forming a “crowding out effect” on green investment (Liu et al., 2025). At this stage, enterprises adopt more symbolic compliance strategies, and the level of substantive green investment is low. The insufficient green capital input makes enterprises unable to optimize high-carbon production processes or eliminate backward polluting production capacity, ultimately driving a continuous increase in corporate carbon emission intensity.

When national sentiment crosses a critical threshold, enterprises no longer regard green investment as a passive response to external institutional pressure, but take proactive low-carbon capital layout as an important part of corporate patriotic strategic layout. Multiple institutional forces will form strong constraints on the acquisition of corporate legitimacy (Pan et al., 2025). In order to obtain institutional legitimacy and balance short-term interests and long-term development, enterprises will actively adjust resource allocation strategies. Benefiting from the scale dividends accumulated by early production expansion, enterprises have relieved initial resource constraints and owned sufficient idle capital to support large-scale green investment, thereby promoting the rise of green investment level (Khan et al., 2024). Given this, there is a U-shaped relationship between national sentiment and green investment.

Finally, green investment, as a substantive strategic response to institutional pressure, is a key precursor to curbing corporate carbon emissions (Li et al., 2021), and its investment results can be effectively translated into improvements in environmental performance. Green investment can directly affect the energy mix of enterprises, promoting the reduction of carbon emission intensity through technological upgrades and efficiency improvements (Ai and Yan, 2024; Kwilinski et al., 2024; Priyan, 2023; Zhong et al., 2024). Therefore, when national sentiment is below the critical value, the level of green investment is suppressed, and enterprises fail to form effective carbon emission reduction capabilities, resulting in an increase in carbon emission intensity with the increase of national sentiment. When national sentiment exceeds the critical value, institutional pressure drives enterprises to increase green investment, forming a significant carbon emission reduction effect through technological upgrading and efficiency improvement, and promoting a subsequent decrease in carbon emission intensity. Based on the above analysis, we put forward the following hypothesis:

H6: Green investment mediates the inverted U-shaped relationship between national sentiment and carbon emission intensity.

Building upon established theoretical foundations and prior literature, we construct the conceptual framework presented in Fig. 1 to systematically examine the impact of national sentiment on carbon emission intensity.

Data and methodology

Data resource

To examine the relationship between national sentiment and carbon emission intensity, our analysis used an unbalanced panel dataset including 26,135 observations from 3395 different firms for the period between 2010 and 2023, and firm-level financial data is from CSMAR database, corporate social responsibility is from HEXUN's net. We obtain industry-level carbon emission provided in the National Greenhouse Gas Emission Factor Database.

We apply three standard filters: (1) excluding financially distressed firms (ST/*ST/PT), (2) omitting financial firms due to their distinct accounting frameworks, and (3) eliminating observations with missing data for key variables. Accordingly, the final sample comprises 3395 firms with 26,135 firm-year observations.

Dependent variables

Carbon emission intensity (*CI*). China has not yet established a unified and publicly verifiable national database of enterprise-level carbon emissions, but carbon emissions have well-established calculation methods. We obtain industry-level carbon emission provided in the National Greenhouse Gas Emission Factor Database, which are then disaggregated to the enterprise level by the proportion of enterprise operating costs to industry costs, followed by natural logarithmic transformation. A higher *CI* value signifies greater environmental impact from emissions, implying proportionally greater potential for emission reduction (Song et al., 2025).

Independent variables

National sentiment (*Nationalism*), a standardized metric for corporate nationalism, was constructed by analyzing listed companies' annual disclosures concerning expressions of patriotism, xenophobia, state nationalism, and corporate missions aligned with nationalist objectives (Wang et al., 2025a). Following the measurement proposed by some scholars (Wang et al., 2025b; Yue et al., 2024), relevant terms were searched from corporate annual reports to construct a measure of national sentiment encompassing four dimensions: national pride, national revival, corporate role, and anti-foreign sentiment. The total frequency of nationalist sentiment terms was then calculated as the sum of the frequencies of these four dimensions, with the key terms of national sentiment presented in Appendix Table 16. Elevated scores of *Nationalism* denote greater prevalence of rhetorical nationalism within the firm's discursive practices (Wang et al., 2025b).

Moderating variables

Market competition (*Mcomp*) is measure as the reciprocal of Lena index. Lena Index is defined as the ratio of core operating profit to total operating revenue. A higher *Mcomp* indicates higher market competition intensity, reflecting direct proportionality between operational efficiency and competitive pressure.

Emission reduction target constraints (*Target*), using textual analysis of prefectural-level government work reports, we constructed a binary variable indicating whether municipal authorities established quantified emission reduction targets in a given year, coded as 1 if explicit numerical goals were specified and 0 otherwise.

Environment penalty (*Epenalty*), constitutes administrative sanctions imposed by environmental protection agencies on regulated entities violating environmental statutes, with our dataset encompassing nationwide multi-

Table. 1 Variable definitions and descriptions.

Variable	Name	Sign	Measure
Explained variable	Carbon emission intensity	<i>CI</i>	Using industry carbon emission data, the result was derived by weighting by the enterprise's total operating costs as a percentage of the industry's main operating costs, to obtain the corporate carbon emission, and then taking the natural logarithm.
Explanatory variable	National sentiment	<i>Nationalism</i>	Nationalism was constructed by analyzing listed companies' annual disclosures concerning expressions of patriotism, xenophobia, state nationalism, and corporate missions aligned with nationalist objectives.
Moderating variables	Market competition	<i>Mcompet</i>	We adopt the reciprocal of the Lerner Index as our measurement metric. The Lerner Index is calculated as the ratio of enterprise operating income minus operating costs, selling expenses, and administrative expenses, divided by operating income, reflecting the firm's pricing power relative to its marginal cost.
	Emission reduction target constraints	<i>Target</i>	Based on textual analysis of prefecture-level government work reports, we constructed a binary variable measuring the establishment of specific emission reduction targets. This indicator equals 1 if a municipal government explicitly specified quantitative environmental governance targets in its annual work report, and 0 otherwise.
	Environment penalty	<i>Epenalty</i>	National provincial, municipal and county environmental protection penalty case data.
Mediating variables	Corporate social responsibility	<i>Csr</i>	Hexun.com's CSR rating data for listed companies
	Green investment	<i>Ginvest</i>	Corporate green investment intensity is calculated by compiling pollution prevention, environmental remediation, ecological governance, and green production expenditures from construction in progress. This aggregate annual green investment is divided by year-end total assets and standardized to yield the final metric.
Control variable	Discretion	<i>Dual</i>	If a CEO held the board chair position in the given year and, the value is 1; otherwise, it is 0
	Board members	<i>Director</i>	The total number of directors holding shares of the company
	Debt level	<i>Lev</i>	Total liabilities divided by total assets
	corporate cash flow ratio	<i>Cash</i>	Corporate cash ratio
	Shareholding ratio	<i>First</i>	The shareholding ratio of the largest shareholder
	Independent directors	<i>Inde</i>	The total number of independent directors
	Firm age	<i>Fag</i>	The time of the enterprise establish
	Return on assets	<i>Roa</i>	Net Profit divided by total assets

tiered jurisdictions (provincial to county levels), and this metric quantifies coercive institutional pressures compelling corporate adherence to environmental standards (Hu and Xu, 2025).

Mediating variables

Corporate social responsibility (*Csr*), HEXUN.com's CSR ratings for listed companies. Specifically, HEXUN's quantitative CSR metric, grounded in audited annual reports and stand-alone CSR disclosures, gauges realized rather than merely reported responsibility, thereby attenuating the typical divergence between symbolic disclosure and substantive performance (Karavitis et al., 2025).

Green investment (*Ginvest*), is computed by aggregating environmental capital expenditures (pollution control, ecological governance, and clean production projects) from construction ledgers, scaling by period-end total assets, and applying min-max normalization. *Ginvest* simultaneously pursues environmental stewardship and economic resilience. Meanwhile, *Ginvest*'s financial support—conventionally modeled as a mediating variable—augments internal capabilities, thereby elevating operational efficiency and environmental compliance (Hag et al., 2025).

Control variables

We firstly controlled for discretion, coded “1” if a CEO held the board chair position in the given year and “0” otherwise (Cannella and Lubatkin, 2017), because it may enhance the efficiency of strategic decision-making and strengthen the consistency of accountability, and promote the transformation of cognition into concrete actions for emission reduction (Jiang et al., 2022). We also included *firm age*, measured by the given year minus the firm’s founding year, Firm age plays a fundamental role in shaping the dynamics of institutional legitimacy acquisition, thereby contributing to a reduction in carbon emission intensity as the firm matures (Ma et al., 2025b). The shareholding ratio of the largest shareholder is selected as its strategic decision-making control power and internalization mechanism of environmental responsibility (Slager et al., 2023). To control for the influence of board structure, we included *Director*, measured by the total number of directors holding shares of the company. It has been shown to influence corporate carbon intensity (Muktadir-Al-Mukit and Bhaiyat, 2023). We also controlled for the amount of independent directors, because researched confirmed that boards with higher representation among independent directors are more likely to have lower carbon emissions (Elsayih et al., 2021). To control for firm performance, we measured debt level by total liabilities divided by total assets (Bi et al., 2025). Return on assets (*ROA*) is measured by dividing net profit by total assets. We also include corporate cash flow ratio, because this controls for the capacities of corporate’s green innovation and corresponding environmental protection (Makpotche et al., 2024). In summary, Table 1 provides the formal definitions of main variables.

Model analysis

The following empirical model is estimated to test the study’s hypotheses:

$$CI_{it} = \beta_1 Nationalism_{it} + \beta_2 Nationalism_{it}^2 + \beta_3 \sum Controls_{it} + \mu_t + \gamma_i + \varepsilon_{it} \quad (1)$$

where subscripts i and t denote the firm and time period, respectively. CI_{it} represent carbon emission intensity. $Nationalism_{it}$ refers to national sentiment. $Control_{it}$ is a set of control variables. μ_t , γ_i represent the year fixed effect and the company fixed effect. ε_{it} is the regression residual term.

To examine the moderating role of *Mcompet*, *Target* and *Epenalty* on the national sentiment and carbon emission intensity, we specify the Eq. (2) for analysis:

$$CI_{it} = \beta_0 + \beta_1 Nationalism_{it} + \beta_2 Nationalism_{it}^2 + \rho_1 Nationalism_{it} \times Moderator_{it} + \rho_2 Nationalism_{it}^2 \times Moderator_{it} + \beta_3 Moderator_{it} + \beta_4 \sum Controls_{it} + \mu_t + \gamma_i + \varepsilon_{it} \quad (2)$$

where $Moderator_{it}$ is moderating effect of *Mcompet*, *Target* and *Epenalty*. Coefficient ρ_1 captures the linear interaction effect, while ρ_2 represents the quadratic interaction term. μ_t and γ_i respectively represent the year fixed effect and the company fixed effect. ε_{it} is the regression residual term.

To test the mediating pathways through which corporation social responsibility and green investment affect the nationalism and carbon emission intensity relationship, we construct the system of Eqs. (3) and (4):

$$Mediators_{it} = \beta_0 + \beta_1 Nationalism_{it} + \beta_2 Nationalism_{it}^2 + \beta_3 \sum Controls_{it} + \mu_t + \gamma_i + \varepsilon_{it} \quad (3)$$

$$CI_{it} = \beta_0 + \beta_1 Nationalism_{it} + \beta_2 Nationalism_{it}^2 + \delta Mediators_{it} + \beta_3 \sum Controls_{it} + \mu_t + \gamma_i + \varepsilon_{it} \quad (4)$$

where $Mediators_{it}$ is mediating effect of *Csr* and *Ginvest*. μ_t and γ_i respectively denotes year and firm fixed effects. ε_{it} represents the residual term.

Table. 2 Descriptive statistics.

Variables	<i>N</i>	Mean	S.D	Min	Max
<i>CI</i>	32,892	9.483	1.076	0	10.570
<i>Nationalism</i>	32,892	0.0041	0.0018	0	0.1941
<i>Nationalism</i> ²	32,892	0.00002	0.0002	0	0.0377
<i>Mcompet</i>	26,135	11.468	301.002	−23,809	26,315
<i>Target</i>	26,135	0.094	0.292	0	1
<i>Epenalty</i>	26,135	850.8	1.203	1	6,391
<i>Csr</i>	26,135	3.010	0.762	−4.605	4.509
<i>Internal</i>	26,135	6.165	1.757	0	9.954
<i>Cpolicy</i>	26,135	21.800	18.300	0	109
<i>Ginvest</i>	26,135	1.230	4.329	0	23.530
<i>Dual</i>	26,135	0.286	0.452	0	1
<i>Director</i>	26,135	2.300	2.089	0	15
<i>Lev</i>	26,135	0.362	0.253	0	4.026
<i>Cash</i>	26,135	0.171	0.144	−0.165	1
<i>First</i>	26,135	34.200	15.260	0.290	100
<i>Inde</i>	26,135	3.182	0.621	0	8
<i>Fag</i>	26,135	10.89	7.729	0	32
<i>Roa</i>	26,135	0.030	0.211	−30.690	7.445

Results

Descriptive statistics and correlation analysis

Table 2 presents key descriptive statistics for the final sample. Variable *CI* ranges from 0 to 10.57 (mean = 9.483), while *Nationalism* exhibits a distribution from 0 to 13.78 with a substantially lower mean of 0.0041. These results collectively indicate suboptimal *Nationalism* levels across firms, suggesting significant potential for enhancement relative to theoretical optima.

Table 3 lists the correlations for all variables in our model. From the perspective of core variable correlation, the analysis reveals a correlation coefficient of 0.132 between *Nationalism* and *CI*, which is positively significant at the 1% level. This indicates a statistically strong positive relationship between national sentiment and corporate carbon emissions, thereby providing preliminary empirical support for subsequent main-effect tests.

Baseline regression results

Table 4 presents baseline regressions examining nationalism's impact on corporate carbon emission intensity (Model 1). Columns (1) and (3) estimate specifications without control variables while maintaining firm and year fixed effects. Column (1) reveals a statistically significant positive coefficient of 0.1408 (at the 1% level) on the linear patriotism term. Column (3) introduces a quadratic patriotism term, yielding a significantly negative coefficient of −2.4795 (at the 1% level). Columns (2) and (4) incorporate control variables, demonstrating sustained statistical significance. The linear coefficient of *Nationalism* is 0.9315 and significantly positive at the 1% level with a 95% confidence interval of (0.601, 1.262). In Column (2), quadratic coefficient is −37.2397 and significantly negative at the 1% level with a 95% confidence interval of (−57.746, −16.733), the above results establish an inverted U-shaped relationship between nationalism and corporate carbon emission intensity, H1 is confirmed. From an institutional legitimacy perspective, we posit that firms demonstrating national sentiment are initially driven by socio-normative legitimacy to prioritize economic value creation as proof of national allegiance. This triggers resource reallocation toward capacity expansion, where carbon emission growth substantially outpaces potential mitigation efforts, manifested as the upward trajectory of the curve. However, beyond a critical legitimacy threshold, low-carbon ethical

Table 3 Correlation analysis of the main variable.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
<i>CI</i>	1.000															
<i>Nationalism</i>	0.132***	1.000														
<i>Nationalism</i> ²	0.009	0.778***	1.000													
<i>Mcompet</i>	-0.0011*	0.0040	0.000	1.000												
<i>Target</i>	-0.027***	0.011**	-0.002	-0.003	1.000											
<i>Epenalty</i>	-0.051***	-0.118***	-0.014**	0.004	0.002	1.000										
<i>Csr</i>	-0.141***	-0.059***	-0.040***	0.031***	-0.019***	-0.021***	1.000									
<i>Ginvest</i>	-0.090***	-0.021***	-0.004	0.003	0.022***	-0.025***	0.006	1.000								
<i>Dual</i>	0.133***	0.007	-0.004	0.000	-0.013***	0.038***	-0.033***	-0.044***	1.000							
<i>Director</i>	0.074***	-0.048***	-0.010**	0.008*	0.003	0.029***	0.050***	-0.007	0.126***	1.000						
<i>Lev</i>	-0.371***	-0.147***	-0.010*	0.014***	0.018***	0.018***	-0.054***	0.099***	-0.138***	-0.094***	1.000					
<i>Cash</i>	0.136***	0.132***	0.017***	-0.007	-0.012***	0.004	0.145***	-0.075***	0.090***	0.053***	-0.366***	1.000				
<i>First</i>	-0.181***	0.047***	0.011**	0.011**	0.009*	-0.002	0.154***	0.044***	-0.039***	-0.207***	0.032***	0.034***	1.000			
<i>Inde</i>	-0.238***	-0.060***	0.001	0.004	0.015***	0.008	0.121***	0.024	-0.134***	-0.007	0.087***	-0.056***	0.031***	1.000		
<i>Fag</i>	-0.304***	-0.097***	0.001	-0.002	0.008	-0.022***	-0.069***	0.063***	-0.243***	-0.340***	0.369***	-0.238***	-0.078***	0.121***	1.000	
<i>Roa</i>	-0.005	0.027***	0.003	0.024***	0.004	-0.031***	0.180***	0.005	0.011**	0.039***	-0.075***	0.088***	0.050***	0.007	-0.068***	1.000

Table. 4 Baseline regression results.

<i>CI</i>	(1)	(2)	(3)	(4)
<i>Nationalism</i>	0.1408*** (0.0485)	0.3646*** (0.1114)	0.4713*** (0.0935)	0.9315*** (0.1687)
<i>Nationalism</i> ²			−2.4795*** (0.6030)	−37.2397*** (10.4589)
<i>Dual</i>		−0.0451** (0.0193)		−0.0448** (0.0192)
<i>Director</i>		−0.0215*** (0.0055)		−0.0206*** (0.0054)
<i>Lev</i>		−0.2378*** (0.0388)		−0.2253*** (0.0383)
<i>Cash</i>		−0.3450*** (0.0533)		−0.3531*** (0.0532)
<i>First</i>		−0.0049*** (0.0015)		−0.0047*** (0.0015)
<i>Inde</i>		−0.0638*** (0.0192)		−0.0619*** (0.0190)
<i>Fag</i>		−0.0541*** (0.0032)		−0.0511*** (0.0031)
<i>Roa</i>		−0.2263 (0.1423)		−0.2231 (0.1431)
Firm fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Cons	9.7522*** (0.0312)	10.4940*** (0.1218)	9.5907*** (0.0496)	10.2783*** (0.1185)
<i>N</i>	32,892	26,135	32,892	26,135
<i>R</i> ²	0.0501	0.1093	0.0518	0.1123
<i>F</i>	82.8493	35.6321	79.8422	34.5097

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

legitimacy restructures corporate responsibility paradigms toward “green contributions”, inducing the subsequent downward inflection of the curve.

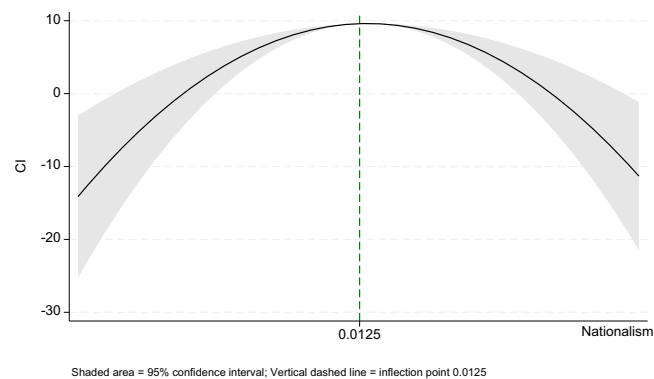
**Fig. 2** Inverted U-shaped relationship between national sentiment and carbon emission intensity.

Table 5 Endogeneity test results.

	Lag first test (1)	GMM (2)
<i>L.Nationalism</i>	0.8733*** (0.1533)	
<i>L.Nationalism</i> ²	−33.9738*** (9.7835)	
<i>Nationalism</i>		2.1514*** (0.6567)
<i>Nationalism</i> ²		−189.6861*** (56.3785)
<i>L.CI</i>		0.8963*** (0.0575)
<i>Dual</i>	−0.0389* (0.0203)	0.0257* (0.0137)
<i>Director</i>	−0.0231*** (0.0054)	−0.0256 (0.0405)
<i>Lev</i>	−0.2678*** (0.0448)	−0.2954 (0.2830)
<i>Cash</i>	−0.3380*** (0.0610)	0.2261 (0.1381)
<i>First</i>	−0.0051*** (0.0015)	−0.0010 (0.0013)
<i>Inde</i>	−0.0608*** (0.0197)	−0.0001 (0.1255)
<i>Fag</i>	−0.0487*** (0.0032)	−0.0078** (0.0034)
<i>Roa</i>	−0.2502* (0.1500)	−3.5282*** (0.7576)
Cons	10.2850*** (0.1225)	0.7865 (0.9076)
<i>N</i>	23,104	22,802
<i>R</i> ²	0.1083	
<i>F</i>	32.3438	
AR (1)		−7.94
[0.000]		
AR (2)		1.25
[0.210]		
Sargan test		63.54
[0.112]		
Hansen test		61.75
[0.144]		

In GMM, number of instruments are 63, and number of groups are 3019. The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

Regarding control variables, our analysis demonstrates that discretion, board structure characteristics and debt structure variables are all significantly reduce carbon intensity at the 1% significance level. Notably, cash ratio serves as robust indicators of financial resilience, while capital allocation exhibits significant carbon mitigation effects. In addition, we should not only focus on CEO dual, but also enhance awareness of the cost of environmental violations

Table. 6 Robust test results of core inverted U-shaped relationship.

	Substituting the dependent variable (1)	Turning point piecewise linearity spline (2)	The median piecewise linearity spline (3)	(4)
<i>Nationalism</i>	−1.0685*** (0.1745)	−1.9986*** (0.1789)	50.1600*** (9.6386)	2.3912*** (0.2520)
<i>Nationalism</i> ²		61.0957*** (11.0663)		
<i>Nationalism_spline1</i>			−103.8302*** (19.0461)	
<i>Nationalism_spline2</i>				−2.5125*** (0.2644)
<i>Dual</i>	0.0209 (0.0228)	0.0204 (0.0226)	−0.0453** (0.0193)	−0.0390** (0.0187)
<i>Director</i>	0.0483*** (0.0054)	0.0468*** (0.0053)	−0.0211*** (0.0055)	−0.0197*** (0.0053)
<i>Lev</i>	0.7827*** (0.0557)	0.7622*** (0.0549)	−0.2312*** (0.0384)	−0.2095*** (0.0373)
<i>Cash</i>	−0.1931** (0.0766)	−0.1797** (0.0763)	−0.3503*** (0.0533)	−0.3304*** (0.0521)
<i>First</i>	0.0057*** (0.0017)	0.0054*** (0.0016)	−0.0048*** (0.0015)	−0.0050*** (0.0014)
<i>Inde</i>	0.1208*** (0.0217)	0.1177*** (0.0214)	−0.0630*** (0.0191)	−0.0535*** (0.0185)
<i>Fag</i>	0.0899*** (0.0036)	0.0850*** (0.0029)	−0.0522*** (0.0031)	−0.0505*** (0.0030)
<i>Roa</i>	0.6918* (0.3724)	0.6865* (0.3737)	−0.2233 (0.1423)	−0.2416 (0.1506)
Firm fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Cons	11.9871*** (0.1504)	12.3410*** (0.1209)	10.4071*** (0.1117)	9.7172*** (0.1275)
<i>N</i>	26,135	26,135	26,135	26,135
<i>R</i> ²	0.3945	0.4009	0.1106	0.1228
<i>F</i>	197.1275	190.4870	34.6366	36.6460

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

by increasing the shareholding of first shareholders. Of course, age brings higher compliance to enterprises, accumulated organizational memory forms institutional knowledge stocks in environmental management.

To graphically demonstrate the established nonlinear relationship, we plot the fitted inverted U-shaped curve between nationalism and carbon emission intensity. As described in Fig. 2, the statistically estimated turning point occurs at a nationalism level of 0.0125, which lies below the 1st quantile of the *Nationalism* sample distribution—an extremely low level in the sample—meaning that for the vast majority (over 99%) of the samples, the impact of national sentiment on carbon emission intensity has shifted from a positive promoting effect to a negative inhibiting effect, a conclusion with strong practical explanatory power. To quantify the accuracy of the inflection point estimation, we calculated its 95% confidence interval [0.0086, 0.0164], which lies entirely within the low-level range of the sample distribution, further statistically validating the robustness of the inflection point location. Below the 0.0125 threshold, carbon emission intensity exhibits a positive association with national sentiment. Conversely, when national sentiment exceeds 0.0125, carbon intensity demonstrates a significant negative relationship.

Table. 7 Lind–Mehlum U-test.

Items	Lower bound	Upper bound
Interval	0	0.19413
Slope	93.1504*** (5.5221)	−1352.751*** (−3.4519)
Control variables	YES	YES
Firm fixed effect	YES	YES
Year fixed effect	YES	YES
<i>t</i> -value	3.45***	

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

Endogeneity test

To mitigate potential reverse causal endogeneity between national sentiment and carbon emission intensity, where high-emission entities may resort to nationalist discourse in response to stricter environmental constraints, this paper systematically examines their relationship using three methods, including lagged core explanatory variables, a lead placebo test, and a dynamic panel specification, with results reported in Table 5.

Firstly, the national sentiment variable was lagged by one period to mitigate estimation bias arising from reverse causality. Column (1) shows that the coefficient of *L.Nationalism* is 0.8733 (significantly positive at the 1% level), while the coefficient of quadratic term *L.Nationalism*² is −33.9738 (significantly negative at the 1% level). It is highly consistent with the baseline regression results and verifies the robust inverted U-shaped relationship between national sentiment and carbon emission intensity.

Then, traditional regression models can lead to biases, such as carbon emissions influencing national sentiments. To address this inverse causal relationship, we adopt GMM for endogeneity testing (Xu et al., 2025b). A dynamic panel setting is employed as an instrumental variable strategy to further address reverse causality. Column (2) reveals that the coefficient of *Nationalism* is 2.1514, which is significantly positive at the 1% level, meanwhile, that of quadratic term *Nationalism*² is −189.6861 (significantly negative at the 1% level), reconfirming the robust inverted U-shaped relationship between national sentiment and carbon emission intensity. Moreover, the AR(1) statistic is −7.94, which is negatively significant at the 1% level; in contrast, the AR(2) statistic is 1.25 and not significant, confirming first-order but not second-order serial correlation and thus supporting the dynamic panel specification. The Hansen test statistic is 61.75 and is insignificant, so we cannot reject the validity of the instruments. Taken together, these results further confirm our empirical findings.

Robustness tests

Firstly, to further verify the robustness of the previously documented relationship between national sentiment and carbon emission intensity, we substitute the dependent variable with carbon performance, defined as the reciprocal of the natural logarithm of the ratio of carbon emissions to main business revenue. The regression results based on this alternative metric are reported in Table 6. The results show a significant U-shaped relationship between nationalism and carbon performance. Given the inverse relationship between carbon performance and carbon emission intensity, these robustness tests employing carbon performance corroborate research hypothesis H1.

Secondly, to avoid the bias caused by the pre-specified functional form of the quadratic polynomial, this paper constructs a piecewise linear model with the median of the inflection points estimated by the quadratic model as the dividing point to conduct a robustness test. And the results are in Column (3) and (4). In Column (3) shows that the coefficient of *Nationalism* is 50.1600, which is significantly positive at the 1% level, and the coefficient of *Nationalism_spline1* is −103.8302 ($p < 0.01$), while Column (4) shows that the coefficient of *Nationalism* is 2.3912, and significantly positive at the 1% level. The coefficient of *Nationalism_spline2* is −2.5125, and significantly negative at the 1% level. These results indicate that the coefficients of the core explanatory variable are significantly positive

Table. 8 The results of adding control variables.

Items	CI					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Nationalism</i>	0.8806*** (0.1659)	0.9270*** (0.1714)	0.9328*** (0.1690)	1.0100*** (0.1706)	0.9637*** (0.1744)	0.8435*** (0.1680)
<i>Nationalism</i> ²	−35.0567*** (9.0291)	−36.1218*** (9.9456)	−37.3675*** (10.5180)	−38.0284*** (9.9159)	−37.6777*** (10.3326)	−32.7324*** (8.6351)
<i>Greencogn</i>	0.0011** (0.0005)					
<i>Cmanstra</i>		−0.0129** (0.0064)				
<i>Epi</i>			−0.0072** (0.0031)			
<i>Internal</i>				−0.1459*** (0.0342)		
<i>EPindex</i>					0.3528* (0.1998)	
<i>Carbon policy</i>						0.0010** (0.0005)
<i>Dual</i>	−0.0297 (0.0188)	−0.0328* (0.0192)	−0.0447** (0.0192)	−0.0423** (0.0206)	−0.0476** (0.0205)	−0.0471** (0.0217)
<i>Director</i>	−0.0186*** (0.0057)	−0.0191*** (0.0054)	−0.0206*** (0.0054)	−0.0238*** (0.0057)	−0.0212*** (0.0059)	−0.0187*** (0.0060)
<i>Lev</i>	−0.2273*** (0.0371)	−0.2072*** (0.0388)	−0.2265*** (0.0382)	−0.3484*** (0.0545)	−0.2353*** (0.0411)	−0.2383*** (0.0413)
<i>Cash</i>	−0.3701*** (0.0546)	−0.3574*** (0.0534)	−0.3504*** (0.0533)	−0.2889*** (0.0626)	−0.4008*** (0.0573)	−0.3647*** (0.0613)
<i>First</i>	−0.0044*** (0.0015)	−0.0052*** (0.0014)	−0.0047*** (0.0015)	−0.0044*** (0.0015)	−0.0046*** (0.0016)	−0.0048*** (0.0017)
<i>Inde</i>	−0.0476** (0.0192)	−0.0672*** (0.0194)	−0.0618*** (0.0190)	−0.0583*** (0.0193)	−0.0581*** (0.0196)	−0.0514** (0.0209)
<i>Fag</i>	−0.0512*** (0.0034)	−0.0511*** (0.0031)	−0.0507*** (0.0031)	−0.0547*** (0.0033)	−0.0479*** (0.0043)	−0.0536*** (0.0031)
<i>Roa</i>	−0.4440*** (0.0986)	−0.2178 (0.1373)	−0.2208 (0.1439)	−0.5718*** (0.1079)	−0.1906 (0.1351)	−0.1843 (0.1509)
<i>Cons</i>	10.2385*** (0.1146)	10.3126*** (0.1156)	10.2750*** (0.1185)	11.2670*** (0.2547)	10.1270*** (0.1570)	10.2926*** (0.1252)
Firm fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
<i>N</i>	23,621	24,261	26,135	23,156	22,522	18,513
<i>R</i> ²	0.1076	0.1168	0.1127	0.1311	0.1168	0.1375
<i>F</i>	28.9198	32.2268	32.9783	33.4777	30.9078	28.6097

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

before the segmentation points and significantly negative after, which is fully consistent with the inverted U-shaped conclusion of the baseline regression, strongly demonstrating that our core results are not driven by the specific form of the quadratic function but by the robust nonlinear characteristics inherent in the data.

Thirdly, to further explore the rigorous inverted U-shaped nexus between national sentiment and carbon emission intensity, and address the methodological limitations of conventional approaches that merely focus on the statistical

significance of quadratic coefficients. We conducted a Lind–Mehlum U-test, and the results are shown in Table 7. the slope coefficient at the lower bound of *Nationalism* is 93.1504 ($P = 0.000$), statistically significant with positive sign at the 1% level. While at the upper bound it is -1352.751 ($P = 0.000$), statistically significant with negative sign at the 1% level. The coefficient of overall test of presence of an inverse U shape is 3.45 ($P = 0.000$), and significant at the 1% level. It confirmed an inverted U-shaped relationship.

Fourthly, to mitigate potential confounding effects, we methodically incorporate six control variables into our regression specification. ① We add green cognition as control variable. We argue that managers with green cognition are a crucial factor in affecting carbon emission. In order to strip away the part of green cognition that affects corporate carbon emissions, and to more clearly identify and verify the net impact of patriotism on corporate carbon emissions, we introduce it into the model 1. In column (1), *Greencogn* has a significantly positive effect on *CI*, and the inverse U shape is stable. ② To isolate the causal channel of patriotism from corporate carbon governance frameworks, we construct a carbon management strategy index via textual analysis of annual reports—quantifying term frequencies (“low-carbon strategy”, “zero-carbon development” and etc.) to capture strategic intensity. Controlling for this institutionalized variable disentangles emission reduction behaviors attributable to structured environmental strategies versus patriotism-driven initiatives, thereby purifying the identified causal effect. As reported in Column (2) of Table 8, the coefficient of *Cmanstra* demonstrates statistically significant explanatory power. Crucially, the inverted U-shaped relationship between national sentiment and carbon emissions persists after controlling for *Cmanstra*, with both linear and quadratic terms remaining significant at the 1% level. This robustness withstands competing explanations from corporate environmental governance, thereby providing confirmatory evidence for Hypothesis 1. ③ Incorporating environmental governance investment (*Epi*) into Model 1, this study operationalizes corporate sustainability commitment through listed firms’ disclosed capital and technological allocations toward pollution control, emission abatement, and resource efficiency. Controlling for *Epi* disentangles competing causal pathways—environmental responsibility investments versus patriotism-driven initiatives—in explaining emission behaviors. Column (3) of Table 8 demonstrates that the inverted U-shaped relationship between national sentiment and carbon emission intensity persists with statistical significance (at the 1% level for linear/quadratic terms), thereby providing robust confirmatory evidence for Hypothesis 1 against environmental investment confounders. ④ To purify the causal effect of national sentiment on carbon abatement, we introduce an internal control variable that operationalizes corporate governance efficacy through production standardization, risk management efficiency, and compliance enforcement rigor. By controlling for this index—which mechanizes emissions reduction via energy process optimization, environmental oversight intensification, and resource allocation refinement—we disentangle institutional governance improvements from patriotism-driven initiatives, thereby isolating the net ecological impact attributable to patriotic motives. As evidenced in Column (4) of Table 8, the inverted U-shaped relationship between patriotism and carbon emission intensity persists with statistical significance (at the 1% level for both terms) after accounting for internal control covariates, thereby reconfirming Hypothesis 1’s robustness against corporate internal control confounders. ⑤ To mitigate confounding from regional regulatory pressures, this study employs a provincial environmental pollution index constructed via entropy weighting-integrating wastewater discharge, industrial SO_2 emissions, and solid waste generation to quantify pollution load intensity. High values signify coercive institutional pressures that mechanically induce emission abatement through compliance costs and penalty risks, thus creating competing explanations for patriotism-driven reductions. Controlling for this variable disentangles externally regulatory pressures effects from patriotic motives. Column (5) of Table 8 demonstrates a statistically significant inverted U-shaped relationship between national sentiment and carbon emission intensity (at the 1% level for linear/quadratic terms) after controlling for environmental pollution covariates. ⑥ To disentangle compliance-based abatement from patriotism-driven voluntary reductions, this study incorporates a carbon policy covariate constructed through textual mining of “carbon reduction emphasis” lexicons in corporate disclosures. This metric captures strategic responses to socio-regulatory legitimacy pressures, enabling isolation of emission effects attributable to external legitimacy demands from the impetus of patriotic motives. Column (6) of Table 8 confirms the persistent inverted U-shaped relationship between national sentiment and carbon emission intensity (at the 1% level for linear/quadratic terms) after controlling for carbon policy covariates. This robustness withstands socio-regulatory confounders, validating Hypothesis 1 against external normative pressure interference.

Table. 9 Robustness tests of standard errors.

	Clustered standard errors at the firm level (1)	Two-way cluster at firm and year level (2)	Driscoll–Kraay standard errors (3)
<i>Nationalism</i>	0.9315*** (0.1687)	2.5663*** (0.3764)	0.9315*** (0.0945)
<i>Nationalism</i> ²	−37.2397*** (10.4589)	−100.9138** (34.2282)	−37.2397*** (8.1165)
<i>Dual</i>	−0.0448** (0.0192)	0.0563** (0.0254)	−0.0448** (0.0155)
<i>Director</i>	−0.0206*** (0.0054)	−0.0253** (0.0084)	−0.0206*** (0.0055)
<i>Lev</i>	−0.2253*** (0.0383)	−1.0974*** (0.0820)	−0.2253*** (0.0559)
<i>Cash</i>	−0.3531*** (0.0532)	−0.2180** (0.0919)	−0.3531*** (0.0434)
<i>First</i>	−0.0047*** (0.0015)	−0.0131*** (0.0012)	−0.0047*** (0.0008)
<i>Inde</i>	−0.0619*** (0.0190)	−0.2916*** (0.0295)	−0.0619*** (0.0109)
<i>Fag</i>	−0.0511*** (0.0031)	−0.0257*** (0.0027)	−0.0511*** (0.0014)
<i>Roa</i>	−0.2231 (0.1431)	−0.8144** (0.3435)	−0.2231 (0.1287)
Firm fixed effect	YES	YES	YES
Year fixed effect	YES	YES	YES
Cons	10.2783*** (0.1185)	10.7880*** (0.1416)	10.2783*** (0.0578)
<i>N</i>	26,135	26,135	26,135
<i>R</i> ²	0.1123	0.2657	
<i>F</i>	34.5097	54.1231	1646.2293

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

Overall, as reported in Table 8, the first-order term of *Nationalism* consistently exhibits positive coefficients significant at the 1% level, while its quadratic term shows negative coefficients statistically significant at the 1% level after adding control variables (*Greencogn*, *Cmanstra*, *Epi*, *Internal*, *EPindex* and *Carbon policy*). This robust pattern persists after controlling for these additional factors, thereby confirming the inverted U-shaped relationship between national sentiment and carbon emissions and further validating Hypothesis H1. Furthermore, carbon emissions exhibit positive associations with heightened managerial environmental awareness, elevated environmental pollution indices, and intensified carbon policies. Conversely, emissions demonstrate significant mitigation effects from enhanced carbon management strategies, increased environmental protection investments, and strengthened internal control systems.

Finally, given potential serial correlation within firms and the possible impact of cross-year shocks on estimation results, we conduct robustness tests using alternative standard error estimation methods. Specifically, we re-estimate the main regression model with firm-level clustered standard errors, and further verify the robustness of the results using two-way clustered (firm and year) standard errors and Driscoll–Kraay standard errors, with the relevant regression results reported in Table 9. ① To mitigate estimation bias arising from potential serial correlation within firms and heteroscedasticity across firms, we re-estimate the main regression model using standard errors clustered at the firm level, and the results is reported in Column (1), The coefficient of *Nationalism* is positively significant

Table. 10 Moderating effect results.

	(1) <i>Mcompet</i>	(2) <i>Target</i>	(3) <i>Epenalty</i>
<i>Nationalism</i>	0.9577*** (0.1762)	0.8900*** (0.1530)	0.8054*** (0.1124)
<i>Nationalism</i> ²	−38.5487*** (11.6246)	−33.5460*** (8.8956)	−25.8550*** (5.0723)
<i>Nationalism</i> × <i>Moderator</i>	0.0008* (0.0005)	0.3840* (0.2173)	0.3176*** (0.1045)
<i>Nationalism</i> ² × <i>Moderator</i>	−0.0919** (0.0443)	−27.2525* (14.8755)	−26.7371** (12.0937)
<i>Moderator</i>	−0.0002 (0.0001)	−0.1168 (0.0723)	−0.0670*** (0.0234)
<i>Dual</i>	−0.0486** (0.0192)	−0.0447** (0.0192)	−0.0260* (0.0158)
<i>Director</i>	−0.1881** (0.0782)	−0.0205*** (0.0054)	−0.0149** (0.0043)
<i>Lev</i>	−0.2300*** (0.0386)	−0.2241*** (0.0383)	−0.1637*** (0.0324)
<i>Cash</i>	−0.3633*** (0.0540)	−0.3527*** (0.0532)	−0.3690*** (0.0584)
<i>First</i>	−0.0029*** (0.0010)	−0.0047*** (0.0015)	−0.0063*** (0.0009)
<i>Inde</i>	−0.0354 (0.0219)	−0.0618*** (0.0190)	−0.0552*** (0.0152)
<i>Fag</i>	−0.0522*** (0.0032)	−0.0511*** (0.0030)	−0.0615*** (0.0138)
<i>Roa</i>	−0.2331 (0.1466)	−0.2216 (0.1434)	−0.2302*** (0.0523)
Firm fixed effect	YES	YES	YES
Year fixed effect	YES	YES	YES
Cons	10.5031*** (0.1834)	10.2884*** (0.1155)	10.4157*** (0.2264)
<i>N</i>	26,135	26,135	16,821
<i>R</i> ²	0.1107	0.1126	0.0842
<i>F</i>	29.3849	30.5832	57.6166

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

($\beta = 0.9315$, $p < 0.01$), and the coefficient of *Nationalism*² is negatively significant ($\beta = -37,2397$, $p < 0.01$), consistent with the baseline regression in terms of sign, magnitude, and significance. This suggests that the core inverted U-shaped relationship between national sentiment and carbon emission intensity is robust to serial correlation within firms, lending preliminary support to the validity of the estimation results. ② To account for potential cross-sectional dependence arising from intertemporal shocks and time-varying variances across firms, this paper further employs two-way clustering of standard errors by firm and year, and the results are presented in Column (2), the coefficient of *Nationalism* is positively significant ($\beta = 2.5663$, $p < 0.01$), and the coefficient of *Nationalism*² is negatively significant ($\beta = -100.9138$, $p < 0.01$), therefore, the coefficients remain largely consistent with those of the baseline regression, confirming that the core findings are not driven by cross-year shocks or cross-sectional dependence across firms, thereby further reinforcing the robustness of the results. ③ Column (3) is the regressions results of the Driscoll–Kraay standard error, the coefficient of *Nationalism* is positively significant ($\beta = 0.9315$, $p < 0.01$), and the

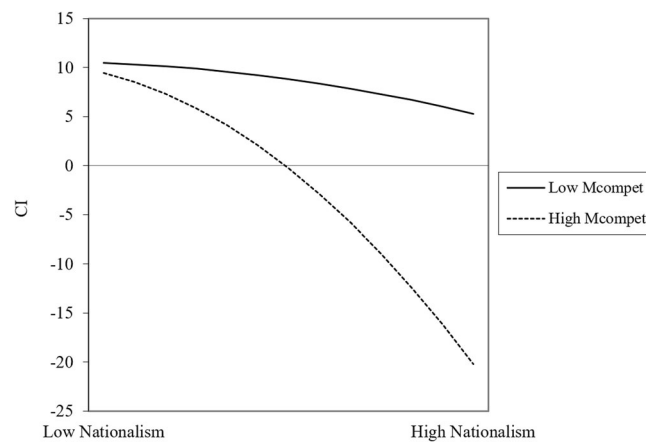


Fig. 3 Moderating effect of market competition.

coefficient of Nationalism2 is negatively significant ($\beta = -37,2397$, $p < 0.01$). The above results indicate that national sentiment continues to exhibit a significant inverted U-shaped relationship with carbon emission intensity, with coefficient estimates and significance levels remaining highly consistent with those from the baseline regression and the two alternative standard error estimation approaches. This further confirms that the core findings of this paper are not driven by potential cross-sectional dependence or other econometric concerns, underscoring the robustness and reliability of the inverted U-shaped relationship between national sentiment and carbon emission intensity.

Moderating effect

Grounded in institutional theory, market competition constitutes the regulatory context for corporate emissions, carbon targets establish normative institutional orientations, and environmental penalties enforce coercive compliance. Consequently, we incorporate market competition, emission reduction target constraints and environment penalty into model as the moderating variables.

The regression results of *Lena* are shown in Table 10. In Column (1), we introduce the interaction term *Nationalism* × *Mcompet* and *Nationalism*² × *Mcompet*. The estimated coefficient of *Nationalism* × *Mcompet* is 0.0008, and is significantly positive at 10% level. The estimated coefficient of *Nationalism*² × *Mcompet* is -0.0919 , and is significantly negative at 5% level. We observe that attenuated market competition sharpens the inverted U-shaped relationship between national sentiment and carbon emission intensity. Figure 3 is the moderating effect of market competition, in which the solid line denotes low market competition and the dashed line denotes high market

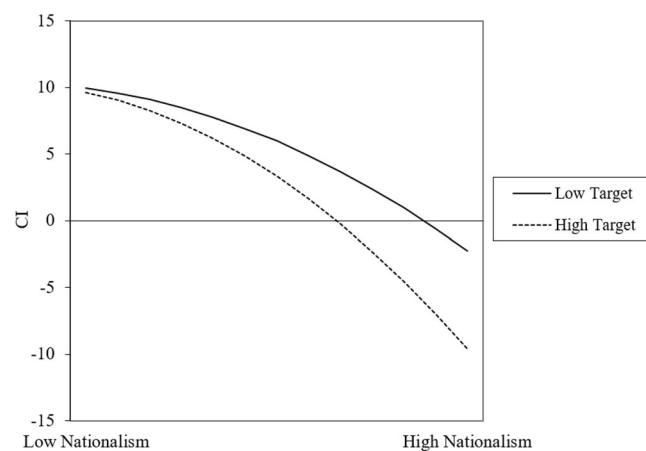


Fig. 4 Moderating effect of carbon targets.

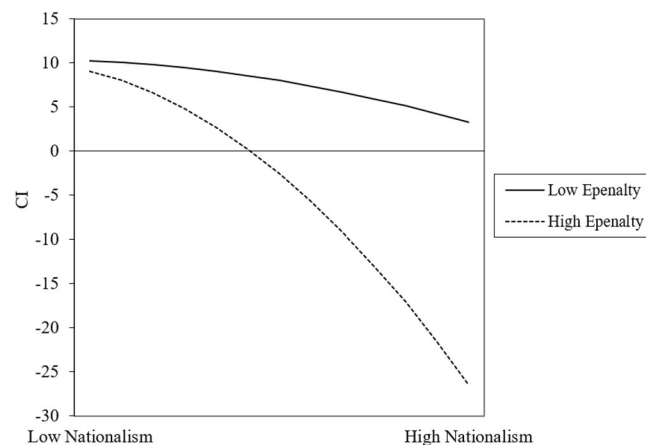


Fig. 5 Moderating effect of environmental penalties.

competition. The graphical evidence shows that under high market competition, the inflection point of the inverted U-shaped curve is advanced, and the curve becomes sharper, indicating that higher market competition enhances the emission reduction effect of nationalism and enlarge the nonlinear nexus between national sentiment and carbon emission intensity. This moderation effect arises as competitive environments foster technological diffusion and innovation incentives, Therefore, H2 is supported.

Table 10 presents the results of the moderating effect of emission reduction target constraints on national sentiment and carbon emission intensity. In Column (2), we introduce the interaction terms of $Nationalism \times Target$ and $Nationalism^2 \times Target$. The regression coefficient of the $Nationalism \times Target$ is 0.3840, which is significantly positive at the 10% level. And the estimated coefficient of $Nationalism^2 \times Target$ is -27.2525 , which is significantly negative at the 10% level. Figure 4 presents the moderating effect of emission reduction targets, where the solid line indicates a low emission reduction target and the dashed line a high target. Under a high level of goal orientation, the inflection point of the inverted U-shaped relationship between national sentiment and carbon emission intensity shifts significantly leftward, and the right descending section of the curve becomes notably steeper. This suggests that a strong goal orientation significantly strengthens the effect of national sentiment. These results demonstrate that *Target* steepen the carbon intensity curve through enhanced corporate decarbonization. Thus, hypothesis H3 is empirically substantiated.

Table 10 shows the moderating results of environmental penalties. In Column (3), we introduce the interaction terms $Nationalism \times Epenalty$ and $Nationalism^2 \times Epenalty$. The estimated coefficient of $Nationalism \times Epenalty$ is 0.3176, which is significantly positive at the 1% level. And the estimated coefficient of $Nationalism^2 \times Epenalty$ is -26.7371 , which is significantly negative at the 5% level. It indicates that *Epenalty* induces a steepened gradient in the curve. Figure 5 is the moderating effect of environmental penalties, in which solid lines represent low environmental penalties, while dashed lines indicate high environmental penalties. Under a stringent regulatory regime, the inflection point of the inverted U-shaped curve occurs earlier, and the right-side downward slope becomes steeper. As a result, the dampening effect of national sentiment on carbon emissions is significantly strengthened, manifesting as a strong negative impact on emissions reduction at high levels of national sentiment. And it likely stems from public disclosure of environmental penalties activates social sanction threats that force legitimacy-seeking firms to escalate emission cuts, providing empirical substantiation for Hypothesis 4.

Mediating effect

We respectively explored the channels through which national sentiment affects the carbon intensity of enterprises under the legitimacy of social norms and the legitimacy of low-carbon morality. Thus, corporate social responsibility and green investment as mediating variables.

Table. 11 Mediating effect results.

	(1) <i>Csr</i>	(2) <i>Csr</i>	(3) <i>CI</i>	(4) <i>G invest</i>	(5) <i>G invest</i>	(6) <i>CI</i>
<i>Nationalism</i>	−0.5035*** (0.0821)	−0.7290*** (0.0986)	0.9150*** (0.0849)	−0.4378** (0.1838)	−0.9078** (0.3794)	0.9397*** (0.1680)
<i>Nationalism</i> ²		16.7391*** (3.9923)	−34.9456*** (4.4573)		6.1346** (2.6879)	−37.6280*** (10.2804)
<i>Csr</i>			−0.0284*** (0.0068)			
<i>Green invest</i>						−0.0075*** (0.0024)
<i>Dual</i>	−0.0156 (0.0175)	−0.0157 (0.0175)	−0.0570*** (0.0136)	0.0134 (0.0627)	0.0136 (0.0810)	−0.0459** (0.0192)
<i>Director</i>	0.0240*** (0.0045)	0.0237*** (0.0045)	−0.0188*** (0.0035)	0.0542*** (0.0169)	0.0523** (0.0261)	−0.0200*** (0.0055)
<i>Lev</i>	−0.1722*** (0.0374)	−0.1757*** (0.0375)	−0.2544*** (0.0264)	0.6249*** (0.1101)	0.6104*** (0.1347)	−0.2266*** (0.0386)
<i>Cash</i>	0.4364*** (0.0489)	0.4400*** (0.0488)	−0.3577*** (0.0424)	0.7520*** (0.1909)	0.7747*** (0.2120)	−0.3613*** (0.0539)
<i>First</i>	0.0070*** (0.0010)	0.0070*** (0.0010)	−0.0048*** (0.0006)	0.0053* (0.0029)	0.0054 (0.0052)	−0.0030*** (0.0010)
<i>Inde</i>	0.0266* (0.0159)	0.0261 (0.0159)	−0.0622*** (0.0118)	−0.0176 (0.0563)	−0.0209 (0.0763)	−0.0619*** (0.0190)
<i>Fag</i>	−0.0329*** (0.0031)	−0.0338*** (0.0031)	−0.0543*** (0.0035)	0.0540*** (0.0092)	0.0484*** (0.0118)	−0.0514*** (0.0031)
<i>Roa</i>	0.4268 (0.3143)	0.4267 (0.3142)	−0.0604 (0.0563)	0.1806** (0.0881)	0.1808*** (0.0540)	−0.2252 (0.1439)
Firm fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
Cons	3.1318*** (0.0866)	3.2093*** (0.0864)	10.3814*** (0.0727)	0.0057 (0.2768)	0.2626 (0.4233)	10.2104*** (0.1080)
<i>N</i>	31,707	31,707	22,291	37,551	37,551	26,135
<i>R</i> ²	0.1004	0.1007	0.1054	0.0099	0.0100	0.1119
<i>F</i>	69.9533	67.3958	108.0643	17.2567	8.1963	33.1945

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

Table 11 reports the regression results between *Nationalism* and *CI*. In column (1), *Nationalism* shows a statistically significant coefficient of −0.5035 at the 1% level. In linear relationships, *Nationalism* has a significant negative impact on *Csr*. In Column (2), *Nationalism* presents a U-shaped relationship with *Csr*. *Nationalism* will lower the *Csr* first, and then increase the *Csr* after the lowest threshold. In Column (3), the coefficient of *Csr* is −0.0284 and is significant at the 1% level. Simultaneously, the inverted U-shaped relationship of *Nationalism* to *CI* is significant. It indicates that *Csr* has a partly mediating effect of *Nationalism* and *CI*. Hypothesis 5 has been confirmed. Therefore, during economic expansions firms with national sentiment strategically reduce social responsibility expenditures; however, they subsequently increase investments in carbon emission mitigation to address legitimacy pressures arising from evolving societal norms.

Then, we explore the role of green investment as a channel for *Nationalism* and *CI*. In column (4), *Nationalism* shows a statistically significant coefficient of −0.4378 at the 5% level. In linear relationships, *Nationalism* has a significant negative impact on *Ginvest*. In Column (5), *Nationalism* presents a U-shaped relationship with *Ginvest*. *Nationalism* will lower the *Ginvest* first, and then increase the *Ginvest* after the lowest threshold. In Column (6), the

Table. 12 Regression results with bootstrap confidence intervals.

	CI			
	(1)	(2)	(3)	(4)
<i>Nationalism</i>	−0.0627 (0.6345)	0.5742 (0.5220)	0.6752 (0.5202)	0.7782 (0.5208)
<i>Nationalism</i> ²	−14.4121 (52.5509)	−34.8251 (51.4559)	−35.1710 (51.8879)	−36.2478 (51.8913)
<i>m_Csr</i>	−1.3637*** (0.4655)			
<i>m_Ginvest</i>		−0.3936*** (0.0721)		
<i>L.m_Csr</i>			−0.8259*** (0.1495)	
<i>L.m_Ginvest</i>				−0.1723*** (0.0603)
<i>Dual</i>	−0.0662*** (0.0152)	−0.0394*** (0.0135)	−0.0398*** (0.0135)	−0.0500*** (0.0136)
<i>Director</i>	0.0117 (0.0115)	−0.0253*** (0.0055)	−0.1452*** (0.0306)	−0.0119** (0.0048)
<i>Lev</i>	−0.4649*** (0.0887)	0.0150 (0.0562)	0.0453 (0.0608)	−0.2041*** (0.0361)
<i>Cash</i>	0.2469 (0.2109)	−0.0482 (0.0718)	−0.0429 (0.0713)	−0.2757*** (0.0527)
<i>First</i>	0.0048 (0.0033)	−0.0026*** (0.0009)	0.0004 (0.0012)	−0.0035*** (0.0009)
<i>Inde</i>	−0.0263 (0.0173)	−0.0702*** (0.0127)	−0.0373*** (0.0137)	−0.0573*** (0.0128)
<i>Fag</i>	−0.0972*** (0.0165)	−0.0320*** (0.0041)	−0.0832*** (0.0064)	−0.0326*** (0.0064)
<i>Roa</i>	0.3588 (0.2678)	−0.1519 (0.1664)	0.0023 (0.1757)	−0.1963 (0.1695)
Cons	14.6549*** (1.5093)	10.3817*** (0.1442)	12.7385*** (0.4843)	10.2500*** (0.1425)
<i>N</i>	26,135	26,135	26,135	26,135
<i>R</i> ²	0.1123	0.1123	0.1123	0.1123

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

coefficient of *Ginvest* is −0.0075 and is significant at the 1% level. Simultaneously, the inverted U-shaped relationship of *Nationalism* to *CI* is significant. It indicates that *Ginvest* has a partly mediating effect of *Nationalism* and *CI*. Hypothesis 6 has been confirmed. From a low-carbon legitimacy perspective, firms initially reduce green resource allocation to prioritize economic development, but ultimately increase investments in environmental initiatives to fulfill legitimacy requirements.

To test mediating effects, this paper first employs the Bootstrap confidence interval method; to further enhance the reliability of causal identification in the estimation results, we simultaneously conduct a test using one-period lagged mediating variables, with results reported in Table 12. Column (1) presents the Bootstrap mediation effect test results for corporate social responsibility, the coefficient of the mediating variable's *m_Csr*, is −1.3637, significantly negative at the 1% level, with a 95% confidence interval of [−2.2761, −0.4514] that does not include zero, indicating a statistically significant mediating effect of corporate social responsibility and suggesting that national sentiment

Table. 13 Heterogeneous regression results.

Items	(1) High-carbon emission enterprises	(2) Low-carbon emission enterprises	(3) High- subsidies firms	(4) Low-subsidies firms	(5) High R&D investment	(6) Low R&D investment
<i>Nationalism</i>	0.6511*** (0.1660)	1.2065** (0.5193)	1.1826** (0.5014)	0.5923*** (0.1371)	−0.4448 (0.7108)	0.9842*** (0.1767)
<i>Nationalism</i> ²	−26.0685*** (7.0519)	−74.3567 (49.9983)	−39.9890* (22.1820)	−27.3020*** (8.4612)	47.3284 (68.2285)	−38.5075*** (10.6247)
<i>Dual</i>	−0.0575** (0.0250)	−0.0163 (0.0253)	−0.0398 (0.0504)	−0.0217 (0.0160)	0.0512 (0.0409)	−0.0526** (0.0210)
<i>Director</i>	−0.0228*** (0.0065)	−0.0179** (0.0074)	−0.0482*** (0.0177)	−0.0134*** (0.0051)	−0.0085 (0.0157)	−0.0218*** (0.0058)
<i>Lev</i>	−0.1404** (0.0556)	−0.2252*** (0.0494)	−0.2972*** (0.0848)	−0.1781*** (0.0400)	0.0773 (0.1213)	−0.2319*** (0.0418)
<i>Cash</i>	−0.1792** (0.0746)	−0.4232*** (0.0695)	−0.0610 (0.2285)	−0.2668*** (0.0512)	−0.1518 (0.1207)	−0.3382*** (0.0593)
<i>First</i>	−0.0058*** (0.0021)	−0.0021 (0.0019)	0.0027 (0.0034)	−0.0043*** (0.0015)	−0.0012 (0.0035)	−0.0046*** (0.0015)
<i>Inde</i>	−0.0788*** (0.0232)	−0.0421 (0.0264)	−0.0128 (0.0295)	−0.0436** (0.0180)	−0.0158 (0.0392)	−0.0707*** (0.0202)
<i>Fag</i>	−0.0509*** (0.0036)	−0.0497*** (0.0048)	−0.0738*** (0.0130)	−0.0388*** (0.0028)	−0.0217** (0.0106)	−0.0533*** (0.0032)
<i>Roa</i>	−0.1457 (0.1693)	−0.3220*** (0.1062)	−0.6249* (0.3218)	−0.1267 (0.1155)	−0.1877 (0.1785)	−0.2091 (0.1513)
Cons	10.3968*** (0.1462)	10.0768*** (0.1903)	9.1391*** (0.3840)	10.3524*** (0.1130)	10.2131*** (0.2807)	10.2810*** (0.1262)
Firm fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
<i>N</i>	10,639	15,496	4297	21,838	2682	23,453
<i>R</i> ²	0.1182	0.0975	0.1604	0.0677	0.0385	0.1217
<i>F</i>	18.5844	18.8840	19.4178	20.4821	2.0570	35.1289

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

influences corporate carbon emission intensity through the corporate social responsibility channel. Column (2) shows the Bootstrap mediation effect test results for green investment, the coefficient of the mediating variable *m_Ginvest* is −0.3936, significantly negative at the 1% level, with a 95% confidence interval of [−1.1190, −0.5329] excluding zero, confirming a similarly significant mediating effect of green investment and that national sentiment also affects corporate carbon emission intensity via the green investment pathway. To mitigate potential endogeneity and reverse causality bias, we further verify the results using one-period lagged mediating variables, as shown in Columns (3) and (4). Column (3) reports the results for the one-period lagged corporate social responsibility (*L.m_Csr*), with a coefficient of −0.8259 (significantly negative at the 1% level) and a 95% confidence interval of [−0.5972, −0.1900] that excludes zero, indicating the mediating effect of corporate social responsibility remains significant after a one-period lag and thus confirming the robustness of the indirect impact of national sentiment on corporate carbon emission intensity through corporate social responsibility. Column (4) presents the results for the one-period lagged green investment variable (*L.m_Ginvest*), with a coefficient of −0.1723 (also significantly negative at the 1% level) and a 95% confidence interval of [−0.2903, −0.0541] that excludes zero, demonstrating the persistent significance of green investment's mediating effect after a one-period lag and affirming the reliability of the indirect impact of

Table. 14 Regression results about different carbon policy.

	(1) Carbon neutrality policy	(2) Post-2018 period	(3) Pre-2018 period	(4) Post-2013 period	(5) Pre-2013 period
<i>Nationalism</i>	0.7055*** (0.1478)	0.5077** (0.2071)	1.0345*** (0.3644)	0.6824*** (0.1645)	0.2721 (0.1751)
<i>Nationalism</i> ²	−27.3175*** (7.0968)	−14.7781** (6.4276)	−55.2417* (32.3287)	−26.1173*** (8.1296)	−13.5990 (8.7629)
<i>Nationalism</i> × <i>Caryear</i>	1.6666*** (0.2444)				
<i>Nationalism</i> ² × <i>Caryear</i>	−64.0872*** (12.3070)				
<i>Caryear</i>	−0.1618 (0.1466)				
<i>Dual</i>	−0.0428** (0.0190)	0.0150 (0.0223)	−0.0604*** (0.0218)	−0.0205 (0.0187)	−0.0117 (0.0293)
<i>Director</i>	−0.0205*** (0.0054)	−0.0021 (0.0067)	−0.0093 (0.0067)	−0.0167*** (0.0050)	−0.0021 (0.0118)
<i>Lev</i>	−0.2225*** (0.0381)	−0.1654* (0.0923)	−0.1758*** (0.0387)	−0.1496*** (0.0431)	−0.0799 (0.0596)
<i>Cash</i>	−0.3524*** (0.0530)	−0.0124 (0.1004)	−0.2829*** (0.0592)	−0.2496*** (0.0629)	−0.1372 (0.0920)
<i>First</i>	−0.0048*** (0.0015)	−0.0033 (0.0026)	−0.0034** (0.0017)	−0.0061*** (0.0017)	0.0018 (0.0053)
<i>Inde</i>	−0.0584*** (0.0187)	−0.0335 (0.0234)	−0.0510** (0.0199)	−0.0333 (0.0218)	−0.0299 (0.0235)
<i>Fag</i>	−0.0847*** (0.0108)	−0.0537*** (0.0056)	−0.0478*** (0.0043)	−0.0565*** (0.0034)	−0.0437*** (0.0083)
<i>Roa</i>	−0.2287 (0.1465)	−0.2399** (0.1081)	0.0155 (0.0920)	−0.2252* (0.1358)	0.1600 (0.1720)
<i>Cons</i>	10.5009*** (0.1202)	10.1445*** (0.1777)	10.0984*** (0.1580)	10.3179*** (0.1294)	9.9721*** (0.2670)
<i>N</i>	26,135	11,604	14,531	19,809	6326
<i>R</i> ²	0.1185	0.0351	0.0576	0.0832	0.0190
<i>F</i>	32.9953	16.1223	19.6751	34.1026	7.0722

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

national sentiment on corporate carbon emission intensity through green investment. Collectively, these results consistently support the institutional theoretical mechanism proposed in this study.

Further research

Considering firm with high-carbon emission industries are more sensitive to legality constraints, we classify companies in industries such as metal smelting, mining, petroleum processing, electricity and heat production and supply, textiles, papermaking, chemical manufacturing, rubber manufacturing and leather as high carbon emitters, and examine the impact of *Nationalism* on *CI* under the enterprises with different degrees of carbon dependence. The regression results are reported in in Table 13. In Column (1), the coefficients of *Nationalism* are 0.6511 and

−26.0685, and are significant at the 1% level. It shows that in high-carbon emissions firms there is a statistically significant inverted U-shaped relationship between national sentiment and carbon emission intensity, whereas this relationship is insignificant in low-carbon emissions firms in column (2). This divergence may arise from high-carbon emissions firms facing stringent regulatory constraints where emission levels directly determine organizational survival legitimacy, so enabling national sentiment to drive mitigation behaviors.

Secondly, government subsidy intensity manifests the institutional conversion efficacy whereby public resources transform into corporate endowments, we categorize sample firms into high- and low-subsidy groups based on the government subsidy mean. The regression outcomes for high-subsidy firms are reported in Column (3), while those for low-subsidy firms appear in Column (4). The coefficient of *Nationalism* for high-subsidy enterprises is 1.1826 (significantly positive at the 5% level), and the coefficient of *Nationalism*² is −39.9890 (significantly negative at the 10% level). Whereas, the coefficient of *Nationalism* for low-subsidy firms is 0.5923 (significantly positive at the 1% level), and the coefficient of *Nationalism*² is −27.3020 (significantly negative at the 1% level). Although both low- and high-subsidy firms exhibit an inverted-U relationship between national sentiment and carbon emission intensity, the inverted-U pattern demonstrates stronger statistical significance among low-subsidy firms. This difference likely originates from that resource-constrained low-subsidy enterprises institutionalize patriotism as a legitimacy tool for rigid regulatory compliance, thereby amplifying policy-response significance through passive conformity.

Thirdly, R&D investment level signifies the institutional pathway toward sustainable development through innovation, enterprises are stratified into high-R&D investment and low-R&D investment groups based on whether their R&D intensity exceeds the sample mean. For low-R&D investment firms (Column (6)), the linear *Nationalism* coefficient (0.9842) is positive and significant at the 1% level, while the quadratic term (−38.5057) shows negative significance at 1%. While low-R&D investment firms exhibit a significant inverted U-shaped relationship between national sentiment and carbon emission intensity, this pattern is absent among high-R&D counterparts. This difference might spring from innovation-constrained low-R&D firms initially increasing emissions due to resource limitations (Luo et al., 2026), then internalizing national sentiment through environmental governance to pursue institutional legitimacy, which cumulatively drives emission reductions. In contrast, high-R&D firms' abundant innovation resources make this relationship disappear.

Given this result, we consider that high R&D investment may flow into non-green areas, while low R&D investment may also focus on green technologies. Therefore, we further analyzed companies' capabilities in green technology reserves and transformation. The results are reported in the Appendix. We find that nationalism has an inverted U-shaped impact on carbon emissions only in enterprises with low-application in green patents, low-application in green invention patents, and low-application in green utility model patents. This result allows us to exclude the special case of low R&D but high proportion of green R&D.

To verify the impact of different macro-carbon policies on the relationship between patriotism and corporate carbon emissions, we further examine the effects of such macro-policies as the 2020 carbon neutrality policy, the 2018 environmental protection tax, and the 2013 air pollution control policy, with the results presented in Table 14.

Firstly, to examine the impact of policy occurrence on national sentiment and carbon emission intensity, we construct a policy dummy variable (*Caryear*), which takes a value of 1 for 2020 and subsequent years and 0 for years prior to 2020. As reported in Column (1) of the table, the coefficient of the interaction term *Nationalism* × *Caryear* is 1.6666, which is statistically significant at the 1% level, while the coefficient of the interaction term *Nationalism*² × *Caryear* is −64.0872, significant negatively at the 1% level. These results clearly indicate that the carbon neutrality policy significantly reinforces the inverted U-shaped relationship between national sentiment and carbon emission intensity. Specifically, after the policy implementation, the inverted U-shaped curve becomes steeper, with both the emission-promoting effect of low-level national sentiment, and the emission-inhibiting effect of high-level national sentiment significantly amplified. Meanwhile, the inflection point only exhibits a minor change, suggesting that the critical threshold at which national sentiment shifts from an “emission-promoting” to an “emission-inhibiting” role has not deviated due to the carbon neutrality policy. Instead, the policy primarily regulates this nonlinear relationship by enhancing marginal effects. Collectively, the advancement of the carbon neutrality policy strengthens the synergy between national sentiment and carbon emission intensity, effectively improving the binding and guiding role of informal institutions in corporate environmental behavior.

Secondly, to further verify the impact of different policies on the relationship between national sentiment and carbon emission intensity, this study divides the sample into two groups based on the implementation of the environmental protection tax in 2018: the pre-2018 period and the post-2018 period. For the pre-2018 period, as reported in Column (3), the coefficient of *Nationalism* is significantly positive ($\beta = 1.0345$, $p < 0.01$) and that of *Nationalism*² is significantly negative ($\beta = -55.2417$, $p < 0.1$). For the post-2018 period, Column (2) shows that the coefficient of *Nationalism* is significantly positive ($\beta = 0.5077$, $p < 0.05$) and that of *Nationalism*² is significantly negative ($\beta = -14.7781$, $p < 0.05$). Post-2018, this nonlinear relationship becomes more statistically significant than pre-2018. Prior to 2018, China primarily operated a pollution discharge fee system characterized by relatively weak environmental regulation and discretionary enforcement. Under limited environmental pressure, informal institutional factors such as patriotism exerted no meaningful constraints on corporate carbon emission behavior. Following the formal introduction of the environmental protection tax in 2018, environmental governance hardened into legally binding constraints, environmental inspections became institutionalized, and regulatory stringency increased substantially. Faced with stronger legal pressure and compliance risks, enterprises began to adjust their environmental practices in response to moral sentiments and institutional identification embodied by national sentiment, thereby giving rise to a more pronounced inverted U-shaped relationship.

Finally, in 2013, China issued the *Action Plan for Air Pollution Prevention and Control*. Treating this 2013 Action Plan as an exogenous shock, this study divides the sample into two groups: the pre-2013 and post-2013 periods. As reported in Column (4), the post-2013 regression results show that the coefficient of *Nationalism* is significantly positive ($\beta = 0.6824$, $p < 0.01$) and that of *Nationalism*² is significantly negative ($\beta = -26.1173$, $p < 0.01$), indicating a significant inverted U-shaped relationship between national sentiment and carbon emission intensity. In contrast, the pre-2013 regression results (Column 5) show that the inverted U-shaped relationship between national sentiment and corporate carbon emissions is not significant, suggesting that this relationship is significant post-2013 but insignificant pre-2013. This finding can be attributed to the fact that prior to 2013, China had not yet established a nationwide, systematic policy framework for air pollution control, environmental supervision was relatively decentralized, and corporate emission behaviors were weakly influenced by informal institutions. Stronger policy constraints and public opinion supervision on enterprises will enable the nonlinear impact of national sentiment on corporate carbon emission behaviors to emerge.

Conclusions and discussion

This study investigates the relationship between national sentiment and carbon emission intensity using a panel dataset comprising 26,135 observations spanning the period from 2010 to 2023 through institutional lens.

Our findings reveal an inverted U-shaped relationship between national sentiment and carbon emission intensity. During national sentiment below optimal levels, firms under pressure to secure economic legitimacy become more inclined to prioritize economic interests and development. This is consistent with the existing literature, which suggests that strong national sentiment can promote green innovation (Wang et al., 2025b) and ESG performance (Ari and Sarıoğlu, 2025), which aligns with firms' strategic economic interests and support long-term sustainable development. However, when national sentiment exceeds optimal levels, it evolves into a long-term sense of social responsibility; during the restructuring of social consensus, businesses shift their pressure from economic legitimacy to low-carbon legitimacy, thereby driving proactive emission reduction efforts. This finding not only broadens the theoretical foundation of national sentiment in corporate environmental behavior but also provides new insights into the design and implementation of carbon reduction strategies. However, when national sentiment exceeds optimal levels, it evolves into a long-term sense of social responsibility; during the restructuring of social consensus, businesses shift their pressure from economic legitimacy to low-carbon legitimacy, thereby driving proactive emission reduction efforts. This finding not only broadens the theoretical foundation of national sentiment in corporate environmental behavior but also provides new insights into the design and implementation of carbon reduction strategies. For business managers, quantifying their national sentiment level can help determine whether they are within the optimal range. Companies with national sentiment below the optimal range can correct their short-term

operational logic and avoid blindly expanding production capacity due to superficial national sentiment; companies in the transitional range can accelerate resource reallocation and increase investment in green projects and social responsibility; companies with national sentiment above the optimal range, should proactively integrate their national mission with long-term low-carbon development, transforming national sentiment into a driving force for sustainable development. For policymakers, an ideal range of national sentiment offers a new perspective for differentiated environmental governance. Targeted guidance can be provided to companies with insufficient national sentiment to correct their biased perceptions of patriotism; for mainstream companies, a positive institutional environment should be created to maintain healthy public sentiment. By combining emission reduction targets with environmental penalties, policymakers can guide public sentiment across industries to remain within an effective and optimal range, thereby fully leveraging the governance role of informal institutions in carbon emission reduction.

Secondly, employing a dual analytical lens encompassing both market mechanisms and policy institutions, this study examines the impact of national sentiment on carbon emissions intensity. When market competition is relatively intense, its function as an institutional buffer tends to intensify the inverted U-shaped relationship between national sentiment and carbon emission intensity (H2). In such cases, when national sentiment is more than infection point, priority should be given to policy instruments aimed at intensifying market competition, including relaxing market entry barriers, regulating market competition order, and dismantling industrial monopolies. These measures strengthen the emission-reduction effect of national sentiment by increasing competitive pressures, thereby preventing its impact from being eroded by insufficient market competition. Meanwhile, we also find that emission reduction target constraints have a positive impact on the inverted U-shaped relationship between national sentiment and carbon emissions (H3). Emission reduction target constraints, as an institutional policy objective, intensify the linkage between national sentiment and carbon emissions. When emission reduction targets are strongly binding, it is crucial to further refine the decomposition of emission reduction targets, by precisely allocating reduction tasks to the enterprise level, while implementing complementary positive incentive policies to guide enterprises in leveraging the motivational role of national sentiment to meet their emission reduction goals. This mechanism provides a theoretical foundation for policymakers to formulate and adjust emission reduction targets in order to achieve desired climate outcomes. Moreover, our findings further indicate that environmental penalties significantly strengthen the inverted U-shaped relationship between national sentiment and carbon emissions intensity (H4). When environmental penalties are sufficiently stringent, they significantly amplify the emission-reduction effect of national sentiment. In such circumstances, it is necessary to further refine the environmental penalty system to raise the costs of illegal emissions, clarify penalty standards and enforcement procedures, and incentivize enterprises to voluntarily reduce emissions through a dual mechanism of “punitive deterrence and emotional guidance”. We extend the institutional perspective on how national sentiment influences carbon emissions and offer a theoretical foundation for designing effective environmental penalty systems.

Thirdly, from the dual perspectives of social-norm pressure and low-carbon moral pressure, this article examines the mediating roles of corporate social responsibility and green investment. Our findings demonstrate that firms indeed can shape carbon emissions by addressing both social and low-carbon legitimacy demands. This study examines the potential of social normative pressure to promote emissions reduction, mediated through CSR. National sentiment is found to exert a complex, U-shaped influence on CSR, ultimately encouraging firms to fulfill their social responsibilities, and CSR serves as a critical mechanism that opens new pathways for emission reductions. Both corporations and governments can achieve emission reduction objectives by strategically enhancing CSR engagement. Moreover, this paper also examines low-carbon normative pressure, which is operationalized through green investment. The relationship between national sentiment and green investment is found to be non-linear, following a U-shaped pattern. In turn, increased green investment facilitates progress toward carbon reduction goals. This offers a novel perspective for corporations seeking to enhance green investment by fostering national sentiment. Green investment serves as a pivotal mechanism for achieving emission reduction and holds strategic importance in advancing the sustainable development of the broader economy.

Fourthly, building upon our initial findings, we further investigated the differential effects of national sentiment on carbon emissions across three distinct types of firms: those characterized by high pollutions, those receiving small government subsidies, and those with low research and development activities. ① In high-carbon emission

enterprises, national sentiment exerts a significant influence on carbon emissions. High-carbon emission firms constitute central regulatory targets for carbon abatement and draw intense scrutiny from the public, mainstream media, and prevailing social values. This context greatly magnifies the sway of informal forces including national sentiment, which exert far stronger influence over operational planning and manufacturing routines within heavy polluters relative to their lightly polluted counterparts. Low-carbon emission enterprises, by comparison, carry inherently lower carbon footprints and face slacker regulatory compliance burdens, such that national sentiment generates only modest marginal shifts in their operational judgments and emission patterns. And it implies that the degree of pollution intensity heightens the importance of informal institutions (such as national sentiment), which can easier to subtly influence business choices and sharp corporate behavior. Then, national identity may inadvertently reinforce carbon-intensive practices. ② Meanwhile, we also find, an inverted U-shaped relationship between national sentiment and corporate carbon emission intensity holds significantly for both high- and low-subsidies firms, yet this curvilinear effect is statistically stronger in low-subsidy enterprises, which are also more susceptible to the influence of national sentiment. Without stable and sustained government financial subsidies backing, such firms face tighter external resource constraints and fiercer market competition (Lei et al., 2023). Under stringent environmental regulatory regimes, they tend to strategically institutionalize national sentiment to secure institutional legitimacy and achieve full compliance with rigorous environmental rules. Unlike resource-abundant high-subsidy firms whose operations and survival rely heavily on governmental policy support and thus enjoy greater institutional protection and resource buffering (Tang et al., 2024), low-subsidy firms' operational decisions and policy responses are more vulnerable to external social sentiment and institutional conditions. They adjust their production and pollution emission behaviors through passive compliance and active policy adaptation, which substantially strengthens the inverted U-shaped governance effect of national sentiment on carbon emission intensity. By contrast, high-subsidies firms are largely insulated from such external pressures, as environmental regulation and public sentiment exert only diluted influences on their carbon strategies, thereby weakening the statistical magnitude and significance of the corresponding inverted U-shaped relationship. These findings indicate that low-subsidy enterprises are more inclined to leverage national sentiment as a strategy for market competition. Hence, at the policy level, regulatory authorities should base themselves on the heterogeneous characteristics of enterprise subsidies, implement differentiated regulatory policies, guide the positive governance value of national sentiment, and guide enterprises with different subsidies to transform sentiment-driven market competition behavior into internal motivation for proactive emission reduction and green transformation. At the corporate level, management should strengthen strategic integration by incorporating national sentiment into their core strategic planning, fostering constructive workplace initiatives that align national sentiment values with long-term corporate development and environmental sustainability. ③ Furthermore, this study also reveals a more pronounced association between national sentiment and carbon emissions in low-R&D enterprises, but high-R&D investment enterprises are not significant. Enterprises with high R&D investment possess well-developed technological innovation systems and ample innovation resources. Their green emission reduction behavior and low-carbon transformation process are primarily driven by core innovation elements such as technological innovation and the accumulation of green patents. Their carbon emission decisions depend more on their own R&D capabilities and technological level, and the impact of national sentiment on their emission reduction behavior is relatively limited. In contrast, enterprises with low R&D investment generally face the realities of scarce innovation resources, weak technological upgrading capabilities, and insufficient motivation for green transformation (Li and Ma, 2026), making it difficult for them to effectively promote green production and energy conservation and emission reduction through independent technological innovation. Against this backdrop, these enterprises will turn to the informal institutional factor of national sentiment to construct a green business logic, compensating for their shortcomings in innovation capabilities through green production behaviors that align with social and national values, thereby significantly changing their carbon emission levels. Hence, it implies that low R&D investment firms may leverage national sentiment to compensate for weaker innovation capacity in shaping green practices. This suggests that, within less innovation-driven contexts, national identity can become intrinsically entangled with emission outcomes. Therefore, emission reduction policies should target low-R&D firms through tailored guidance frameworks that translate national sentiment into tangible drivers of low-carbon innovation. Concurrently, corporate management should strategically align national sentiment with broader national strategies and long-term governance, ensuring it reinforces

—rather than undermines—sustainable development objectives. ④ What's more, this paper further examine R&D output, national sentiment is significantly influence carbon emission in those with low levels of green patent applications, including both green invention patents and green utility model patents, This finding indicates that firms with low green patent applications may leverage more national sentiment in addressing environmental challenges. Policy interventions should target such firms by strategically channeling national sentiment toward the development of green patents through tailored incentives and institutional guidance. Meanwhile, corporate management ought to avoid superficial symbolic integration of national sentiment and instead focus on its substantive alignment with the development of green technology systems and R&D investments, thereby achieving synergy among national sentiment, substantial green innovation (Sheng et al., 2026), and emission reduction outcomes. ⑤ The advancement of carbon neutrality policies strengthens the relationship between national sentiment and carbon emission intensity, effectively enhancing the binding and guiding role of informal institutions in corporate environmental behavior; following the release of the *2013 Action Plan for Air Pollution Prevention and Control*, and 2018 environmental protection tax, this relationship becomes more pronounced. Therefore, when national sentiment reaches its inflection point, policymakers should introduce more macro-environmental policies, which will be more conducive to leveraging national sentiment—as an informal institution—to promote carbon emission reduction.

Finally, among firms with low R&D expenditure and few green patent applications, the association between national sentiment and carbon emission intensity is particularly pronounced. Such firms may leverage national sentiment for merely symbolic environmental publicity without undertaking substantive emission reduction measures, such as increasing green investments or enhancing the environmental dimension of their CSR performance, and may even exploit national sentiment to mask high-emission behaviors, thereby exacerbating carbon emission pressures. In response, at the policy level, a differentiated regulatory mechanism should be established to prioritize oversight of the environmental conduct of these firms, requiring them to publicly disclose substantive emission reduction data (e.g., green investments and environmental expenditures) to preclude symbolic emission reductions. At the corporate level, firms should be guided to deeply integrate national sentiment with green innovation and substantive emission reduction actions rather than relying on superficial publicity, thereby channeling national sentiment into concrete measures such as green R&D, technological upgrades, and environmental investments, and ensuring that national sentiment effectively contributes to emission reduction goals.

Limitation and future research

This study is characterized by several limitations that point toward meaningful directions for future research. First, this study focuses exclusively on Chinese listed companies; therefore, generalizing the findings to unlisted firms and non-Chinese contexts would require further demonstration. These entities are often subject to different institutional pressures and governance structures, and may provide particularly relevant settings for examining the relationship between national sentiment and carbon emissions. Our findings in this paper regarding regulatory factors such as market competition, emission reduction targets, and environmental penalties have certain reference value for other countries and regions in transition and facing similar environmental governance pressures. Further research is warranted to explore this dynamic within cross-country comparative frameworks. Second, although this study investigates the influence of national sentiment from an institutional theory perspective, carbon emission intensity is likely shaped by the synergistic effects of multiple internal and external factors. Future research could thus examine how other determinants interact with national sentiment to jointly affect emission levels. Third, our findings identify CSR and green investment as mediating mechanisms between national sentiment and carbon emission intensity; however, other potential channels remain unexplored and warrant further investigation in future studies. Fourth, concerning causal identification, although we employed various robustness tests, including alternative standard error estimation methods, piecewise linear models, and placebo tests, to mitigate potential endogeneity concerns, we cannot entirely rule out the influence of unobserved confounding factors, such as unmeasured corporate cultural characteristics, which may affect the accuracy of the estimated causal relationship between national sentiment and carbon emission intensity. Future research can apply more rigorous causal identification strategies to explore

unobserved confounding. Finally, limitations exist regarding the research context. This study is primarily conducted within the current context of China's advancing carbon neutrality policy and the continuous intensification of environmental governance; however, the relationship between national sentiment and corporate carbon emission intensity may vary across different economic cycles and policy environments. For instance, during economic recessions, firms face greater pressure to secure economic legitimacy, which may weaken the emission-reduction orientation driven by public sentiment—a relationship that warrants further exploration in future research.

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Declarations

Competing Interests The authors declare no competing interests.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors

Informed consent This article does not contain any studies with human participants performed by any of the authors.

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Appendix

Building on the R&D-based heterogeneity analysis, this article examines innovation output's role in the nationalism–carbon emission intensity relationship through green patent grouping. Samples are partitioned into low- and high-application groups relative to the green patent application mean. Specifically, appendix columns (1)–(2) indicate that the inverted U-shaped relationship between nationalism and carbon emissions exhibits greater statistical significance in low-green-patent groups than in high-application counterparts, which may result from their technology-follower position, low-green-patent firms prioritize economic profits in business strategy, inducing early-stage emission increases during expansion. However, their intrinsic policy sensitivity—amplified by nationalism—enhances enforcement responsiveness and drives later carbon performance improvements. Whereas high-green-patent counterparts lack such regulatory reactivity. To further examine green patent heterogeneity, we separate samples into low- and high-application groups based on green invention and utility model patent volumes relative to their sample means. Appendix Columns (3)–(4) reveal a statistically significant inverted U-shaped relationship between nationalism and carbon emission intensity in low-green-invention groups, while this relationship remains insignificant in high-application counterparts. Similarly, Columns (5)–(6) demonstrate a significant inverted U-shaped effect of nationalism on carbon emissions in low-utility-model groups, whereas this nonlinear pattern shows no statistical significance in corresponding high-application groups. Collectively, these results demonstrate greater statistical significance in the inverted U-shaped relationship between nationalism and carbon emissions for low-green-patent-application groups relative to high-application counterparts. Furthermore, appendix results reveal statistically stronger inverted U-shaped relationships between nationalism and carbon emission intensity in low-innovation-output groups. This finding robustly echoes stratified analyses based on innovation input, where low-R&D-investment groups

Table. 15 Regression results.

	(1) High- application in green patent	(2) Low- application in green patent	(3) High- application in green invention patent	(4) Low- application in green invention patent	(5) High- application in green utility model patent	(6) Low- application in green utility model patent
<i>Nationalism</i>	1.1484*** (0.4270)	0.9153*** (0.1779)	0.8247* (0.4362)	0.9404*** (0.1792)	0.9821*** (0.3244)	0.8940*** (0.1804)
<i>Nationalism</i> ²	−37.0805* (22.1772)	−37.7994*** (11.1963)	−25.5946 (20.8622)	−38.6985*** (11.5403)	−32.3877 (19.9629)	−36.1752*** (10.8295)
<i>Dual</i>	0.0518 (0.0452)	−0.0604*** (0.0207)	0.0624 (0.0441)	−0.0600*** (0.0206)	−0.0268 (0.0403)	−0.0544*** (0.0206)
<i>Director</i>	−0.0209 (0.0182)	−0.0196*** (0.0056)	−0.0316 (0.0198)	−0.0194*** (0.0056)	−0.0212 (0.0132)	−0.0214*** (0.0058)
<i>Lev</i>	−0.2313*** (0.0823)	−0.2112*** (0.0425)	−0.3153*** (0.0914)	−0.2075*** (0.0416)	−0.2637*** (0.0639)	−0.2038*** (0.0439)
<i>Cash</i>	−0.4971*** (0.1568)	−0.3141*** (0.0560)	−0.4231** (0.1706)	−0.3205*** (0.0559)	−0.5335*** (0.1192)	−0.3065*** (0.0579)
<i>First</i>	−0.0043 (0.0032)	−0.0046*** (0.0016)	−0.0035 (0.0033)	−0.0048*** (0.0016)	−0.0080*** (0.0028)	−0.0048*** (0.0016)
<i>Inde</i>	−0.0510 (0.0389)	−0.0570*** (0.0218)	−0.0460 (0.0390)	−0.0592*** (0.0214)	−0.0465 (0.0299)	−0.0699*** (0.0227)
<i>Fag</i>	−0.0659*** (0.0112)	−0.0460*** (0.0030)	−0.0614*** (0.0120)	−0.0479*** (0.0030)	−0.0703*** (0.0078)	−0.0466*** (0.0032)
<i>Roa</i>	−0.3254 (0.2529)	−0.2057 (0.1532)	−0.3240 (0.2822)	−0.1973 (0.1473)	−0.4200* (0.2412)	−0.1886 (0.1494)
Cons	9.7423*** (0.3312)	10.2986*** (0.1256)	9.7597*** (0.3395)	10.3135*** (0.1247)	10.2005*** (0.2253)	10.3536*** (0.1300)
Firm fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
<i>N</i>	3822	22,313	3309	22,826	5424	20,711
<i>R</i> ²	0.1410	0.1021	0.1586	0.1039	0.1511	0.1013
<i>F</i>	11.4251	26.4663	10.0291	27.7004	16.4298	25.2057

The robust standard errors are reported in the parentheses. ***, **, * are significant at 1%, 5% and 10% levels, respectively.

similarly exhibit more pronounced nationalism-emission curvilinearity. Hence, these patterns demonstrate consistently heightened significance of the inverted U-shaped relationship in low-innovation cohorts across both input and output dimensions (Tables 15 and 16).

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Table. 16 The key words of national sentiment.

National sentiment	Keywords
National pride	Chinese nation, time-honored brands, pioneer, Chinese culture, revival; tribute, Chinese Dream, commemoration, praise, folk customs, treasure, millennium plan, soul, great rejuvenation of the Chinese nation, inheritance, spirit of the times, stories, narration, sing praises, confidence, treasure, thousands of years, great rejuvenation, over four hundred years, classics
National revival	12th Five-Year Plan, outline, expanding domestic demand, strategic emerging industries, 11th Five-Year Plan; joining WTO, joining the World Trade Organization, deepening reforms, 40th anniversary, healthcare reform, long history, treasure, Chinese Dream, inheritor, Chinese culture, great rejuvenation of the Chinese nation, greatness, dream, life value, motherland, moderately prosperous society, Belt and Road, One Belt One Road, great rejuvenation of the Chinese nation, strong military
Corporate role	Dedication, undertake, benefit humanity, benefit, bravely undertake, world-class, top-tier, leading, pioneer, industrial patriotism, patriotism, stay true to the original aspiration, hard work, Independent, core technology, technological innovation, technology, originality, domestic production, industrialization, self-production, upgrading
Anti-foreign	Oligopoly, monopolize the market, break, control, oligopoly, anti-dumping and countervailing, trade war, election, anti-dumping, dispute, friction, rising protectionism, trade war, conflict, Anti-globalization, international trade protectionism, protectionism, rising protectionism, Sovereign debt crisis, economic and trade friction, friction, European debt crisis, dispute
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