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Assessing the Impact of Board Sustainability Committees on Greenhouse Gas Performance: Evidence From Industrialised European Countries

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ABSTRACT

This study examines the impact of executive compensation (EC) and board sustainability integration index (BSII) on both greenhouse gas emissions (GHGE) and greenhouse gas management processes (GGMP). Additionally, it investigates the relationship between GGMP and GHGE to assess the effectiveness of process-oriented measures in reducing actual emissions. Through the lens of legitimacy theory and incentive alignment theory, we harness an extensive dataset encompassing 15,876 firm-year observations across 22 industrialised European countries from 2002 to 2022. First, the findings show that although EC positively correlates with enhanced GGMP, it has an insignificant effect on GHGE reduction. Second, the results suggest that although BSII independently bolster sustainability initiatives, the moderating effect of BSII on EC (EC*BSII) may lead to a legitimacy gap. This gap emerges when the relationship of EC and BSII falls short of societal expectations regarding environmental performance, potentially eroding organisational legitimacy. Third, the findings indicate that firms that engage in GGMP also tend to have higher levels of GHGE, pointing to the use of GGMP by firms as a means of symbolic legitimation.

1 | Introduction

Global climate change remains a key source of alarm for firms, governments and other stakeholders as a result of increasing greenhouse gas (GHG) emissions (Albitar, Al-Shaer, and Liu 2023; Kolk 2016). This phenomenon has resulted in increased pressure by governments and shareholders that firms should demonstrate accountability and responsibility to stakeholders by engaging in, as well as reporting on corporate practices concerning climate change mitigation and minimising GHG emissions (GHGE) (Backman, Verbeke and Schulz 2017; Pisani et al. 2017). In this regard, firms can play a more active role in the transition towards a low-carbon economy. As a result, global efforts have been made by firms and governments to combat climate change and global warming by implementing a variety of guidelines, initiatives and practices (Gaganis et al. 2021; Haque and Ntim 2018). For instance, the Net-Zero Coalition involves over 70 countries and over 3000 firms dedicated to attaining net-zero emissions by 2050 in several ways, including renewable energy innovation, and mobilising finance for climate change (UN 2023). In addition, at the recent COP28 held in Dubai, global leaders pledged to accelerate efforts towards net zero emissions and transition away from fossil fuels in energy systems through utilisation of zero and low-carbon fuels.

We focus our research on the role of firms in reducing GHGE and the transition to a low-carbon economy because these large firms make substantial contribution to the global GHGE (Haque and Ntim 2020). The privileged position held by the large firms means that they have the capacity to reduce not only their own GHGE but could potentially influence the operation of their suppliers, partners and distributors (Adu, Flynn, and Grey 2022a). This makes GHGE reduction initiatives of firms of paramount interest when exploring how to transition to low-carbon economy. Firms have a symbiotic association with their suppliers, distributors, partners and subsidiaries. In particular, firms depend on their suppliers for raw materials and other resources and distributors to get their products to the consumers, and similarly, suppliers and distributors' subsidiaries rely on the firms for financial support and direction to become long-term partners (Alexander, Pilonato, and Redigolo 2023). In this context, firms can potentially act as climate change initiatives champions or promotors in the corporate environment. Yet, for firms to achieve this goal, they need to have a paradigm shift from the traditional business model to a low GHGE setting.

We examine the impact of executive compensation (EC) on both symbolic greenhouse gas management processes (GGMP) and substantive GHGE. Moreover, we investigate whether corporate governance (CG) mechanisms such as board sustainability integration index (BSII) moderate these relationships, as consequence, improve the link between EC and GHGE reduction. Our dataset consists of firms in 23 industrialised European countries, covering the period 2002 to 2022, and is notable for its comprehensive coverage and detailed firm-level information. Industrialised European countries were selected due to their leading roles in global climate governance and advanced regulatory environments, which provide a unique context for understanding corporate responses to sustainability pressures. These countries have stringent environmental regulations and advanced CG practices, making them ideal for studying the effects of governance mechanisms like BSII and EC on GHGE. This context allows for a thorough examination of how EC and BSII interact in regions with high stakeholder expectations for sustainability, offering insights that can inform global standards and practices (Kolk 2016; Haque and Ntim 2020). Previous studies have emphasised the significance of CG in developing climate change initiatives that add value to shareholders (Aguilera et al. 2021; Hussain, Rigoni and Orij 2018). Previous studies have also emphasised the significance of CG in developing climate change initiatives that add value to shareholders (Aguilera et al. 2021; Hussain, Rigoni and Orij 2018). Effective CG measures, for example, can promote accountability for sustainable business practices (SBPs) through fostering involvement with corporate social responsibility (CSR) practices, thereby providing a robust diligent response to the potential negative social and environmental impact of firms (Orazalin and Baydauletov 2020). In this instance, board sustainability committee is critical in planning environmental initiatives and implementing SBPs to encourage accountability, stakeholder participation, address concerns of sustainability and improve firm performance (Orazalin, Ntim and Malagila 2024).

Board sustainability committees have therefore evolved into a more prominent CG tool for tackling climate change and promoting sustainability (Burke, Hoitash, and Hoitash 2019). Nonetheless, research exploring the influence of the board sustainability committee on GHG performance (GHGP)[1] has been comparatively scarce (Orazalin 2020; Orazalin, Ntim, and Malagila 2024). Therefore, this research contributes to the emergent strand of research by presenting novel evidence on the moderating role of a broad BSII in this context. In doing so, the study sheds new light on the possible pathways through which firms can support the transition towards a low-carbon economy. Leveraging economic and socio-based theories, notably legitimacy and incentive alignment theoretical views, this study employs a multi-theoretical framework to examine the relationships between EC and GHGP while taking into account the moderating role of board sustainability committee and sustainability-based incentives.

Additionally, although climate change research has been expanding steadily, there is little focus on process-oriented GHG management processes (GGMP), which are designed to enhance minimising total GHGE (Orazalin, Ntim, and Malagila 2024). Prior studies have predominantly concentrated on evaluating the impact of GHG on financial performance (FP), yielding varying results (e.g., Adu, Flynn, and Grey 2022a; Delmas, Nairn-Birch, and Lim 2015; Homroy 2023; Lewandowski 2017). For instance, Lewandowski (2017) reports a curvilinear relationship between GHGP and FP, suggesting that firms with higher levels of emission reduction have a positive relationship between carbon performance and FP, and vice versa.

We contribute to the literature in several ways. First, we provide novel evidence on whether BSII has any value on firms, in the context of transitioning to a low GHGE. Although prior studies focused on the existence of sustainability committees (Adu, Flynn, and Grey 2022a; Orazalin, Ntim, and Malagila 2024) with the risks of failing to isolate potential impacts driven by board sustainability committee-specific characteristics, we focus on diverse attributes of the committee, namely, the existence and structure; reporting and transparency, reporting framework and linkage to EC. Therefore, we advance the board sustainability committee literature by proposing and testing an alternative proxy for capturing board sustainability committees. Previous studies (eg., Adu, Flynn, and Grey 2022a) argue that these attributes of the board sustainability committee help in assessing the effectiveness of the oversight role of the committee. Yet, no prior research has explored the impact of these unique attributes on GHGE reduction of firms. Our result offers the first empirical evidence on the effect of the broad sustainability committee index (BSII) on both GGMP and GHGE for firms in the context of transition to a low-carbon economy. More specifically, our findings demonstrate that BSII does not have a beneficial impact on both GGMP and GHGE. The findings indicate that although EC and BSII each independently support sustainability initiatives, their joint implementation could result in what can be termed as a 'legitimacy gap'. This gap arises when the combined influence of EC and BSII does not adequately meet societal standards for environmental performance, thereby posing a risk to the perceived legitimacy of the organisation.

By employing a multi-theoretical framework combining incentive alignment theory and legitimacy theory, this research provides novel insights into how executive incentives and governance structures influence environmental performance. First, the study extends the application of incentive alignment theory in the context of environmental sustainability by demonstrating that linking EC to sustainability outcomes drives substantive environmental actions. This contribution is particularly important given the global emphasis on aligning financial incentives with environmental goals to support the transition towards a low-carbon economy (Cohen et al. 2023).

Second, the integration of legitimacy theory allows us to explore how firms use symbolic environmental practices, such as GGMP, to maintain their social licence to operate without necessarily achieving meaningful emissions reductions. This dual focus helps explain why firms might engage in visible but ineffective environmental initiatives, aligning with findings from previous studies that highlight the prevalence of greenwashing (Berrone, Fosfuri, and Gelabert 2017; Haque and Ntim 2020). Third, by investigating the moderating role of BSII, the study reveals the complexities involved when governance mechanisms intended to enhance environmental performance instead create a 'legitimacy gap'. This gap occurs when the symbolic alignment of compensation and governance structures does not translate into substantive improvements in emissions reduction, contributing to the ongoing debate on the efficacy of corporate sustainability strategies.

Overall, the findings contribute to a deeper understanding of the intersection between CG, executive incentives, and environmental performance, offering practical implications for policymakers and firms aiming to design effective governance frameworks that truly drive sustainability outcomes.

Further, by examining the effects of EC and BSII on both GHG management processes and GHGE, we also contribute to the ongoing debate about whether corporate environmental initiatives lead to genuine improvements or merely symbolic actions (Berrone, Fosfuri, and Gelabert 2017). This dual focus allows us to extend the application of legitimacy theory in explaining corporate environmental behaviour.

Notwithstanding emerging interest in climate change studies (Abbass et al. 2022), relatively, a few studies have explored the link between GHGE and GGMP. As a result, this study is one of the first to investigate the impact of GGMP on GHGE while considering the moderating function of BSII in this relationship. The findings corroborate the symbolic legitimation theory, as firms that engage in more GGMP continue to produce significant amounts of pollution. Further, this study also engages in several in-sampling comparative analysis specifically examining the aforementioned relationships in countries located in predominantly coastal and inland regions. The results suggest that due to their proximity to water, firms in coastal areas continue to produce high GHGE. In this case, the engagement in BSII and GGMP can help curb this problem. The study also examines the relationships in firms located in countries that have a carbon tax policy and vice versa. The findings suggest that countries with carbon tax policies engage in corporate sustainability strategies such as EC and BSII.

The remaining sections of this paper are organised as follows: The second section presents the literature review, theoretical framework and hypothesis development. The third section outlines the methodology. The fourth section reviews prior studies and discusses the findings. Finally, the fifth section provides the conclusion.

2 | Literature Review

2.1 | Theoretical Framework

Several studies (e.g., Adu et al. 2024; Nigam, Benetti, and Mbarek 2018; Phung et al. 2022) have explored different aspects of the EC, BSII and GHGE performance utilising different economic-, regulatory- and socio-based theories. The present paper utilises a multi-theoretical framework to examine relationships among the study variables, employing the legitimacy theory and incentive alignment theoretical perspectives.

The legitimacy theory is a multifaceted theory that draws on explicit and/or implicit links to traditional economic (agency and resource dependence) and social (stakeholder and legitimacy) theories simultaneously (Adu et al. 2024; Haque and Ntim 2020; Suchman 1995). Also, the legitimacy theory can be viewed from two perspectives: economic efficiency and social legitimacy perspectives. The economic efficiency perspective comprises firms engaging in cost-effective SBPs that reduce GHGE, therefore actually benefiting the environment (Mazouz and Zhao 2019). In terms of social legitimacy, firms may figuratively strive to comply with institutional powers in order to earn and retain organisational legitimacy (Suchman 1995). In this case, firms with high levels of legitimacy can obtain better access to economic resources, attract and retain top talent, enhance relations with stakeholders and compete at a higher level in the market (Oliver 1991; Pfeffer and Salancik 1978). In order to garner acceptability from the society, firms seeking legitimacy tend to be motivated by symbolic legitimation strategies such as using an impression management approach by engaging in superficial impressions in order to manage stakeholders' concerns about sustainability-related problems rather than driving about significant advances in environmental/social outcomes (Ashforth and Gibbs 1990). Enhanced sustainability disclosures, for example, can help firms to improve their corporate legitimacy and reputation (Adu, Flynn, and Grey 2022b; Crossley, Elmarghi, and Ntim 2021; Haque and Ntim 2020). However, the firms' actual GHGP may be subpar.

Alternatively, firms strive to obtain or make well-informed decisions that improve their economic efficiency by engaging in substantive practices (Dahlmann, Branicki, and Brammer 2019; Haque and Ntim 2020). In the context of this study, firms can take cost-effective efforts to mitigate climate change by implementing GGMP, which may result in improved actual GHGE. Engaging in extensive GGMP could relatively take a large amount of time and resources to achieve, thus, firms are more likely to use symbolic GGMP and promote CG structures, such as BSII, to create a positive perception (greenwashing) among stakeholders (Berrone and Gomez-Mejia 2009). Nonetheless, such measures do not improve actual GHGE (Aguilera et al. 2007). This issue highlights the critical need for a more robust alignment between executive incentives and environmental performance, a gap that incentive alignment theory seeks to address.

The incentive alignment theory suggests that linking EC to environmental performance metrics can drive executives to adopt substantive environmental initiatives, such as GGMP (Morrison, Adu, and Guo 2024). This theory posits that aligning incentives with sustainability goals motivates executives to make decisions that not only meet financial objectives but also promote environmental responsibility (Cohen et al. 2023). Firms that implement incentive structures tied to sustainability outcomes are more likely to see a genuine commitment to environmental practices, as executives are financially motivated to achieve these targets. This approach encourages the development of CG mechanisms, such as BSII, that reinforce the firm's commitment to reducing GHGE and enhancing environmental performance (Maas 2018).

Research has shown that incentive-based compensation can lead to improved environmental performance, as executives work to meet specific environmental targets set within their compensation packages (Berrone and Gomez-Mejia 2009). By aligning managerial incentives with sustainability goals, firms can drive significant environmental benefits, such as reduced emissions and enhanced resource efficiency, which support the broader objective of transitioning to a low-carbon economy (Jensen and Murphy 2010). Thus, incentive alignment theory supports the adoption of GGMP and the integration of sustainability-related governance structures, ensuring that executive actions align with both financial and environmental objectives. Recent studies have highlighted that effective corporate governance mechanisms, such as BSII, further strengthen this alignment, enhancing the impact of executive incentives on environmental outcomes (Al-Shaer, Albitar, and Liu 2023).

2.2 | Executive Compensation and Greenhouse Gas Performance

EC plays a pivotal role in influencing corporate environmental strategies and performance. Executives are instrumental in guiding firms towards SBPs and GGMP, as they directly impact strategic decisions related to environmental performance (García-Sánchez, Hussain, and Martínez-Ferrero 2019; Shahab et al. 2020). The efficiency perspective of legitimacy theory suggests that firms should design EC structures that incentivise executives to engage in SBPs, particularly GGMP, which can enhance both environmental performance and economic efficiency (Campbell et al. 2007). Investments in GGMP, such as energy and water conservation, not only address environmental concerns but also offer economic benefits, positioning firms to achieve cost savings and improve operational efficiency (Mahoney and Thorn 2006).

Empirical evidence supports the notion that EC linked to environmental goals can drive substantive environmental actions. For instance, Tauringana and Chithambo (2015) argue that incentive-based corporate governance systems can significantly enhance corporate carbon performance. Empirical studies have frequently reported a positive association between EC and carbon performance, demonstrating that EC motivates executives to adopt environmental strategies that align with broader corporate goals (Haque 2017; Haque and Ntim 2020; Maas 2018). Haque and Ntim (2020), in their study of firms in 13 industrialised European countries, found that EC is positively associated with GHGP, highlighting the critical role EC plays in shaping a firm's carbon management strategies.

The integration of incentive alignment theory further highlights the importance of EC in driving environmental performance. According to this theory, aligning executive incentives with sustainability objectives motivates executives to pursue substantive environmental actions, which can lead to increased efficiency, reduced emissions and enhanced long-term firm performance (Cohen et al. 2023; Jensen and Murphy 2010). When EC is tied to environmental performance metrics, executives are more likely to prioritise GGMP, which are process-oriented initiatives designed to manage and reduce emissions. This alignment ensures that executive actions contribute to both financial and environmental outcomes, reinforcing the firm's commitment to sustainable practices. However, legitimacy theory suggests that although EC can drive environmental initiatives, these actions may be primarily symbolic, aimed at enhancing the firm's image and legitimacy rather than achieving meaningful reductions in GHGE (Burke, Hoitash, and Hoitash 2019; Haque and Ntim 2020). Firms may adopt visible GGMP to appear compliant with societal expectations and regulatory standards, without implementing deeper, costlier changes that would lead to actual emissions reductions. This duality is evident in firms that engage in GGMP to signal environmental responsibility but do not necessarily achieve substantive improvements in their GHGE (Berrone and Gomez-Mejia 2009).

The combination of these theoretical perspectives helps to hypothesise that EC positively influences GHGP, particularly through GGMP. The incentive alignment provided by EC drives executives to implement process-oriented initiatives like GGMP, which may be more visible and manageable compared to the direct reduction of GHGE. Consequently, it is hypothesised that:

H1a. *EC is positively associated with GHGP.*

This hypothesis reflects the expectation that EC will have a more substantial impact on GGMP, which are often easier to integrate into corporate governance structures and align with financial incentives, compared to the more complex task of achieving direct emissions reductions.

2.3 | The Moderating Effect of Board Sustainability Integration Index on Executive Compensation and Greenhouse Gas Performance

The relationship between EC and GHGP can be significantly influenced by the presence of strong sustainability governance structures, such as the BSII. The BSII represents the extent to which sustainability practices are embedded within a firm's governance framework, reflecting the commitment of the board to integrate environmental considerations into corporate decision-making processes. This section explores how the BSII moderates the relationship between EC and GHGP, drawing on both legitimacy theory and incentive alignment theory.

Legitimacy theory posits that firms engage in sustainable practices not only to achieve substantive environmental outcomes but also to enhance their legitimacy in the eyes of stakeholders, regulators and the broader society (Suchman 1995). Firms with a higher BSII are more likely to adopt transparent and visible sustainability measures, which serve to signal their commitment to environmental standards and societal expectations. By doing so, these firms seek to maintain their social licence to operate and bolster their corporate image as responsible entities. The alignment of EC with sustainability objectives, facilitated by a robust BSII, ensures that firms can effectively demonstrate their commitment to reducing GHGE through process-oriented initiatives such as GGMP.

From the perspective of incentive alignment theory, the integration of sustainability into corporate governance structures through BSII enhances the impact of EC by aligning executive incentives with environmental goals. Boards with a high BSII are more likely to design compensation packages that incentivise executives to prioritise environmental performance alongside financial objectives (Cohen et al. 2023; Jensen and Murphy 2010). This alignment encourages executives to engage in substantive environmental improvements, such as reducing GHGE, rather than merely adopting symbolic actions that enhance the firm's legitimacy without achieving real environmental benefits.

The moderating role of BSII is crucial because it strengthens the alignment between EC and GGMP, ensuring that executive actions are not solely focused on financial gains but are also directed towards achieving meaningful environmental outcomes. BSII helps to bridge the gap between symbolic and substantive sustainability practices by providing a governance framework that holds executives accountable for their environmental impact. This moderating effect is particularly important in contexts where firms face increasing pressure from stakeholders to demonstrate genuine commitment to sustainability rather than engaging in greenwashing or superficial compliance (Haque and Ntim 2020).

Empirical evidence suggests that boards with higher sustainability integration are more likely to support EC structures that effectively drive environmental performance. By aligning executive compensation with sustainability outcomes, BSII enhances the likelihood that executives will implement GGMP that lead to tangible reductions in GHGE, rather than actions that primarily serve to maintain corporate legitimacy. This alignment of incentives ensures that sustainability goals are not only symbolic but are translated into real environmental benefits, reflecting a deeper commitment to addressing climate change and enhancing the firm's overall environmental performance.

In this theoretical context, it is hypothesised that the presence of a strong BSII will enhance the positive effects of EC on GHGP, as it ensures that compensation incentives are closely aligned with broader environmental objectives. This moderating effect highlights the importance of integrating sustainability into governance structures to drive substantive environmental actions.

H1b. *BSII has a positive moderating effect on the relationship between EC and GHGP.*

This hypothesis is grounded in the idea that BSII strengthens the alignment between EC and environmental performance, ensuring that executive compensation structures are designed not only to reward financial success but also to incentivise genuine environmental improvements. By moderating the relationship between EC and GHGP, BSII plays a crucial role in enhancing the effectiveness of sustainability governance mechanisms within firms, leading to more substantive environmental outcomes.

2.4 | Board Sustainability Integration Index and Greenhouse Gas Performance

The BSII represents a firm's commitment to integrating sustainability into its governance structures. BSII reflects the extent to which sustainability principles are embedded within the board's decision-making processes, enhancing the alignment between corporate actions and broader societal expectations. This section explores how BSII influences GHGP, drawing on legitimacy theory and incentive alignment theory to support the hypothesis that BSII is positively associated with GHGP. Legitimacy theory posits that firms strive to maintain their legitimacy by conforming to societal norms, values and expectations, particularly in areas that are under significant public scrutiny, such as environmental sustainability (Suchman 1995). Firms with higher BSII demonstrate their commitment to sustainability by aligning their governance practices with societal expectations regarding environmental performance. This alignment helps companies to project a responsible image and build trust with stakeholders, including regulators, investors and consumers who increasingly demand transparency and accountability in environmental matters (Haque and Ntim 2020). By integrating sustainability into their core governance structures, firms can mitigate reputational risks, secure stakeholder support and enhance their social licence to operate.

From the incentive alignment theory perspective, BSII plays a crucial role in linking executive actions to environmental goals through the use of targeted compensation schemes. Boards with higher BSII are more likely to design executive compensation packages that incorporate environmental performance metrics, thereby directly incentivising executives to engage in substantive environmental actions (Cohen et al. 2023; Jensen and Murphy 2010). This approach ensures that executives are not only motivated to meet financial objectives but are also held accountable for the firm's environmental impact. By aligning executive compensation with sustainability outcomes, boards can drive the adoption of GGMP that go beyond symbolic actions and result in actual reductions in GHGE.

The integration of sustainability into board governance, as indicated by a high BSII, also enhances the board's capacity to formulate and implement effective environmental policies. Boards with strong sustainability integration are better positioned to address environmental challenges proactively, leading to more efficient and impactful initiatives aimed at reducing GHGE (Maas 2018). This proactive stance allows firms to not only comply with regulatory demands but also to demonstrate leadership in environmental performance, setting them apart in the market as sustainable and responsible businesses.

Empirical evidence supports the notion that boards with robust sustainability integration are more effective in driving meaningful environmental performance. Studies suggest that higher BSII correlates with improved environmental outcomes, as it reflects a board's commitment to embedding sustainability within corporate strategy and ensuring that executive actions are aligned with both financial and environmental goals (Maas 2018). By fostering a governance environment that prioritises sustainability, BSII enhances the firm's ability to implement GGMP that lead to tangible emissions reductions, contributing to the broader objective of transitioning towards a low-carbon economy.

Drawing on the combined insights from legitimacy theory and incentive alignment theory, it is hypothesised that boards with higher BSII are more likely to drive substantive improvements in GHGP. Legitimacy theory highlights the importance of aligning governance practices with societal expectations, whereas incentive alignment theory highlights how BSII ensures that executive actions are directly tied to environmental goals through compensation structures. Together, these theories provide a comprehensive framework for understanding how BSII influences a firm's environmental performance.

Based on the discussion above, the next hypothesis of the study is as follows:

H2. *BSII is positively associated with GHGP.*

2.5 | Greenhouse GasEmissions and Greenhouse Gas Management Processes

From the legitimacy theory perspective, firms often engage in SBPs to achieve strategic objectives such as enhancing legitimacy, securing stakeholder support and gaining access to critical resources (Suchman 1995). In this context, firms may implement GGMP as either symbolic gestures to appear environmentally responsible or as substantive efforts that lead to actual reductions in greenhouse gas emissions. Substantive GGMP involve concrete actions such as GHG mitigation initiatives, supply chain decarbonisation and retrofitting operations, which demonstrate a genuine commitment to environmental performance (Berrone, Fosfuri, and Gelabert 2017).

However, firms often face a trade-off between symbolic and substantive actions due to the high costs, complexity and time required for meaningful changes. For instance, substantive GGMP, such as supply chain decarbonisation, can be particularly challenging because they require collaborative efforts across the value chain, making them less immediately visible and more resource intensive (McKinsey 2021). As a result, many firms opt for symbolic initiatives that enhance their legitimacy without necessarily achieving significant reductions in GHGE (Siddique et al. 2021).

Empirical studies support this view, showing that firms frequently engage in GGMP to manage perceptions and maintain legitimacy rather than to bring about substantive environmental change (Damert, Paul, and Baumgartner 2017; Haque and Ntim 2020). For example, Haque and Ntim (2020) found no significant relationship between firms' carbon reduction initiatives and actual reductions in carbon emissions, aligning with greenwashing arguments. These findings suggest that firms often prioritise actions that bolster their image rather than those that yield tangible environmental benefits, highlighting the dual nature of GGMP as either substantive or symbolic.

Given the relationship between substantive and symbolic GGMP, it is critical to understand how these processes relate to actual greenhouse gas emissions. The combination of legitimacy and incentive alignment theories provides a framework to explore whether GGMP are being used effectively to reduce emissions or primarily to manage perceptions.

H3a. *There is a relationship between process-oriented GHGP and actual GHGP.*

2.6 | The Moderating Effect of Board Sustanability Integration Index on Greenhouse Gas Performance

According to incentive alignment theory, the presence and initiatives of a BSII indicate a firm's commitment to aligning executive actions with environmental objectives. Boards with high BSII are more likely to structure executive compensation and governance policies in ways that incentivise meaningful engagement in GGMP, aiming to reduce emissions rather than merely enhancing corporate image (Cohen et al. 2023; Jensen and Murphy 2010).

The board's role in integrating sustainability into corporate governance through BSII can significantly influence the effectiveness of GGMP by aligning executive incentives with broader environmental goals. BSII not only enhances the strategic direction of firms but also sets measurable performance targets linked to compensation, encouraging executives to engage in substantive rather than symbolic GGMP (Bui, Hoque and Zaman 2021). This alignment ensures that sustainability initiatives go beyond mere compliance and lead to real environmental improvements.

However, consistent with legitimacy theory, boards may also use BSII as a symbolic tool to signal commitment to environmental standards, even when the underlying initiatives do not result in substantial emission reductions (Haque and Ntim 2020; Orazalin, Ntim, and Malagila 2024). In such cases, the existence of a high BSII might be more about managing external perceptions rather than driving significant environmental outcomes. For instance, boards could adopt sustainability practices to satisfy stakeholder expectations without truly altering the firm's operational impact on the environment (Berrone and Gomez-Mejia 2009).

Prior studies have shown that although BSII can enhance corporate sustainability strategies and environmental performance, its effectiveness often depends on whether the board's commitment is genuine or primarily aimed at maintaining legitimacy (Orazalin 2020; Walls, Berrone, and Phan 2012). This dual role of BSII both as an incentive alignment mechanism and as a symbolic gesture suggests that its impact on GGMP and GHGE is complex and context dependent. Thus, the final hypothesis for this study is:

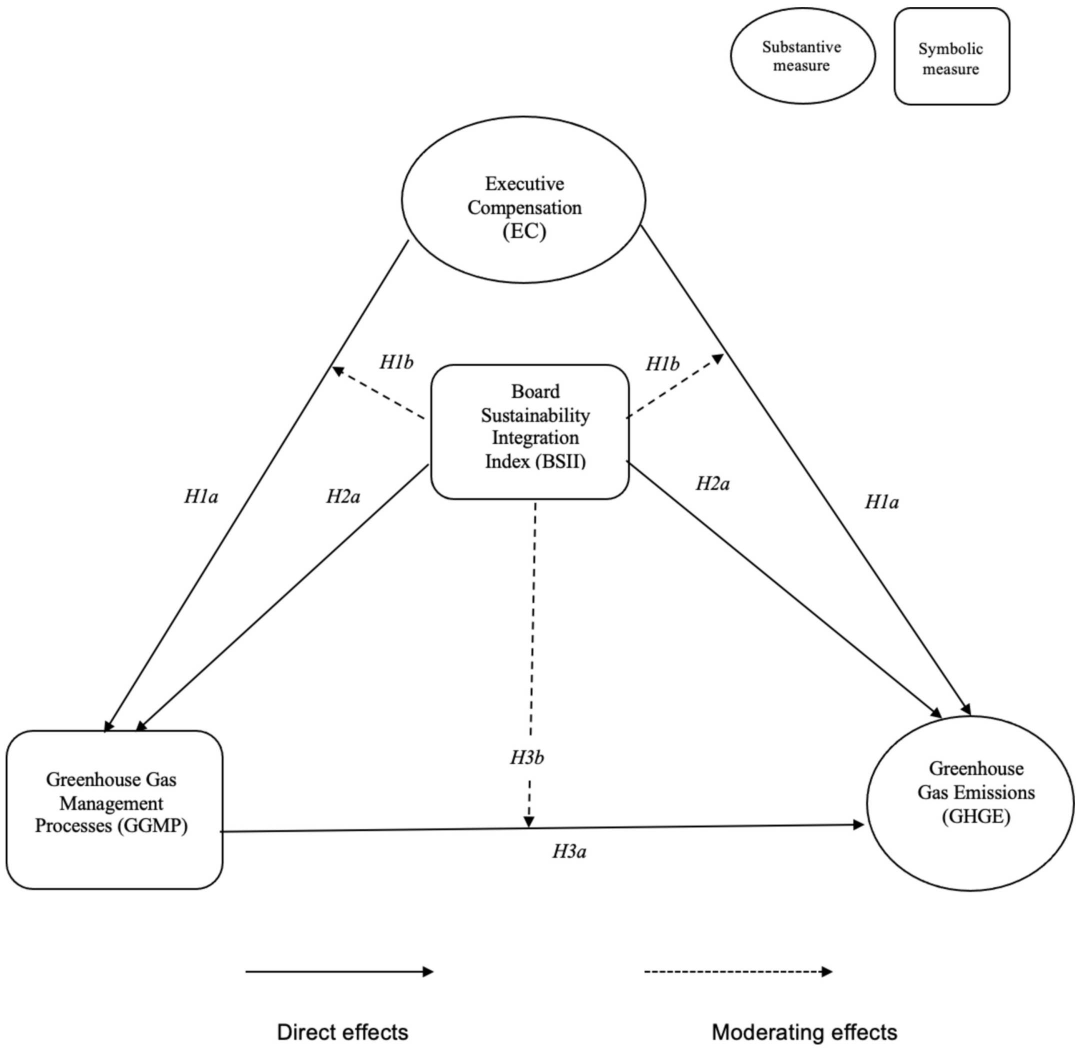

FIGURE 1 | Conceptual framework.

H3b. *BSII moderates the relationship between process-oriented GHGP and actual GHGP.*

Finally, drawing on the literature discussion presented above, Figure 1 depicts the graphical representation of the conceptual framework for the present study. This outlines the hypothesised links between two substantive (GHGE and EC) and three symbolic variables (GGMP, BSII and SBIs). The framework illustrates the direct effects of EC, SBIs and BSII on GGMP and GHGE, as well as the moderating effects of SBIs and BSII in these interactions.

3 | Data and Methodology

3.1 | Data

This study encompasses European firms, with data ranging from 2002 to 2022. Initially, the sample included 63 industrialised countries, selected based on the availability of data in the LSEG Workspace. This was later refined to exclude financial firms due to their unique regulatory, accounting and governance characteristics (Luo and Tang 2021; Orazalin, Ntim, and Malagila 2024). The focus shifted to non-financial firms with consistent data over at least 5 consecutive years. Essential data, including GHGE, GGMP, BSII, EC, CG and firm-specific metrics, were sourced from the LSEG Workspace. Country governance indicators were gathered using the Worldwide Governance Indicators by Kaufmann, Kraay, and Mastruzzi (2011), and macroeconomic factors like GDP growth rates and inflation were obtained from the World Bank database (World Bank 2020). The final sample comprises 700 firms across 66 distinct industries, totalling 15,876 firm-year observations. Table 1 details the sample selection and distribution by countries and industries.

3.2 | Empirical Models

The following models are employed to examine the effects among EC, BSII and the moderating effect of BSII on the EC–GHGP relationship as well as the GHGE–GGMP relationship:

TABLE 1 | Sample distribution.

Panel A: Sample selection process

Steps	Process	Sample observations
1	Obtain a list of non-financial firms with data in the LSEG workspace	43,120
2	Access a list of European firms that with data on EC for at least 5 years	15,876
3	Narrow down the list of firms that with data on GGMP for at least 5 years	15,876
4	Narrow down the list of firms that with data on BSII for at least 5 years	15,876
5	Narrow down the list of firms that with data on GHGE for at least 5 years	9657

Panel B: Sample distribution by country

Country	Firms	Obs.	Percentage (%)	Cum. (%)
Austria	6	126	0.79	0.79
Belgium	18	378	2.38	3.17
Czech Republic	1	42	0.26	3.44
Denmark	19	399	2.51	5.95
Finland	24	504	3.17	9.13
France	79	1659	10.45	19.58
Germany	73	1533	9.66	29.23
Greece	6	126	0.79	30.03
Hungary	2	42	0.26	30.29
Ireland	4	168	1.06	31.35
Italy	34	714	4.5	35.85
Luxembourg	1	21	0.13	35.98
Netherlands	24	504	3.17	39.15
Norway	19	1197	7.54	46.69
Poland	13	546	3.44	50.13
Portugal	10	210	1.32	51.46
Russia	19	399	2.51	53.97
Spain	21	441	2.78	56.75
Sweden	32	672	4.23	60.98
Switzerland	47	987	6.22	67.2
Turkey	37	777	4.89	72.09
United Kingdom	211	4431	27.91	100
Total	700	15,876	100	

Panel C: Sample distribution by industry

Aerospace and defence	17	399	2.51	2.51
Air freight and logistics	9	189	1.19	3.7

(Continues)

TABLE 1 | (Continued)

Panel C: Sample distribution by industry				
Automobile components	13	273	1.72	5.42
Automobiles	6	126	0.79	6.22
Beverages	12	252	1.59	7.8
Biotechnology	4	84	0.53	8.33
Broadline retail	1	21	0.13	8.47
Building products	10	231	1.46	9.92
Chemicals	30	693	4.37	14.29
Commercial services and supplies	13	273	1.72	16.01
Communications equipment	4	84	0.53	16.53
Construction and engineering	21	483	3.04	19.58
Construction materials	8	168	1.06	20.63
Consumer staples distribution and retail	15	336	2.12	22.75
Containers and packaging	6	147	0.93	23.68
Distributors	3	63	0.4	24.07
Diversified consumer services	1	21	0.13	24.21
Diversified REITs	5	105	0.66	24.87
Diversified telecommunication services	21	504	3.17	28.04
Electric utilities	17	441	2.78	30.82
Electrical equipment	12	252	1.59	32.41
Electronic equipment, instruments and com	8	168	1.06	33.47
Energy equipment and services	15	567	3.57	37.04
Entertainment	2	42	0.26	37.3
Food products	19	567	3.57	40.87
Gas utilities	5	105	0.66	41.53
Ground transportation	4	84	0.53	42.06
Health care equipment and supplies	12	252	1.59	43.65
Health care providers and services	7	147	0.93	44.58
Health care REITs	1	21	0.13	44.71
Health care technology	1	21	0.13	44.84
Hotels, restaurants and leisure	26	546	3.44	48.28
Household durables	14	294	1.85	50.13
Household products	3	63	0.4	50.53
IT services	8	168	1.06	51.59
Independent power and renewable electricals	7	147	0.93	52.51
Industrial conglomerates	5	105	0.66	53.17
Industrial REITs	3	63	0.4	53.57
Interactive media and services	5	105	0.66	54.23
Life sciences tools and services	3	63	0.4	54.63

(Continues)

Panel C: Sample distribution by industry				
Machinery	39	861	5.42	60.05
Marine transportation	5	105	0.66	60.71
Media	22	525	3.31	64.02
Metals and mining	37	861	5.42	69.44
Multi-utilities	11	231	1.46	70.9
Office REITs	9	189	1.19	72.09
Oil, gas and consumable fuels	35	840	5.29	77.38
Paper and forest products	7	147	0.93	78.31
Passenger airlines	9	210	1.32	79.63
Personal care products	5	105	0.66	80.29
Pharmaceuticals	15	315	1.98	82.28
Professional services	14	294	1.85	84.13
Real estate management and development	15	315	1.98	86.11
Residential REITs	1	21	0.13	86.24
Retail REITs	8	168	1.06	87.3
Semiconductors and semiconductor equipment	10	252	1.59	88.89
Software	4	84	0.53	89.42
Specialised REITs	2	42	0.26	89.68
Specialty retail	23	483	3.04	92.72
Technology hardware, storage and peripherals	2	42	0.26	92.99
Textiles, apparel and luxury goods	17	399	2.51	95.5
Tobacco	2	42	0.26	95.77
Trading companies and distributors	12	252	1.59	97.35
Transportation infrastructure	10	210	1.32	98.68
Water utilities	3	63	0.4	99.07
Wireless telecommunication services	7	147	0.93	100
Total	700	15,876	100	

$$\begin{aligned}\mathrm{GHGP}_{it} = {} & \alpha_0 + \beta_1 * \mathrm{EC}_{it} + \beta_2 * \mathrm{BSII}_{it} + \beta_3 * \left(\mathrm{EC}_{it} * \mathrm{BSII}_{it}\right) \\ & + \beta_4 * \mathrm{BMEET}_{it} + \beta_5 * \mathrm{BSIZE}_{it} + \beta_6 * \mathrm{BIND}_{it} + \beta_7 * \mathrm{BGEN}_{it} \\ & + \beta_8 * \mathrm{CEOCD}_{it} + \beta_9 * \mathrm{FSIZE}_{it} + \beta_{10} * \mathrm{PROF}_{it} + \beta_{11} * \mathrm{LEVE}_{it} \\ & + \beta_{12} * \mathrm{SLACK}_{it} + \beta_{13} * \mathrm{CAPIN}_{it} + \beta_{14} * \mathrm{GDP}_{kt} + \beta_{15} * \mathrm{INF}_{kt} \\ & + \beta_{16} * \mathrm{WGI}_{kt} + \gamma_i + \mu_t + \varepsilon_t\end{aligned} \tag{1}$$

$$\begin{aligned}\mathrm{GHGE}_{it} = {} & \alpha_0 + \beta_1 * \mathrm{GGMP}_{i[t|t-1|t-2]} \\ & + \beta_2 * \mathrm{BSII}_{i[t|t-1|t-2]} + \beta_3 * \left(\mathrm{GGMP}_{i[t|t-1|t-2]} * \mathrm{BSII}_{i[t|t-1|t-2]}\right) \\ & + \beta_4 * \mathrm{BMEET}_{i[t|t-1|t-2]} + \beta_5 * \mathrm{BSIZE}_{i[t|t-1|t-2]} + \beta_6 * \mathrm{BIND}_{i[t|t-1|t-2]} \\ & + \beta_7 * \mathrm{BGEN}_{i[t|t-1|t-2]} + \beta_8 * \mathrm{CEOCD}_{i[t|t-1|t-2]} + \beta_9 * \mathrm{FSIZE}_{i[t|t-1|t-2]} \\ & + \beta_{10} * \mathrm{PROF}_{i[t|t-1|t-2]} + \beta_{11} * \mathrm{LEVE}_{i[t|t-1|t-2]} + \beta_{12} * \mathrm{SLACK}_{i[t|t-1|t-2]} \\ & + \beta_{13} * \mathrm{CAPIN}_{i[t|t-1|t-2]} + \beta_{14} * \mathrm{GDP}_{k[t|t-1|t-2]} + \beta_{15} * \mathrm{INF}_{k[t|t-1|t-2]} \\ & + \beta_{19} * \mathrm{WGI}_{k[t|t-1|t-2]} + \gamma_i + \mu_t + \varepsilon_{i[t|t-1|t-2]}\end{aligned} \tag{2}$$

where GHGP $\left(\mathrm{GHGP}_{it}\right)$ represents both GHGE and GGMP of firm i at period t. γ_i and μ_t also represent the industry-specific fixed effects and time-specific fixed effects, respectively. EC*BSII represents the interaction term between SBIs and BSII, and GGMP*BSII represents the connection between GGMP and BSII.

In Equation (2), t represents the current period, and $t-1$ and $t-12$ represent 1 and 2 years prior to the current year, respectively. First, the lagged terms help capture delayed impacts of governance changes, board characteristics and economic conditions on GHGE, providing a more accurate relationship representation (Rothenberg, Hull, and Tang 2017). Second, considering past values reveals how past decisions and conditions influence current GHGE, capturing consistent trends instead of short-term anomalies (Li et al. 2011). Third, including multiple time periods enhances analysis robustness, ensuring observed

TABLE 2 | Descriptions of variables.

Variable	Symbols	Description	Source
Greenhouse gas emissions	GHGE	The natural logarithm of total GHG emissions, encompassing both Scope 1 (direct emissions from sources that are owned or controlled by the firm) and Scope 2, consists of indirect emissions stemming from the use of purchased electricity, cooling, heat, steam and similar sources in tonnes. Higher positive total greenhouse gas values signify elevated levels of greenhouse gas emissions, indicating weaker carbon performance and vice versa	LSEG Workspace
Executive compensation	EC	The natural logarithm of the aggregate fixed and variable compensation disbursed to all senior executives, reported in USD. The fixed component encompasses the base salary and additional non-monetary benefits, including housing, healthcare and transportation. The variable component encompasses bonuses and other long-term incentive schemes, such as equity ownership and extended share options	LSEG Workspace
Greenhouse gas management processes	GGMP	The index represents a sector-adjusted weighted average, derived from 40 specific firm-level elements pertinent to climate change initiatives and practices. Its scale extends from 0 (indicating an absence of climate GGMP) to 40 (signifying fully implemented GGMP)	LSEG Workspace
Board sustainability integration index	BSII	The index represents a sector-adjusted weighted average index derived from 8 firm-specific items (refer to Table S2) related to sustainable reporting initiatives by the board sustainability committee. It ranges between 0 (no board sustainability committee initiatives) and 8 (fully instituted board sustainability committee initiatives)	LSEG Workspace
Number of board meetings	BMEET	The natural logarithm of the number of board meetings during the year	LSEG Workspace
Board size	BSIZE	The natural logarithm of the total number of board directors at the end of the fiscal year	LSEG Workspace
Board independence	BIND	The proportion of board members who are independent	LSEG Workspace
Board gender diversity	BGEN	The proportion of female board members	LSEG Workspace
CEO chairman duality	CEOCD	A binary variable is applied, where it is assigned a value of 1 when the CEO and the board chair are distinct individuals and 0 in cases where they are the same person	LSEG Workspace
Firm size	FSIZE	The natural logarithm of total assets	LSEG Workspace
Profitability	PROF	The ratio of net income to total asset value	LSEG Workspace
Leverage	LEVE	The ratio of total debt divided to the aggregate value of total assets	LSEG Workspace

(Continues)

TABLE 2 | (Continued)

Variable	Symbols	Description	Source
Slack	SLACK	The ratio of cash and cash equivalents divided to the aggregate value of total assets	LSEG Workspace
Capital intensity	CAPIN	The ratio of property, plant and equipment to the aggregate value of total assets	LSEG Workspace
Country-level variables	**Symbols**	**Description**	**Source**
GDP growth	GDP	The total production value, encompassing the gross value added by local producers, inclusive of product taxes, while deducting subsidies not included in the product values	World Bank
Inflation rates	INF	The yearly percentage change in the prices of goods and services, which can either remain constant or fluctuate within the year	World Bank
WGI	WGI	A composite index constructed to represent country governance quality. Computed based on CG factors including regulatory quality, rule of law, government effectiveness and political stability. This metric ranges between 0 (poor governance quality) and 1 (highest possible level of governance excellence)	Worldwide Governance Indicators

TABLE 3 | Descriptive statistics.

Variable	Observations	Mean	Standard dev.	Minimum	Maximum
EC (ln)	15,876	15.49	1.15	5.71	23.90
GHGE (ln)	9,657	12.51	2.55	2.71	19.33
GGMP	15,876	10.68	0.36	0.00	37.00
BSII	15,876	3.64	3.00	0.00	8.00
BMEET (ln)	15,876	2.18	0.43	0.00	4.80
BSIZE (ln)	15,876	2.68	0.36	0.00	3.67
BIND (%)	15,876	56.86	24.39	0.00	100.00
BGEN (%)	15,876	20.92	15.34	0.00	75.00
CEOCD	15,876	0.211	0.41	0.00	1.00
FSIZE (ln)	15,876	22.21	1.67	11.34	27.13
PROF (%)	15,876	0.05	0.37	−34.45	4.35
LEVE (%)	15,876	0.06	0.82	0.00	104.91
SLACK (ratio)	15,876	0.09	0.09	−0.15	1.03
CAPIN (ratio)	15,876	0.29	2.97	−379.65	39.07
GDP (%)	15,876	3.80	2.37	1.00	9
INF (%)	15,876	8.24	10.64	−4.48	49.00
WGI (%)	15,876	0.73	0.18	0.00	0.89

TABLE 4 | Pairwise correlation matrix.

Variables	GHGE	EC	GGMP	BSII	BMEET	BSIZE	BIND	BGEN	CEOCD	SLACK	LEVE	FSIZE	PROF	CAPIN	GDP	INF	WGI
GHGE	1.00																
EC	0.25**	1.00															
GGMP	0.38**	0.32**	1.00														
BSII	0.25**	0.28**	0.76**	1.00													
BMEET	0.06**	−0.05**	0.04**	0.12**	1.00												
BSIZE	0.34**	0.30**	0.36**	0.25**	−0.13**	1.00											
BIND	0.04**	0.08**	0.13**	0.24**	0.13**	−0.21**	1.00										
BGEN	−0.10**	0.05**	0.37**	0.41**	0.13**	0.13**	0.05**	1.00									
CEOCD	0.04**	0.03**	0.10**	−0.04**	−0.07**	0.17**	−0.12**	0.11**	1.00								
SLACK	−0.15**	−0.03**	−0.06**	−0.08**	−0.03**	−0.07**	−0.15**	−0.10**	0.08**	1.00							
LEVE	0.01	0.01	0.05***	0.06***	−0.02	0.02***	0.09***	−0.01	0.01	0.01	1.00						
FSIZE	0.64***	0.44***	0.55***	0.50***	−0.01***	0.56***	0.08***	0.11***	0.11***	−0.26***	0.02	1.00					
PROF	−0.33**	0.01	−0.03	−0.10	−0.05**	0.02***	−0.01	−0.032***	0.01	0.04***	−0.72***	0.02	1.00				
CAPIN	0.42***	−0.01	0.01	0.001	−0.001	−0.02	0.01	0.01	0.01	−0.01	−0.02	−0.001	0.001	1.000			
GDP	−0.01	−0.04***	−0.14***	−0.12***	−0.01	−0.07***	0.03***	−0.01	−0.07***	−0.01	0001	−0.09***	0.02***	0.02***	1.00		
INF	0.06 ***	−0.04***	−0.38***	−0.38**	0.04***	0.01	−0.03***	−0.14***	−0.04	0.01	−0.06***	−0.14***	−0.01	0.012***	0.38***	1.00	
WGI	−0.02	−0.05***	−0.05***	−0.19***	−0.21***	−0.09***	−0.10	0.04***	−0.19***	−0.03***	−0.02***	−0.13***	0.02***	−0.01	−0.01	−0.12	1.00

***$p < 0.01$.
**$p < 0.05$ (two-tailed).

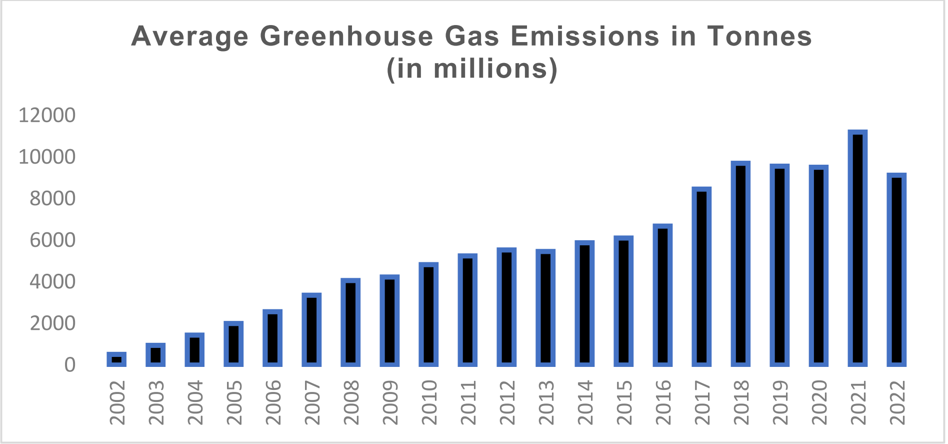

FIGURE 2 | Average greenhouse gas emissions in tonnes (millions) by year.

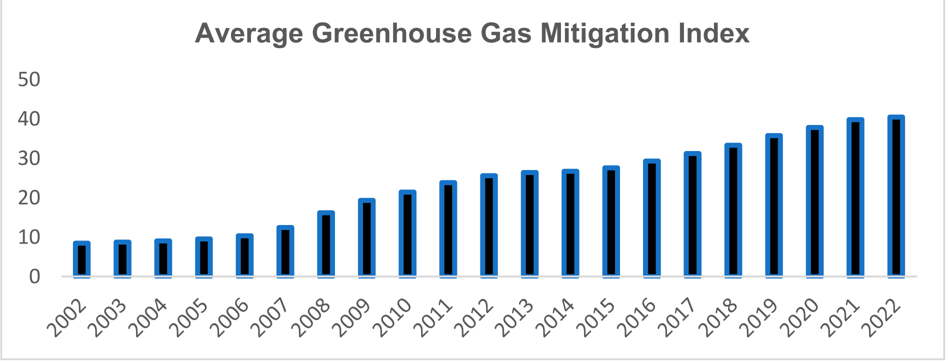

FIGURE 3 | Average greenhouse gas mitigation index by year.

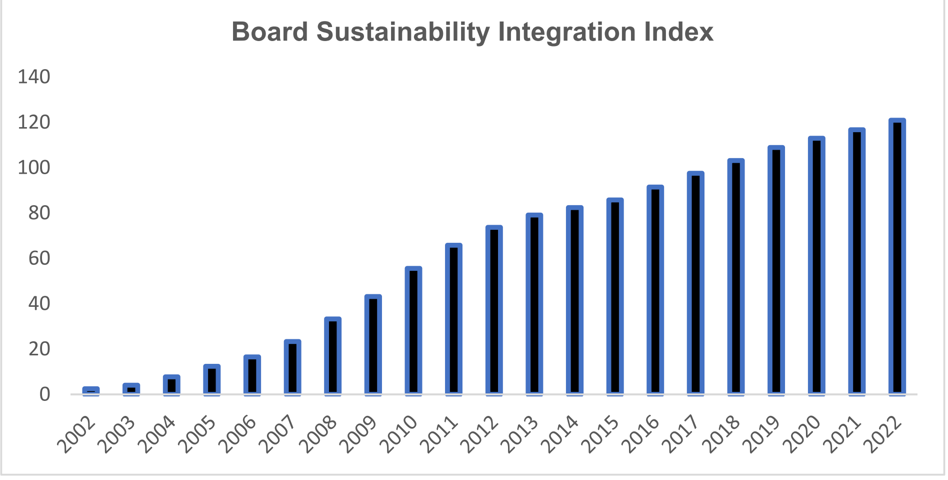

FIGURE 4 | Average board sustainability integration index by year.

effects are stable over time and not driven by temporary factors (Henderson, Gulati, and Tushman 2015). The definitions for all the variables are provided in Table 2.

This study employs panel data regression analysis as the optimal method due to its suitability in capturing the dynamic relationship between independent and dependent variables over time, as well as its adeptness in handling data structured in a longitudinal panel-time (firm-year) format. This analytical technique is particularly advantageous in mitigating the potential for multicollinearity and circumventing any estimation biases that might otherwise compromise the integrity of the research outcomes. Consequently, FE panel regression is determined to be the most suitable method for the research models and hypotheses testing. The FE panel regression also helps to mitigate the risk of omitted variable bias. This methodology is also adopted in similar studies (Elbardan et al. 2023; Orazalin, Ntim, and Malagila 2024). Post-estimation tests,

TABLE 5 | The effects of executive compensation and board sustainability integration index on the greenhouse gas management processes.

Models	**(1)**	**(2)**	**(3)**
Dependent variable	**GGMP**	**GGMP**	**GGMP**
EC	0.611***		0.398***
	(2.71)		(4.80)
BSII		1.692***	1.549***
		(7.90)	(7.01)
EC*BSII			−0.016*
			(−1.71)
BMEET	0.98***	0.592***	0.623***
	(6.51)	(4.79)	(5.03)
BSIZE	1.679***	0.566**	0.436*
	(5.54)	(2.34)	(1.74)
BIND	0.026***	0.007***	0.007***
	(8.32)	(2.71)	(2.79)
BGEN	0.147***	0.069***	0.066***
	(3.71)	(18.12)	(17.46)
CEOD	0.246	0.078	0.141
	(1.47)	(0.57)	(1.03)
FSIZE	2.633***	1.325***	1.127***
	(2.67)	(13.79)	(11.47)
PROF	−0.805***	−0.344***	−0.342
	(−3.16)	(−2.73)	(−1.63)
LEVE	1.389***	0.718***	0.704***
	(4.47)	(2.77)	(2.75)
SLACK	4.367***	3.447***	3.292***
	(5.70)	(5.44)	(5.22)
CAPIN	0.02*	0.013	0.015*
	(1.93)	(1.46)	(1.69)
GDP	0.001***	0.001	0.001
	(2.78)	(0.39)	(0.89)
INF	−0.125***	−0.076***	−0.066***
	(−20.35)	(−15.17)	(−12.92)
WGI	−8.146***	1.75	−1.72
	(−2.68)	(0.72)	(−0.69)
Constant	−57.534***	−28.588***	−27.042***
	(−6.17)	(−9.91)	(−8.60)
Country effects	Fixed	Fixed	Fixed
Industry effects	Fixed	Fixed	Fixed
Year effects	Fixed	Fixed	Fixed

(Continues)

TABLE 5 | (Continued)

Models	**(1)**	**(2)**	**(3)**
Dependent variable	**GGMP**	**GGMP**	**GGMP**
Observations	15,876	15,876	15,876
R-squared	0.355	0.589	0.534

Note: This table reports the regression results of executive compensation and board sustainability integration index on the greenhouse gas management processes. All variables are defined and measured in Table 2. *t*-statistics estimated using robust standard errors are reported in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

including the *F*-test, Breusch and Pagan Lagrange multiplier (LM) test and Hausman's test, guide the selection of our regression analysis method. The *F*-test and Hausman's test results suggest a preference for fixed-effects (FE) panel regression over ordinary regression and random-effects (RE) panel regression, respectively (not reported due to brevity, but available upon request).

3.3 | Key Variables

As illustrated in the conceptual framework (Figure 1), in addition to the EC and BSII variables, this study utilises a symbolic measure of GHG (e.g., GGMP) and a substantive measure for GHG (e.g., GHGE). Based on previous studies (e.g., Haque and Ntim 2020; Orazalin, Ntim, and Malagila 2024), the GGMP index is developed to measure the GGMP.[2] GGMP is an index adjusted for sector specifics and weighted based on 40 unique GHG reduction initiatives at the firm level, where higher GGMP values indicate increased advocacy for climate-related issues. The list of 40 provisions for the index is attached in Table S1. Alternatively, consistent with similar studies (Moussa et al. 2020; Orazalin, Ntim, and Malagila 2024), this study utilises the natural logarithm of the GHGE, encompassing both Scope 1 and Scope 2 emissions in tonnes as the substantive measure for carbon performance.[3] For EC, consistent with similar studies (Adu, Flynn, and Grey 2022b; Haque and Ntim 2020), this study employs the natural logarithm of total fixed and variable compensation in USD, paid to all senior executives, as disclosed by the firms as a substantive measure of EC and the SBIs as a symbolic measure. Additionally, the BSII also represents 8 firm specific board sustainability committee initiatives (refer to Table S2). A variety of control variables are used in this investigation to consider the possible influence of distinct country- and firm-specific characteristics on the GHG performance. Following related studies (e.g., Orazalin, Ntim, and Malagila 2024), this study utilises a range of CG characteristics including board independence, board size and the duality of CEO-Chairman roles. Furthermore, consistent with previous studies (Adu, Flynn, and Grey 2022b; Siddique et al. 2021), the study employs various control variables at the firm level, including factors such as firm size, leverage, profitability and capital intensity. Ultimately, the study employs country-level governance and macroeconomic indicators such as inflation and GDP growth rates, as in previous studies (Marin and Vona 2021; Orazalin, Ntim, and Malagila 2024).

4 | Findings and Discussion

4.1 | Descriptive Statistics

Table 3 displays the summary statistics of all the variables. Values of the GGMP index extend from a minimum of 0 to a maximum of 37, with a mean value of 10. The GHGE vary from 2.71 to 19.33, with a mean value of 12.51 and a standard deviation of 2.55. Additionally, consistent with similar studies (Adu, Flynn, and Grey 2022b; Haque and Ntim 2020), the pairwise correlation coefficients displayed in Table 4 indicate that both GHGE and GGMP are positively correlated with each other and with the level of EC. The correlation coefficients across independent variables that do not surpass 0.80, the upper limit of allowable correlation, might indicate the integrity of the multicollinearity problems (Shrestha 2020). Despite the correlation coefficient of 0.76 between GGMP and BSII, both variables are maintained in the sample as such high value is expected due to both indexes reflecting the firms' initiatives towards sustainability. Further, the VIF[4] of 1.57 and 1.64 for GGMP and BSII, respectively, are well below the threshold of 10.

Figures 2–4 illustrate the annual spread of GHGE, GGMP and BSII, respectively from 2002 to 2022. The annual average of GHGE indicates an increasing trend from 2002 to 2018 before establishing a consistent pattern between 2018 and 2020 and then a sharp increase in 2021 before returning to previous levels in 2022. Figures 3 and 4 show a consistent steady increase in the GGMP from 2002 to 2022, which is consistent with similar studies (Haque 2017; Orazalin, Ntim, and Malagila 2024).

4.2 | Main Results

4.2.1 | Executvie Compensation, Board Sustainability Integration Index and Greenhouse Gas Management Processes

In analysing the various relationships, the country, industry and year effects are controlled to ensure that the observed associations are not confounded by these external, time-invariant factors. Table 5 displays the results of the fixed-effects regression of EC and BSII against GGMP with each column representing different models. Model 1 shows that EC has a statistically significant positive relationship with GGMP

TABLE 6 | The effects of executive compensation and board sustainability integration index on greenhouse gas emissions.

Models	(1)	(2)	(3)
Dependent variable	**GHGE**	**GHGE**	**GHGE**
EC	0.004		−0.052***
	(0.57)		(−2.62)
BSII		0.006*	−0.137***
		(1.72)	(−2.8)
EC*BSII			0.009***
			(2.99)
BMEET	−0.067***	−0.068***	−0.07***
	(−2.82)	(−2.89)	(−2.95)
BSIZE	0.239***	0.199***	0.233***
	(4.9)	(4.22)	(4.75)
BIND	0.001	−0.001	0.001
	(0.16)	(−0.18)	(0.15)
BGEN	−0.004***	−0.004***	−0.004***
	(−5.43)	(−5.58)	(−5.64)
CEOD	0.082***	0.081***	0.081***
	(3.05)	(3.07)	(3)
FSIZE	0.475***	0.469***	0.47***
	(22.67)	(22.72)	(22.16)
PROF	−0.106***	−0.083***	−0.104***
	(−2.72)	(−3.88)	(−2.69)
LEVE	−0.085*	−0.083*	−0.089**
	(−1.9)	(−1.85)	(−1.99)
SLACK	−0.635***	−0.580***	−0.647***
	(−4.93)	(−4.53)	(−5.03)
CAPIN	0.113*	0.134**	0.116**
	(1.95)	(2.39)	(1.99)
GDP	0.001	0.001	0.001
	(0.80)	(0.43)	(0.85)
INF	−0.005***	−0.005***	−0.005***
	(−5.14)	(−4.58)	(−5.06)
WGI	2.812***	2.579***	2.833***
	(5.92)	(5.55)	(5.96)
Constant	−0.862	−0.389	0.075
	(−1.42)	(−0.65)	(0.11)
Country effects	Fixed	Fixed	Fixed
Industry effects	Fixed	Fixed	Fixed
Year effects	Fixed	Fixed	Fixed

(Continues)

Models	(1)	(2)	(3)
Dependent variable	GHGE	GHGE	GHGE
Observations	9657	9657	9657
R-squared	0.371	0.378	0.373

Note: This table reports the regression results of executive compensation and board sustainability integration index on the greenhouse gas emissions. All variables are defined and measured in Table 2. *t*-statistics estimated using robust standard errors are reported in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

($p < 0.01$), demonstrating that EC is has a significant impact in improving the GGMP of organisations worldwide. Thus, supporting H1a, which consistent with the findings of Adu, Flynn, and Grey (2022b) and Haque and Ntim (2020), suggesting that increase in EC can further motivate business executives to engage in certain initiatives to enhance their firms' environmental performance. The result is consistent with incentive alignment theory, which posits that aligning executive rewards with environmental performance encourages executives to adopt sustainability-focused practices.

Further, Model 2 demonstrates a positive link between BSII and GGMP ($p < 0.01$). This result indicates that firms who invest in their board sustainability committee characteristics end up improving their environmental performance. In contrast, Model 3 suggests that the coefficient of EC*BSII reveals a significant negative relationship with GGMP, suggesting a legitimacy gap. This gap refers to the disconnect between the symbolic commitment to sustainability governance and the failure to achieve substantive environmental outcomes that meet societal standards, such as reducing GHGE (Ashforth and Gibbs 1990; Suchman 1995). Societal standards for environmental performance typically include regulatory benchmarks, industry best practices and stakeholder expectations, which demand genuine reductions in emissions rather than superficial compliance. The negative effect of EC*BSII on GGMP implies that when EC and BSII interact, firms may prioritise FP or other business operations over environmental improvements, resulting in actions that do not adequately address environmental standards. This aligns with previous studies that highlight how symbolic governance measures can mask insufficient substantive efforts, leading to a legitimacy gap where firms appear committed to sustainability but fail to deliver meaningful environmental results (Berrone, Fosfuri, and Gelabert 2017; Haque and Ntim 2020).

This is in contrast to the expectations of H1b, which could imply that when the EC and BSII align or interact, the focus may move towards activities that raise emissions, possibly as a result of prioritising specific business operations or financial results over environmental ones. Simultaneously, this alignment appears to detract from commitment to or implementation of process-oriented efforts, this could be implied that these activities do not fit with the incentives produced by EC and BSII combined effect.

4.2.2 | Executive Compensation, Board Sustainability Integration Index and Greenhouse Gas Emissions

Table 6 displays the results of the fixed-effects regression of EC and BSII on GHGE. Model 1 shows that EC has a positive coefficient but the relationship with GHGE is not statistically significant, indicating that EC alone does not significantly influence emissions reduction. Model 2 also shows that BSII has significant positive effect on GHGE ($p < 0.05$), as a negative coefficient in relation to GHGE indicates a reduction in GHGE. This finding suggests that strong sustainability integration within board governance is effective in reducing emissions, supporting H2. This finding highlights that boards with higher sustainability involvement can drive substantive environmental improvements, consistent with legitimacy theory, where governance mechanisms help align corporate actions with societal environmental standards. Unexpectedly, the results presented in Model 3 show that EC*BSII is also negatively linked to GHGE ($p < 0.01$). In this case, BSII individually contributes positively to a reduction in GHGE.

The positive sign of the EC*BSII interaction on GHGE highlights a misalignment between EC incentives and sustainability governance. This misalignment suggests that when combined, EC and BSII might inadvertently prioritise financial performance or other operational goals over environmental sustainability, reflecting a complicated relationship of incentives that do not fully align with emissions reduction. According to incentive alignment theory, the combined effects of EC and BSII may create conflicting priorities, such as emphasising short-term financial outcomes over long-term environmental goals, resulting in operational inefficiencies or a failure to adequately implement emissions reduction initiatives (Jensen and Murphy 2010). This could also suggest that when EC and BSII are combined, the focus shifts in a way that neglects certain stakeholder groups (e.g., environmental activists and community groups) or prioritises certain interests (e.g., short-term financial goals of shareholders) that are not aligned with broader environmental sustainability goals.

The contrasting signs of the coefficients for the EC*BSII interaction on GGMP (negative) and GHGE (positive) suggest a divergence between process-oriented initiatives and actual environmental outcomes. Although EC and BSII individually may support stakeholder concerns regarding sustainability, their

TABLE 7 | The effects of the greenhouse gas management processes and board sustainability integration index on greenhouse gas emissions.

Models	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	GHGE	**GHGE**	**GHGE**	**GHGE**	**GHGE**	**GHGE**
GGMP	0.002***			0.001***		
	(3.09)			(3.27)		
BSII	0.003			0.001**		
	(0.56)			(3.12)		
GGMP*BSII				−0.001*		
				(−1.70)		
$GGMP_{t-1}$		0.001			0.001***	
		(0.10)			(3.08)	
$BSII_{t-1}$		−0.001			−0.022***	
		(−0.18)			(3.01)	
$GGMP_{t-1}$*$BSII_{t-1}$					−0.001***	
					(−3.02)	
$GGMP_{t-2}$			0.006***			0.006***
			(2.91)			(4.91)
$BSII_{t-2}$			−0.005			0.005*
			(−0.59)			(1.95)
$GGMP_{t-2}$*$BSII_{t-2}$						−0.001***
						(−3.85)
$BMEET_{[t;t-1;t-2]}$	−0.069***	−0.033	−0.001*	−0.069***	−0.033	−0.029
	(−2.93)	(−1.45)	(−1.85)	(−2.94)	(−1.45)	(−1.24)
$BSIZE_{[t;t-1;t-2]}$	0.197***	0.099**	−0.029	0.197***	0.099**	0.09**
	(4.18)	(2.17)	(−1.24)	(4.17)	(2.17)	(1.98)
$BIND_{[t;t-1;t-2]}$	−0.001	0.001	0.09**	−0.001	0.001	−0.001
	(−0.21)	(0.07)	(1.98)	(−0.21)	(0.07)	(−0.56)
$BGEN_{[t;t-1;t-2]}$	−0.004***	−0.006***	−0.001	−0.004***	−0.006***	−0.006***
	(−5.69	(−9.07)	(−0.56)	(−5.7)	(−9.05)	(−9.14)
$CEOD_{[t;t-1;t-2]}$	0.081***	0.081***	−0.006***	0.081***	0.081***	0.038
	(3.06))	(3.17)	(−9.14)	(3.06)	(3.17)	(1.48)
$FSIZE_{[t;t-1;t-2]}$	0.466*	0.455***	0.038	0.466***	0.455***	0.424***
	(2.75)	(22.99)	(1.48)	(22.35)	(22.98)	(20.78)
$PROF_{[t;t-1;t-2]}$	−0.082***	−0.076***	0.424***	−0.082***	−0.076***	−0.075***
	(−3.83)	(−3.53)	(20.78)	(−3.83)	(−3.53)	(−3.56)
$LEVE_{[t;t-1;t-2]}$	−0.084*	−0.152***	−0.075***	−0.084*	−0.152***	−0.198***
	(−1.88)	(−3.46)	(−3.56)	(−1.88)	(−3.46)	(−4.37)
$SLACK_{[t;t-1;t-2]}$	−0.583***	−0.737***	−0.198***	−0.584***	−0.737***	−0.691***
	(−4.56)	(−6.01)	(−4.37)	(−4.56)	(−6.00)	(−5.49)

(Continues)

TABLE 7 | (Continued)

Models	(1)	(2)	(3)	(4)	(5)	(6)
	GHGE	GHGE	GHGE	GHGE	GHGE	GHGE
$CAPIN_{[t;t-1;t-2]}$	0.135**	0.091*	−0.691***	0.135**	0.091*	0.012
	(2.40)	(1.7)	(−5.49)	(2.39)	(1.7)	(0.23)
$GDP_{[t;t-1;t-2]}$	0.001	0.001	0.012	0.001	0.001	0***
	(0.43)	(1.61)	(0.23)	(0.43)	(1.61)	(4.28)
$INF_{[t;t-1;t-2]}$	−0.004***	−0.004***	0.001***	−0.004***	−0.004***	0.001
	(−4.49)	(−4.31)	(4.28)	(−4.5)	(−4.31)	(0.52)
$WGI_{[t;t-1;t-2]}$	2.576***	2.627***	0.001	2.574***	2.626***	1.559***
	(5.55)	(5.88)	(0.52)	(5.54)	(5.88)	(3.51)
Constant	−0.324	0.104	1.559***	−0.309	0.104	1.6***
	(−0.54)	(0.18)	(3.51)	(−0.51	(0.18)	(2.77)
Country effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Industry effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Year effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Observations	9091	9091	9091	9091	9091	9091
R-squared	0.321	0.373	0.408	0.380	0.373	0.307

Note: This table reports the regression results of greenhouse gas management processes and board sustainability integration index on greenhouse gas emissions. All variables are defined and measured in Table 2. *t*-statistics estimated using robust standard errors are reported in parentheses.
***$p<0.01$.
**$p<0.05$.
*$p<0.1$.

interaction appears to shift focus away from emissions reductions, underscoring a potential conflict or trade-off in aligning incentives. This divergence may occur due to the prioritisation of short-term financial goals over broader environmental commitments or misalignment in governance strategies that fail to translate process-oriented efforts into substantive emissions reductions (Ashforth and Gibbs 1990).

4.2.3 | Greenhouse Gas Performance and Board Sustainability Integration Index

Table 7 reports the results of the fixed-effects regression of GHGE against GGMP and BSII. In Models 1–6, GGMP and $GGMP_{(t-2)}$ have a statistically significant positive relationship with GHG ($p<0.01$). The findings imply that firms that engage in GGMP keep producing substantial levels of pollution. Some GHGE reduction measures may take longer to execute. Theoretically, these results support the symbolic legitimation/greenwashing hypothesis, given that firms are inclined to undertake GGMP to preserve legitimacy, yet such efforts have no impact on actual emission reductions (Orazalin, Ntim, and Malagila 2024). Supported by previous studies (Issa 2023; Orazalin, Ntim, and Malagila 2024), symbolic sustainable practices by way of participation in SBPs and thorough sustainability disclosures are popular, but these symbolic pledges may not always enhance actual GHGE (Orazalin, Ntim, and Malagila 2024; Shevchenko 2021).

Additionally, the coefficients of BSII, $BSII_{(t-1)}$, and $BSII_{(t-2)}$ are all statistically insignificant. The insignificance of BSII coefficients suggests that the BSII does not necessarily translate into measurable changes in emissions. Alternatively, the insignificant results for lagged BSII variables suggest that the effects of board sustainability integration on emissions may not be immediate or may operate over different time frames than $(t-1)$ and $(t-2)$. These outcomes match previous research (Orazalin, Ntim, and Malagila 2024; Walls, Berrone, and Phan 2012), which found a favourable relationship between the presence of a board sustainability committee and sustainability issues. However, the interaction terms GGMP*BSII, $GGMP_{(t-1)}, * BSII_{(t-1)}$, and $GGMP_{(t-2)}, * BSII_{(t-2)}$ all have a statistically significant negative relationship with GHGE ($p<0.01$ for $GGMP_{(t-1)}, * BSII_{(t-1)}$ and $GGMP_{(t-2)}, * BSII_{(t-2)}$; $p<0.05$ for GGMP*BSII), suggesting that BSII can moderate the relationship between GGMP and GHGE. These results dispute those of Orazalin, Ntim, and Malagila (2024), who discovered that the presence of a board sustainability committee had no moderating effect on the GGMP–GHGE relationship.

Nonetheless, the results in Table 7 show that the BSII is insufficient to reduce GHGE. On the other hand, when a firm invests in specific characteristics of its sustainability committee, they may be much more inclined to partake in the activities that reduce actual GHGE levels. The findings also suggest that the impact of BSII contributes to a sustained reduction in actual GHG levels

TABLE 8 | GMM results.

Models	(1) GHGE	(2) GHGE	(3) GGMP	(4) GGMP	(5) GHGE
L.GHGE	0.856***	0.921***			1.027***
	(16.75)	(18.36)			(17.64)
L.GGMP			0.916***	1.146***	
			(32.17)	(21.24)	
GGMP					0.215**
					(2.19)
EC	−0.079		1.712***		
	(−0.73)		(2.69)		
BSII		−0.041**		−1.423***	−0.151**
		(−2.37)		(−5.22)	(−2.54)
Control variables	Included	Included	Included	Included	Included
Country effects	Fixed	Fixed	Fixed	Fixed	Fixed
Industry effects	Fixed	Fixed	Fixed	Fixed	Fixed
Year effects	Fixed	Fixed	Fixed	Fixed	Fixed
Observations	13,175	13,175	13,175	13,175	13,175
Arellano–Bond (AR-1)	0.000	0.000	0.000	0.000	0.000
Arellano–Bond (AR-2)	0.602	0.463	0.207	0.408	0.463
Hansen test (*p*-value)	0.403	0.807	0.550	0.309	0.721

Note: This table presents the estimation results for the generalised method of moments (GMM) regressions for the effects of executive compensation and board sustainability integration index on both greenhouse gas management processes and greenhouse gas emissions. The definitions for all variables are provided in Table 2. The *t*-statistics calculated with robust standard errors are shown in brackets.
***$p<0.01$.
**$p<0.05$.
*$p<0.1$.

over time, rather than being a short-term measure aimed solely at maintaining legitimacy.

This suggests that firms with stronger and more active sustainability committees on their boards tend to have a more effective response to GGMP in terms of reducing emissions. The significance of BSII implies that CG structures related to sustainability and environmental responsibility can influence the impact of GGMP. Firms with well-structured sustainability committees may be better equipped to implement and monitor GHGE mitigation strategies effectively.

4.3 | Robustness Tests

A variety of additional analyses are performed in this study to ensure the reliability of the results. To start with, Equations (1) and (2) are estimated using a dynamic two-step system generalised methods of moments (GMM), developed by Arellano and Bond (1991) and Blundell and Bond (1998). In the GMM regression of GHGP, EC is utilised as an endogenous variable; the specification of GHGE also includes EC as an endogenous variable. The results from GMM (in Table 8) are comparable to those reported in Table 5, demonstrating the robustness of the main results to sample selection bias and endogeneity.

4.4 | Further Analysis

4.4.1 | Firms in Coastal Regions vs. Firms Inland

When examining the determinants and environmental impacts of businesses and climate change efforts, it is critical to include differences in regional and industry settings (Aslam et al. 2021; Liu et al. 2021). Accordingly, this study also explores various measures: geographical and industry groups. First, this study estimates Equation (2) to better comprehend the relationships between the GHG measures in predominantly coastal and predominantly inland nations. Table 9 shows that the firms in predominantly coastal regions continue to produce high emissions, whereas firms in the inland regions reduce emissions through carbon mitigation initiatives. Subsequently, firms in the inlands invest in their board sustainability committee to aid in reducing carbon emissions. However, GGMP*BSII and its lagged forms

TABLE 9 | The effects of the greenhouse gas mitigation index and board sustainability integration index on greenhouse gas emissions.

Panel A: Costal regions						
Models	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Dependent variable	**GHGE**	**GHGE**	**GHGE**	**GHGE**	**GHGE**	**GHGE**
GGMP	0.005***			0.001***		
	(3.10)			(4.10)		
BSII	0.007*			0.005*		
	(1.70)			(1.80)		
GGMP*BSII				−0.001		
				(−0.91)		
$GGMP_{t-1}$		0.003***			0.002***	
		(3.14)			(3.12)	
$BSII_{t-1}$		0.001			0.006***	
		(0.19)			(3.42)	
$GGMP_{t-1}$*$BSII_{t-1}$					−0.001**	
					(−1.98)	
$GGMP_{t-2}$			0.005***			0.010***
			(2.85)			(2.97)
$BSII_{t-2}$			−0.008			0.004*
			(−1.22)			(1.65)
$GGMP_{t-2}$*$BSII_{t-2}$						−0.001***
						(−3.62)
Country effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Industry effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Year effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Observations	6082	6371	6056	6082	6371	6056
R-squared	0.394	0.386	0.435	0.396	0.383	0.434

Panel B: Inland regions						
Models	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Dependent variable	**GHGE**	**GHGE**	**GHGE**	**GHGE**	**GHGE**	**GHGE**
GGMP	−0.004			0.003**		
	(−0.99)			(2.47)		
BSII	−0.002			0.020**		
	(−0.19)			(2.10)		
GGMP*BSII				−0.001**		
				(−2.36)		
$GGMP_{t-1}$		−0.004*			−0.002**	
		(−1.85)			(−2.07)	

(Continues)

TABLE 9 | (Continued)

Panel B: Inland regions

Models	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Dependent variable	**GHGE**	**GHGE**	**GHGE**	**GHGE**	**GHGE**	**GHGE**
$BSII_{t-1}$		−0.003			0.014**	
		(−0.29)			(2.23)	
$GGMP_{t-1}$*$BSII_{t-1}$					−0.002**	
					(−1.97)	
$GGMP_{t-2}$			−0.007**			−0.003
			(−2.04)			(−0.61)
$BSII_{t-2}$			−0.005			0.011
			(−0.05)			(0.67)
$GGMP_{t-2}$*$BSII_{t-2}$						−0.001
						(−0.90)
Country effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Industry effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Year effects	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Observations	2503	2569	2391	2503	2569	2391
R-squared	0.361	0.354	0.338	0.359	0.352	0.334

Note: This table reports the regression results of the greenhouse gas management processes, board sustainability integration index on greenhouse gas emissions for firms in coastal and inland regions. Inland regions refer to areas that are situated away from the coast or border of a country or region. Coastal regions, on the other hand, are areas that are adjacent to the shoreline or large bodies of water such as inland lakes. Coastal regions are exposed to a range of coastal hazards, including sea-level rise and coastal flooding, and are more densely populated than inland regions. All variables are defined and measured in Table 2. *t*-statistics estimated using robust standard errors are reported in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

have statistically significant negative coefficients, indicating that firms in the coastal regions achieve carbon emission reduction when their carbon initiatives are managed by their investment in board sustainability committee.

4.4.2 | Paris vs. Kyoto vs. Pre-Reform Climate Regimes

To assess the effects of global climate change reforms, Equations (1) and (2) are estimated for the following subsamples in this study: Paris (2022–2016), Kyoto (2015–2005), and pre-reforms (2004–2002). The results in Table 10[5] display a statistically significant link between all the independent variables EC, BSII and EC*BSII and the dependent variables GGMP and GHGE across the Paris and Kyoto subsamples. The findings also reveal a positive significant link between the interaction term $GGMP_{(t-1)}, * BSII_{(t-1)}$ and GHGE during the pre-reform era, whereas it indicates a negative coefficient in the Paris and Kyoto regimes. This implies that since the pre-reforms, firms have adopted robust board sustainable committees, thus emphasising the necessity of worldwide initiatives in enhancing awareness amid stakeholders and institutions about the detrimental effects of GHGE.

4.4.3 | Carbon Tax Implementation vs. Non-carbon Tax Implementation

Finally, the study estimates Equation (2) for countries with national carbon tax implementation. The findings show that countries with carbon tax policies make an effort to engage in corporate sustainability strategies such as EC and BSII (refer to Table S4). The analysis of firms operating under carbon tax regimes reveals that EC and the BSII significantly enhance GGMP and reduce GHGE. Specifically, in countries with carbon tax policies, EC shows a positive and significant impact on GGMP, indicating that regulatory pressures effectively align executive incentives with corporate sustainability goals. This finding is consistent with studies suggesting that financial incentives under stringent regulations drive substantive sustainability actions (Aguilera et al. 2021).

BSII also plays a critical role in these settings, as firms with strong sustainability governance are more likely to implement effective GGMP, highlighting BSII as a valuable resource that enhances corporate environmental performance (Haque and Ntim 2020). However, the negative interaction between EC and BSII suggests that complex dynamics may arise, where symbolic

TABLE 10 | The effects of executive compensation and board sustainability integration index on greenhouse gas management processes.

	Paris (2022–2016)			Kyoto (2015–2005)			Pre-reform (2004–2002)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Models	GGMP	GGMP	GGMP	GGMP	GGMP	GGMP	GGMP	GGMP	GGMP
EC	0.220***		0.576***	0.332***		0.357	0.303		0.356
	(5.18)		(4.89)	(5.41)		(0.14)	(1.31)		(1.26)
BSII		0.914***	1.861***		1.173***	1.289**		0.661	1.673**
		(4.94)	(6.47)		(6.38)	(2.34)		(1.15)	(2.07)
EC*BSII			−0.064**			0.053***			−0.066
			(−3.43)			(2.74)			(−0.47)
Observations	4463	4576	4463	5041	5307	5041	484	626	484
R-squared	0.369	0.503	0.505	0.446	0.678	0.684	0.048	0.108	0.151

Note: This table displays the regression results of the executive compensation and board sustainability committee integration index on greenhouse gas management process for three different regimes: Paris (2022–2016), Kyoto (2015–2005) and pre-reform (2004–2002). The definitions for all variables are provided in Table 2. The *t*-statistics calculated with robust standard errors are shown in brackets.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

actions could overshadow substantive measures, aligning with research on the challenges of integrating governance and compensation strategies (Berrone, Fosfuri, and Gelabert 2017).

In contrast, in non-carbon tax contexts, the impact of EC and BSII on both GGMP and GHGE is weaker and often not significant, highlighting the crucial role of regulatory enforcement in driving real environmental improvements. This aligns with findings by Damert, Paul, and Baumgartner (2017), who noted that in the absence of external pressures, firms are less likely to engage in substantial sustainability initiatives. The results suggest that regulatory frameworks like carbon taxes are vital in transforming corporate governance mechanisms into effective tools for environmental performance enhancement.

5 | Conclusion

The global community faces challenges in establishing sustainable business practices to enhance sustainability and lower GHGE. Various initiatives have been developed and implemented in the recent past by non-governmental bodies, policy organisations and governments with the aim of tackling climate change by reducing GHGE. These efforts include international agreements such as the Paris Agreement and the Net-Zero Coalition, which aim to reduce GHGE while encouraging sustainable economic practices. Nonetheless, there is minimal evidence on the potential of CG processes such as EC and BSII in tackling and/or mitigating climate change risks. This study aimed to remedy this void by evaluating the interrelationships between EC, BSII, GHGE, and GGMP utilising a dataset of 563 firms from 23 industries representing 12,999 firm-year observations from 2002 to 2022.

First, the results contribute to an emergent literature (Haque and Ntim 2020; Orazalin, Ntim, and Malagila 2024) by suggesting that EC has a positive impact on process-oriented carbon reduction initiatives such as GGMP but has no impact on actual GHGE, thereby confirming the symbolic legitimation view. Second, this study is one of the first to establish that engaging in GGMP does not necessarily reduce GHGE, further confirming the symbolic legitimation view. Third, firms that engage in symbolic GGMP may use CG instruments such as EC and BSII together as impression management tools to promote positive perceptions among stakeholders and protect their legitimacy. Thereby, highlighting the existence of a 'legitimacy gap.' This gap surfaces when the combined approach of EC and BSII fails to meet societal expectations for environmental performance, potentially undermining organisational legitimacy. The findings reflect the complexity of aligning business strategies, executive incentives, and sustainability goals. They suggest that although individual components of governance and compensation might be geared towards sustainability, their interaction can lead to conflicting outcomes, underscoring the need for careful alignment and integration of these aspects. This could occur if stakeholders perceive that the firm's sustainability efforts are not genuine or effective, especially when executive compensation is involved.

Our findings also have implications for international business managerial practice. The inductive insights from this study yield valuable lessons for firms in a challenging business environment regarding reducing carbon footprint. First, to ensure that GHGE is sufficiently integrated into the core business of firms, firms could consider actual GHGE cut related targets in compensation contracts, with the aim of motivating both boards and executives to achieve goals which will have a positive impact on climate threat. Second, firms are encouraged to be transparent and communicate the actual carbon emission reduction to their stakeholders, investors and the society. Such initiatives will promote trust, help them gain legitimacy and in so doing expose them to opportunities in different institutional and country environments.

Notwithstanding, our study has some limitations which provide opportunities for further research. First, due to data restrictions, this study captures the reporting structure of board sustainability committees rather than individual committee members attributes such as gender, educational degree, expertise, age, and cultural background. Second, the measures for EC, BSII, GHGE and GGMP might not accurately represent real-world practices. Future research could also explore which specific initiatives of board sustainability committees within the BSII are most influential. Finally, this study is limited to firms openly listed on stock exchanges across the globe. Therefore, future studies could examine the relationships within the scope of non-publicly listed firms.

Endnotes

[1] GHGP in this study refers to both GHGE and GGMP.

[2] Greenhouse gas management processes (GGMP) refer to executive-driven efforts encompassing actions, planning, frameworks, transparency measures and strategic policies aimed at mitigating the profound repercussions of climate change.

[3] Scope 1 encompasses emissions directly originating from sources owned or managed by the firm, whereas Scope 2 consists of indirect emissions stemming from the use of purchased electricity, cooling, heat, steam and similar sources. Higher positive greenhouse gas emissions (GHG) values signify elevated levels of greenhouse gas emissions, indicating weaker carbon performance and vice versa.

[4] For each variable, the variation inflation factor (VIF) is estimated. A VIF value larger than 10 suggests the presence of multicollinearity (Vatcheva et al. 2016). The results (unpublished) demonstrate that the largest VIF is 3.79 and the average VIF is 1.54, establishing that multicollinearity is not an issue in this investigation.

[5] See Table S3 for the results of Panels B and C investigating impacts of executive compensation, board sustainability integration index on greenhouse gas emissions and effects of greenhouse gas management processes and board sustainability integration index on greenhouse gas emissions.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.