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The Role of Circular Economy Entrepreneurship, Cleaner Production, and Green Government Subsidy for Achieving Sustainability Goals in Business Performance

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Abstract: In response to escalating environmental concerns and regulatory demands, this study investigates how circular economy entrepreneurship contributes to sustainability-oriented business performance, with a focus on the mediating role of cleaner production and the moderating role of green government subsidies. Drawing on institutional theory, the research examines how institutional pressures shape firms' adoption of sustainable practices within the Turkish manufacturing sector. A quantitative design was employed, using stratified random sampling to collect data from 383 firms across various industries. Structural equation modeling (PLS-SEM) was used to test the proposed relationships. The results reveal that circular economy entrepreneurship positively influences sustainability performance, primarily through the mediating effect of cleaner production practices. Furthermore, green government subsidies strengthen the impact of circular economy entrepreneurship on both cleaner production and sustainability outcomes, underscoring the importance of policy support in enhancing the effectiveness of eco-entrepreneurial initiatives. Practically, this study provides actionable insights for managers and policymakers seeking to integrate sustainability into strategic planning, technological investment, and regulatory design. By aligning entrepreneurial innovation with institutional incentives, firms can simultaneously achieve environmental responsibility and long-term competitive advantage.

Keywords: circular economy entrepreneurship; cleaner production; green government subsidies; institutional theory; sustainability performance; emerging markets; Turkish manufacturing

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1. Introduction

The global imperative for sustainable business models has intensified due to escalating climate change, resource depletion, and environmental degradation [1]. In this context, the circular economy (CE) has emerged as a transformative model aiming to decouple economic growth from resource use by promoting regenerative systems and eliminating waste [2,3]. Circular economy entrepreneurship (CEE), characterized by business models focusing on reuse, recycling, and product life extension, plays a pivotal role in this transition [4–6]. However, the success of such entrepreneurial ventures in contributing to sustainability hinges not only on visionary business strategies but also on practical implementation mechanisms and supportive institutional environments [7].

In Turkey, the integration of CE principles into business practices is still in its early stages [8,9]. Despite ratifying the Paris Agreement in 2021 [10], Turkey's progress on the Sustainable Development Goals (SDGs) remains uneven [11]. The country ranked 72nd out of 166 in the 2023 SDG Index, with significant shortfalls in responsible consumption and production (SDG 12), climate action (SDG 13), and industry innovation (SDG 9) [11–13]. This indicates that while sustainability transformation is underway, it is not sufficiently advanced to ensure competitiveness and long-term resilience, particularly within manufacturing sectors [14].

The Turkish manufacturing sector contributes nearly a quarter of the country's GDP and approximately 30% of national greenhouse gas emissions [15,16]. Industries such as textiles, food, automotive, and chemicals are resource-intensive and face substantial challenges in waste management, energy efficiency, and eco-innovation [17]. Cleaner production (CP) practices, designed to reduce environmental impacts at the source, are often underutilized due to technical, financial, and regulatory barriers [18,19]. While there are success stories, widespread adoption of CP remains limited, and efforts to link CE entrepreneurship with CP outcomes have yet to be institutionalized on a large scale [20].

In response to these challenges, the Turkish government has initiated steps to promote green transformation. The National Circular Economy Action Plan (2022–2027) outlines strategic goals in sustainable resource use, green innovation, and waste prevention [21,22]. Additionally, green government subsidies (GGSs) have been introduced to support cleaner technologies, eco-innovation, and low-carbon practices [23]. However, the reach and efficacy of these subsidies vary across sectors, and there is limited understanding of how GGS interacts with entrepreneurial initiatives to foster meaningful sustainability outcomes in Turkey.

Turkey's institutional environment presents a unique blend of regulatory pressures, stakeholder demands, and economic volatility [24]. While national sustainability regulations exist, they are often criticized for inconsistent enforcement and limited coordination among stakeholders, including investors, NGOs, and consumers [25,26]. These institutional complexities influence how Turkish firms respond to environmental challenges and whether they adopt transformative practices or maintain business-as-usual strategies [27]. Given these national dynamics, understanding the drivers and mechanisms of sustainability in Turkish firms is both timely and essential.

From a social science perspective, institutional theory posits that government policies and normative pressures significantly influence organizational behavior [28,29]. Accordingly, subsidies and policy incentives may function as enabling conditions that moderate the relationship between CEE and sustainable outcomes [30]. This study aims to explore how circular economy entrepreneurship influences sustainability goals in business performance, with a particular focus on the mediating role of cleaner production and the moderating influence of green government subsidies in the context of Turkey. Based on this overarching aim, this study is guided by the following research questions:

- RQ1: How does circular economy entrepreneurship influence sustainability goals in business performance?
- RQ2: To what extent does cleaner production mediate the relationship between circular economy entrepreneurship and sustainability goals in business performance?
- RQ3: How does green government subsidy moderate the direct relationship between circular economy entrepreneurship and sustainability goals in business performance?
- RQ4: How does green government subsidy moderate the relationships between circular economy entrepreneurship and cleaner production, and between cleaner production and sustainability goals in business performance?

This study makes three key contributions: First, it empirically tests a novel framework linking CEE, CP, and GGS to the sustainability goals of business performance—an underexplored configuration, particularly in emerging market contexts. Second, it enhances understanding of how cleaner production mediates the relationship between entrepreneurship and sustainability outcomes, offering new insights into operational mechanisms. Third, it addresses the contextual gap in the literature by examining how Turkey's national institutional environment, policy tools, and industrial dynamics affect sustainable entrepreneurship.

The remainder of this paper is structured as follows: Section 2 reviews the relevant literature and develops the study hypotheses. Section 3 presents the methodology, including data collection and measures. Section 4 reports the empirical results. Finally, Section 5 discusses the findings and their implications, and concludes this study and outlines future research directions.

2. Theoretical Framework and Hypotheses Development

2.1. Institutional Theory

Institutional theory highlights how external structures—such as regulatory frameworks, social norms, and professional standards—shape organizational behavior [28]. Firms respond to these influences through coercive (regulatory), normative (societal and professional), and mimetic (imitation) pressures to achieve legitimacy and social acceptance [31–33].

Organizations often reduce uncertainty by emulating successful peers and conforming to standards endorsed by influential stakeholders. These responses not only secure legitimacy but also enhance stakeholder trust and long-term competitiveness [34,35].

In the context of developing economies, institutional theory offers a valuable lens for understanding how government policies, industry norms, and societal expectations drive firms toward sustainable practices [36]. Firms that align with these pressures foster internal cultures supportive of environmental responsibility and sustainability [37]. By embedding such values, organizations shape employee beliefs and behaviors in ways that reinforce long-term sustainability goals.

2.2. Circular Economy Entrepreneurship

Circular Economy Entrepreneurship (CEE) refers to entrepreneurial activities aimed at identifying and exploiting opportunities that advance circular economy principles—such as resource efficiency, waste minimization, and regenerative practices—across the value chain [5,38,39]. It integrates environmental, economic, and social objectives by encouraging the development of business models that close material loops, extend product lifecycles, and promote sustainable production and consumption [40,41].

CEE extends beyond traditional entrepreneurship by enabling firms, particularly in manufacturing, to acquire circular knowledge, build technical capabilities, and develop eco-innovations that offer both competitive and sustainability advantages [5]. Collaboration with stakeholders further enhances access to resources, technologies, and markets aligned with circularity [41,42].

At its core, the circular economy prioritizes durability, restoration, and waste reduction, benefiting businesses and society alike [43]. However, implementing CEE remains challenging due to the need for systemic change and alignment with broader societal and environmental goals. National initiatives, such as Green Procurement Plans, reinforce this transition by encouraging sustainable purchasing and waste reduction [44,45].

In emerging markets like Turkey, CEE provides a strategic framework for manufacturing firms to enhance sustainability performance by aligning entrepreneurial action with circular principles [18,19]. Through the development of technical capacity and environmental responsiveness, CEE helps firms transition toward more sustainable and resilient business models [46].

2.3. Sustainability Goals of Business Performance

While production is vital for economic development—supporting livelihoods, reducing poverty, and generating employment—it also imposes environmental burdens through high resource consumption and pollution [47]. These negative impacts threaten sustainability goals such as climate action, biodiversity conservation, and access to clean water [48]. To address this, firms are increasingly expected to adopt environmentally responsible practices that balance economic objectives with ecological and social considerations [49].

One effective approach is the principle of "doing more with less", rooted in lean thinking [50]. Originally focused on reducing waste and improving efficiency, lean manufacturing has evolved to support environmental sustainability by minimizing overproduction, resource use, and emissions [51]. Although lean was not initially designed with ecological concerns in mind, its synergy with green practices has made it a strategic tool for integrating sustainability into production systems.

Thus, aligning operational efficiency with environmental responsibility contributes to sustainable business performance. Firms that embed these principles into their strategies can better meet sustainability targets while maintaining competitiveness.

2.4. Circular Economy Entrepreneurship and Sustainability Goals of Business Performance

CEE promotes sustainable innovation by designing business models that prioritize reuse, recycling, and resource efficiency [4–6]. Rather than relying on linear production systems, CEE ensures materials remain in circulation, thereby reducing environmental harm and enhancing long-term economic resilience [39]. This approach aligns with increasing societal expectations for businesses to balance profitability with ecological and social responsibility [52].

CEE not only supports environmental objectives but also contributes to job creation and community welfare through local repair, recycling, and remanufacturing initiatives [53]. By investing in green infrastructure—such as renewable energy, water conservation, and efficient logistics—firms can reduce their environmental footprint while fostering inclusive economic growth.

The circular economy framework aims to decouple growth from resource depletion by extending product lifecycles and closing resource loops [44,54]. This integrated approach to sustainability considers environmental, economic, and social dimensions. As emphasized in the United Nations' sustainability agenda, such holistic strategies are essential for achieving global development goals [55,56].

Institutional theory further explains how firms respond to societal pressures for responsible practices [28,29]. Businesses adopt CEE principles not only to comply with regulations but also to maintain legitimacy among stakeholders through transparency, innovation, and social engagement [37]. These strategic shifts often involve technological upgrades, process innovations, and the reconfiguration of operations to enhance both efficiency and performance.

Given that institutional pressures encourage firms to align with sustainable and circular practices, it is reasonable to expect a positive impact on sustainability-related business outcomes. Therefore, this study proposes the following hypothesis:

H1. *Circular economy entrepreneurship is positively related to the sustainability goals of business performance.*

2.5. Circular Economy Entrepreneurship and Cleaner Production

CEE plays a critical role in promoting cleaner production by enabling resource-efficient, low-waste operations. As a closed-loop system, the circular economy emphasizes minimizing waste and maximizing the reuse, recycling, and regeneration of materials, thereby ensuring continuous resource circulation and reducing environmental degradation [57]. Effective implementation of these principles requires robust regulatory frameworks and collaborative efforts across industries [58]. Several countries, including China, the United Kingdom, and EU member states, have introduced policies and incentives to support this transition [59].

In practice, cleaner production strategies include waste audits, reduced packaging, product redesign for durability and reusability, and the establishment of recycling systems [60]. These efforts reflect the core ethos of the circular economy—reduce, reuse, recycle—and contribute to reduced emissions, lower resource consumption, and improved operational efficiency [61]. In addition to enhancing environmental performance, such initiatives help firms lower production and disposal costs, improve product quality, and increase profitability [62].

Institutional theory offers a valuable framework for understanding how firms adapt their operations to meet environmental and societal expectations. It suggests that external pressures—particularly regulatory mandates and normative concerns—encourage businesses to align with sustainable practices that meet compliance standards and build long-term legitimacy [28,29]. In this context, firms are incentivized to adopt CEE practices that support ecological preservation and economic resilience. As Afum et al. [63] emphasize, the central objectives of such efforts include reducing waste, extending the lifecycle of resources, and improving ecosystem outcomes through sustainable design and innovation.

Given these considerations, CEE is positioned as a key enabler of cleaner production by driving systemic change across value chains and aligning business practices with ecological priorities. Therefore, this study proposes the following hypothesis:

H2. *Circular economy entrepreneurship is positively related to cleaner production.*

2.6. Cleaner Production and Sustainability Goals of Business Performance

Cleaner production is increasingly driven by institutional forces and stakeholder expectations that promote environmental accountability. Regulatory requirements, growing investor interest in sustainability, and consumer demand for eco-friendly products collectively motivate firms to implement cleaner production strategies [64]. These approaches not only reduce ecological harm but also strengthen corporate reputation and open access to emerging green markets [65].

Empirical studies have shown that cleaner production yields both environmental and financial advantages, particularly in resource-intensive industries such as metal mechanics, where recycling and waste reduction significantly lower operational costs [64,66,67]. While much of the research has focused on multinational corporations—owing to their visibility and regulatory exposure—the underlying motivations for adopting cleaner production, including compliance, improved transparency, and enhanced shareholder value, are relevant across all sectors [68,69].

This link between cleaner production and sustainability performance is underpinned by multiple theoretical perspectives. Stakeholder theory emphasizes that firms adopt sustainable practices to meet the diverse expectations of customers, investors, and communities [49]. Legitimacy theory suggests that these practices help organizations gain social approval and maintain their societal license to operate [70]. Institutional theory adds that firms align with prevailing norms and regulatory frameworks to enhance stability and legitimacy within their industries [28,29].

Taken together, these theoretical foundations and empirical insights highlight cleaner production as a pivotal mechanism through which firms advance their sustainability goals. Therefore, this study proposes the following hypothesis:

H3. *Cleaner production is positively related to the sustainability goals of business performance*.

2.7. The Mediating Mechanism of Cleaner Production

Cleaner production encompasses environmentally responsible operational strategies aimed at reducing a firm's ecological footprint while simultaneously enhancing efficiency and lowering costs [71]. By minimizing emissions, waste, and resource use, cleaner production also improves organizational transparency and reduces the risk of greenwashing—where firms exaggerate or misrepresent their environmental performance [62].

Circular economy practices foster the adoption of cleaner production by promoting closed-loop systems centered on recycling, reuse, and remanufacturing [72]. These strategies help reduce resource dependency and environmental degradation, thereby aligning environmental goals with economic efficiency.

As sustainability becomes a strategic concern, especially in light of growing consumer demand for environmentally responsible products, cleaner production emerges as a competitive necessity. Evidence suggests that green creativity and eco-innovation are key enablers of such practices, allowing for firms to create sustainable solutions that attract eco-conscious consumers while enhancing brand value and market positioning [60,73,74].

From a theoretical standpoint, institutional theory offers a useful lens through which to understand how regulatory, normative, and cultural pressures drive organizations to internalize sustainability values [28,29]. In response, firms adopt cleaner production as a strategic means to conform to societal expectations, enhance legitimacy, and achieve performance outcomes aligned with sustainability objectives [65].

Given this, cleaner production is conceptualized as a mediating mechanism that links CEE to the sustainability goals of business performance. Therefore, this study proposes the following hypothesis:

H4. *Cleaner production mediates the positive relationship between circular economy entrepreneurship and the sustainability goals of business performance*.

2.8. The Moderating Role of Green Government Subsidies

Green government subsidies play a pivotal role in fostering sustainable innovation by reducing financial barriers and mitigating the risks associated with green technology adoption [75,76]. These subsidies, which often support research and development, cleaner technologies, and sustainable infrastructure, help make environmentally friendly solutions more accessible and economically viable. By offsetting the high initial costs typically involved in eco-innovation, government support encourages firms to invest in cleaner production methods and circular practices [77].

Within the framework of institutional theory, government subsidies represent coercive institutional pressures—regulatory mechanisms that compel organizations to align with sustainability mandates [28]. Normative influences from professional networks and sustainability standards, alongside mimetic pressures to emulate successful industry practices, further shape firms' strategic orientation toward green innovation [78,79]. In such a landscape, government incentives function not only as financial enablers but also as legitimizing forces that reinforce the integration of circular economy principles and cleaner production practices.

Subsidies may also affect the strength and direction of the relationship between CEE and key sustainability outcomes. When public support is substantial, firms are more likely to intensify their commitment to environmental goals and adopt cleaner technologies in response to institutional expectations [60,80]. Conversely, in contexts where subsidies are limited or absent, the translation of CEE into measurable sustainability outcomes may be constrained.

Accordingly, this study proposes the following hypotheses to explore the moderating role of green government subsidies in these relationships:

H5. *Green government subsidies positively moderate the relationship between circular economy entrepreneurship and cleaner production.*

H6. *Green government subsidies positively moderate the relationship between circular economy entrepreneurship and the sustainability goals of business performance.*

H7. *Green government subsidies negatively moderate the relationship between cleaner production and the sustainability goals of business performance.*

Figure 1 below presents the proposed conceptual framework, illustrating the hypothesized relationships among CEE, cleaner production, sustainability goals of business performance, and the moderating role of green government subsidies.

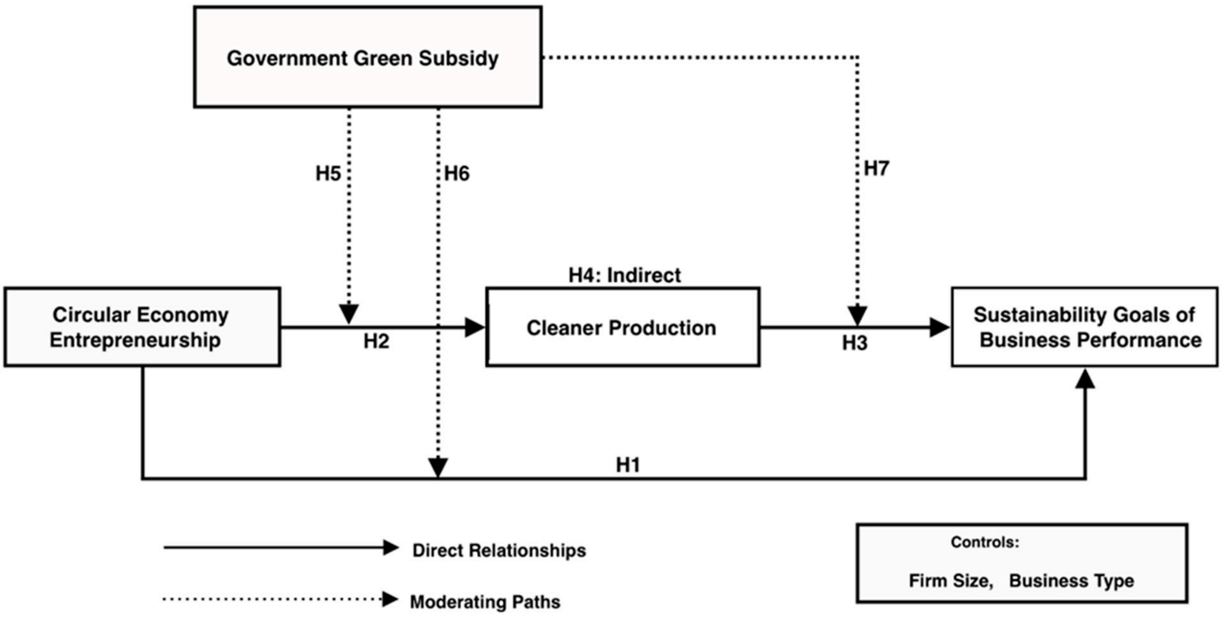

Figure 1. Conceptual model.

3. Research Methods

3.1. Sample and Data Collection

Turkey serves as a highly appropriate context for investigating the intersections of CEE, cleaner production, and sustainability goals in the manufacturing sector. As a G20 economy positioned at the crossroads of Europe, Asia, and Africa, Turkey plays a pivotal role in global trade and supply chain networks [81]. In this context, firms face increasing pressures from governments and other stakeholders to adopt sustainable practices and comply with environmental regulations [82,83]. Beyond these pressures, Turkey's unique socio-economic and institutional landscape aligns with calls to diversify research beyond commonly studied emerging markets [8]. These factors underscore Turkey's significance for exploring cleaner production and sustainability transitions [14].

The sample for this study focuses on medium- and large-sized manufacturing firms in Turkey, as these firms possess the resources and infrastructure needed for integrating circular economy principles and cleaner production strategies [49,81,84,85]. We used the Union of Chambers and Commodity Exchanges of Turkey (TOBB) database as the sampling frame [86]. This database is a comprehensive source of industrial data, including over 40,000 registered firms across diverse manufacturing industries [87]. As a key nongovernmental organization in Turkey, TOBB provides essential information in a country where alternative firm-level data sources are often incomplete or fragmented [88]. Following a rigorous screening process to identify firms actively engaged in manufacturing and innovative activities, we randomly sampled 800 firms to ensure broad generalizability of the results.

The survey was designed following Dillman's [89] tailored design method to enhance response quality and reduce bias. A total of 2500 questionnaires were distributed to 800 manufacturing firms, targeting multiple respondents (two to four) per firm. Respondents were selected based on their managerial roles, decision-making authority, and knowledge of their organizations' sustainability, innovation, and production activities [81]. The inclusion of multiple respondents per firm was critical to improving data validity by capturing a broader organizational perspective [90]. Furthermore, the survey emphasized engaging managers actively involved in or overseeing sustainability initiatives, ensuring the relevance of the collected data to the study objectives.

Data collection occurred from March to July 2024, supplemented by reminder emails, yielding a total of 402 completed questionnaires, of which 383 were deemed usable. This resulted in an effective response rate of 15.3%. Although this response rate appears modest, it aligns with previous studies in organizational research that target high-level managerial respondents in industrial contexts [91].

To assess the possibility of non-response bias, we conducted an analysis comparing early and late respondents, as recommended by Armstrong and Overton [92]. No significant differences were found in the means of key study variables, indicating no evidence of non-response bias. Additionally, we compared responding and non-responding firms based on available data regarding industry representation and firm size (number of employees) and found no statistically significant discrepancies. A Chi-squared test of industry distribution confirmed that the respondent firms did not differ significantly from the target population. These results reinforce the representativeness of the final sample and support the generalizability of the findings across the Turkish manufacturing sector.

The final sample exhibits considerable diversity, encompassing firms from various manufacturing sectors, including "automotive and industrial equipment" (11.2%), "machinery, steel, iron, and metal" (3.1%), "apparel, clothing, and textile" (9.1%), "pharmaceuticals, chemical, and medicine" (6.5%), "wood, forestry, and construction products" (4.7%), "paper, food, and beverage" (32.4%), "plastics, ceramics, glass, and cement" (19.6%), "consumer electrical, electronics, and durables products" (8.9%), and "other manufacturing" (4.4%). This sectoral distribution ensures that the findings reflect the complexity and heterogeneity of sustainability and cleaner production practices across industries. Table 1 presents the characteristics of this study's 383 valid respondents and responding companies.

Table 1. Demographics of respondents.

Characteristics		**Frequency**	**%**
Managerial level	Lower-level managers	105	27.4
	Middle-level manager	209	54.6
	Top-level managers	69	18

Table 1. *Cont.*

Characteristics		Frequency	%
Educational level	High school	21	5.5
	Undergraduate	221	57.7
	Master	87	22.7
	PhD	54	14.1
Tenure (years)	Less than 5 years	71	18.5
	5–10	128	33.4
	11–20	111	29
	More than 20 years	73	19.1
Industry type (manufacturing)	Automotive and industrial equipment	43	11.2
	Machinery, steel, iron, and metal	12	3.1
	Apparel, clothing, and textile	35	9.1
	Pharmaceuticals, chemicals, and medicine	25	6.5
	Wood, forestry, and construction products	18	4.7
	Paper, food, and beverage	124	32.4
	Plastics, ceramics, glass, and cement	75	19.6
	Consumer electrical, electronics, and durables products	34	8.9
	Other manufacturing	17	4.4
Firm size (no. of employees)	50–249	73	19.1
	250–500	81	21.1
	501–1000	88	23
	1001–5000	79	20.6
	>5000	62	16.2
Total		**383**	**100%**

3.2. Measurements

To ensure the accuracy and reliability of the data, the measurement process in this study followed rigorous and well-established protocols. A structured questionnaire served as the primary data collection instrument, employing the back-translation method [93]. This method involved translating the original English questionnaire into Turkish and then back-translating it into English to verify the equivalence of meaning. This ensured linguistic and cultural appropriateness of the questionnaire for the target sample. The Turkish version of the survey was further validated through a pre-testing procedure [94].

Before final dissemination, a pilot survey was conducted with participants whose characteristics were representative of this study's target population. This step further ensured the instrument's face validity and helped refine the wording of items based on feedback [94]. All constructs in this study were measured using a 7-point Likert scale, ranging from 1 = "strongly disagree" to 7 = "strongly agree". Managerial perceptions served as the basis for evaluation, providing insight into the firms' capabilities, mechanisms, and processes, an approach validated in prior studies [49,86,90,95,96].

The constructs employed in this research were operationalized using scales adapted from the extant literature. Circular economy entrepreneurship was measured using a 5-item scale grounded in the recent studies [5,38,39]. The concept of cleaner production, encapsulating environmentally sustainable manufacturing practices, was assessed using a 4-item scale adapted from previous research [60,61,63]. To measure green government subsidy, a construct that reflects state-supported incentives for green initiatives, a 4-item scale from prior studies [75–77] was employed. Lastly, sustainability goals of firm performance, addressing economic, social, and environmental dimensions, were captured with an 8-item scale based on the works of previous studies [52,70,97]. Additionally, firm size and industry type were incorporated as control variables to address potential confounding effects [81,86,90]. All items used in this study with their corresponding constructs are shown in Table 2.

Table 2. Item scale measurement.

Constructs/Indicators	Sources
Circular economy entrepreneurship (CEE)	[5,38,39]
CEE1. We keep in mind that our primary purpose is to discover and capitalize on new chances in the closed-loop economy.	
CEE2. We recognize that our key responsibility is to improve resource efficiency.	
CEE3. We contemplate that our primary responsibility is to enhance sustainable economic, social, and environmental values.	
CEE4. We believe that our fundamental obligation is to sustainably improve the overall performance of the manufacturing value chain.	
CEE5. We consider that our major mission is to help achieve worldwide and national sustainable development objectives.	
Cleaner Production (CP)	[60,61,63]
CP1. Our firm uses clean and more energy efficient technologies in capacity decisions.	
CP2. Our firm uses less or non-polluting/toxic materials that are environmentally friendly.	
CP3. Our production processes focus on using clean, recyclable and reusable materials.	
CP4. Our firm redesign production and operation processes to improve environmental efficiency.	
Green government subsidy (GGS)	[75–77]
GGS1. Tax incentives.	
GSS2. Funding.	
GSS3. Fuel subsidies.	
GSS4. Subsidies to reduce emissions.	
Sustainability goals of business performance (SGBP)	[52,70,97]
SGBP1. Consumption of primary resources decreases over time.	
SGBP2. The extent of conversion to using recycled materials rises over time.	
SGBP3. The extent of waste declines over time.	
SGBP4. Greenhouse gas emissions reduce over time.	
SGBP5. We provide stable employment for society and the community over time.	
SGBP6. Over time, more is done to advance social well-being.	
SGBP7. Our operating costs decrease over time.	
SGBP8. Financial performance escalates over time.	

3.3. Common Method Bias

To mitigate common method bias (CMB), a combination of procedural and statistical measures was employed [98]. Procedurally, questionnaire items were randomized to minimize response biases, and respondents were assured of confidentiality and anonymity, encouraging candid answers [99]. Additionally, multiple responses were obtained from each firm (2–4 managers), enhancing data reliability and reducing the risk of single-source bias [100]. Statistically, Harman's single-factor test indicated that a single factor accounted for 38.25% of the total variance, below the acceptable threshold of 50%, confirming that CMB was not a major issue [101]. As mentioned before, non-response bias was assessed using Armstrong and Overton's [92] independent t-test approach, which showed no significant differences between early and late respondents. Moreover, the Kaiser–Meyer–Olkin (KMO = 0.908) and Bartlett's test of sphericity ($p < 0.001$) confirmed the adequacy of the sample for factor analysis and ruled out any issues with high intercorrelations [102]. These comprehensive steps ensure the validity and reliability of the findings.

4. Analysis and Results

4.1. Data Analysis Procedure

This study employed Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS 4.1.0.9 to test the hypothesized relationships and validate the research model. PLS-SEM is a variance-based statistical technique that is particularly suitable for studies focused on prediction and theory development, as opposed to purely confirmatory analysis seen in covariance-based SEM [103,104]. Its ability to handle complex structural relationships and non-normal data distributions, often associated with Likert-scale survey instruments, makes it ideal for research in operation and production [105,106]. By adopting a two-stage approach [107], this study first evaluated the measurement model to ensure construct reliability and validity, followed by an assessment of the structural model to examine direct, indirect, and moderating effects [103]. PLS-SEM's capability to assess predictive accuracy and statistical relevance across intricate models underscores its value in advancing research in circular supply chain management [52,108].

4.2. Measurement Model Estimation

The measurement model estimation was carried out to evaluate the psychometric properties of the constructs and ensure the reliability and validity of this study's indicators. Reliability was assessed through composite reliability (CR) and Cronbach's alpha (CA), both of which must meet or exceed the threshold of 0.70 to ensure consistency within constructs [103,109]. As shown in Table 3, the CR values ranged from 0.870 to 0.908, and CA values ranged from 0.818 to 0.884, thereby confirming strong internal reliability [110]. Additionally, indicator reliability was verified through factor loadings (FLs), which fell between 0.707 and 0.862, surpassing the acceptable cutoff of 0.70 [105].

Table 3. Assessment of the measurement model.

Construct/Indicators	FL	Means	Standard Deviation	VIFs	CA	CR	AVE
Circular economy entrepreneurship (CEE)					0.818	0.870	0.574
CEE1	0.717	5.462	1.441	2.022			
CEE2	0.841	5.329	1.352	2.180			
CEE3	0.772	5.559	1.311	2.379			
CEE4	0.778	5.209	1.380	1.784			
CEE5	0.766	5.762	1.268	1.222			

Table 3. *Cont.*

Construct/Indicators	FL	Means	Standard Deviation	VIFs	CA	CR	AVE
Cleaner production (CP)					0.854	0.901	0.694
CP1	0.862	5.219	1.236	2.069			
CP2	0.858	5.042	1.234	2.264			
CP3	0.801	4.661	1.384	1.904			
CP4	0.809	5.047	1.276	1.708			
Green government subsidy (GGS)					0.865	0.908	0.711
GGS1	0.858	5.298	1.250	2.272			
GGS2	0.835	5.337	1.215	2.154			
GGS3	0.847	5.407	1.225	2.022			
GSS4	0.832	5.117	1.282	1.888			
Sustainability goals of business performance (SGBP)					0.884	0.906	0.551
SGBP1	0.751	5.345	1.372	2.229			
SGBP2	0.761	5.439	1.385	2.447			
SGBP3	0.768	5.948	1.051	1.979			
SGBP4	0.707	5.303	1.482	1.727			
SGBP5	0.709	5.757	1.275	1.733			
SGBP6	0.750	5.723	1.173	1.924			
SGBP7	0.781	5.666	1.312	2.131			
SGBP8	0.710	5.641	1.116	1.627			

Note(s): factor loading (FL), variance inflation factors (VIFs), Cronbach's alpha (CA), composite reliability (CR), average variance extracted (AVE).

Convergent validity was determined by average variance extracted (AVE), with a threshold of >0.50 indicating that the constructs capture a sufficient amount of variance from their indicators [111]. All AVE values ranged from 0.551 to 0.711, demonstrating satisfactory convergent validity across constructs. To confirm discriminant validity, the Heterotrait/Monotrait (HTMT) ratio was applied [112], as it provides a robust evaluation of construct distinctiveness. As shown in Table 4, all HTMT values were between 0.409 and 0.694, well within the acceptable limit of <0.85 [103,110,113], confirming adequate discriminant validity. Overall, the results from the measurement model estimation indicated that the constructs are both reliable and valid, with no serious psychometric issues identified. These findings provide a strong foundation for structural model analysis.

Table 4. HTMT discriminant validity.

Constructs	1	2	3	4
1. Circular economy entrepreneurship	0			
2. Cleaner production	0.409	0		
3. Green government subsidy	0.694	0.460	0	
4. Sustainability goals of business performance	0.573	0.515	0.645	0

4.3. Goodness of Fit Analysis

The structural model's goodness of fit was assessed using multiple criteria to confirm its adequacy and predictive strength. First, the model demonstrated explanatory power [114], with R^2 values indicating that it accounted for 21.2% of the variance in cleaner production and 45.2% in the sustainability goals of business performance (Figure 2). Predictive relevance, evaluated using Q^2 values through the blindfolding procedure, exceeded zero for both constructs, with $Q^2 = 0.184$ for cleaner production and $Q^2 = 0.362$ for sustainability goals, establishing sufficient predictive relevance [103,115]. The effect size (f^2) analysis revealed a moderate impact of circular economy entrepreneurship on sustainability goals ($f^2 = 0.184$) and small effects on cleaner production ($f^2 = 0.089$) and its indirect influence on sustainability goals ($f^2 = 0.096$), following guidelines by Benitez et al. [110].

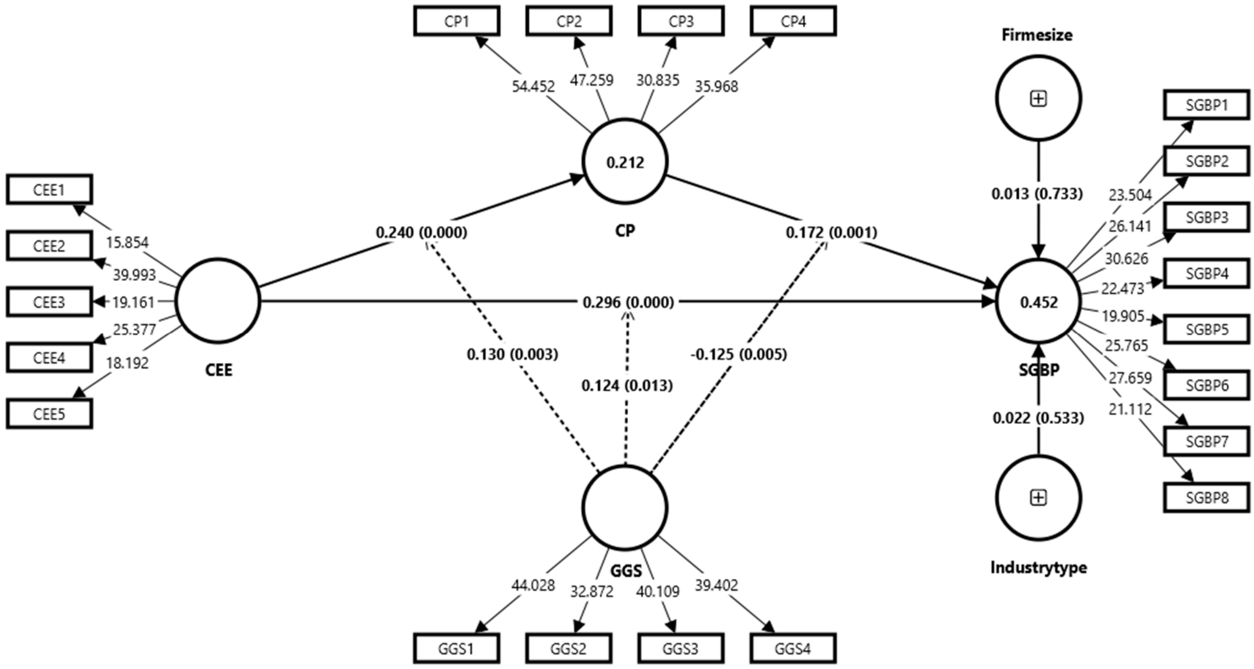

Figure 2. Structural model results. Note: Solid arrows indicate significant direct relationships, while dashed arrows represent indirect or mediating effects. Path coefficients (β) and *p*-values are shown along each path. The ⊕ symbol denotes control variables (Firm size and Industry type).

Furthermore, the model achieved a GoF value of 0.46 (large fit) and satisfied the thresholds for SRMR (0.055) and NFI (0.928), indicating a strong model fit [103,116–118]. Specifically, the goodness of fit (GoF) index, developed by Tenenhaus et al. [119] and extended by Wetzels et al. [118], represents the geometric mean of the average communality and the average R^2 of endogenous variables. A GoF value above 0.36 is considered large; thus, the current model's GoF = 0.46 suggests a robust global model fit.

The Standardized Root Mean Square Residual (SRMR) reflects the difference between the observed and predicted correlations; values below 0.08 suggest an acceptable model fit [103,116]. The obtained SRMR of 0.055 meets this threshold, confirming minimal residual discrepancies. Similarly, the Normed Fit Index (NFI) compares the model to a null model, with values above 0.90 indicating good fit [103]. The model's NFI value of 0.928 exceeds the recommended threshold, reinforcing its adequacy.

Multicollinearity was ruled out as VIF values ranged between 1.222 and 2.447 (Table 3), below the acceptable threshold of 3.3 [120]. These results collectively validate the robustness of the model in explaining cleaner production and sustainability goals.

4.4. Structural Model Estimation

The structural model was examined to evaluate the hypothesized relationships using bootstrapping procedures [103,121]. This analysis confirmed that all path coefficients were statistically significant ($p < 0.05$), with confidence intervals excluding zero, providing robust support for all hypotheses (Table 5). Specifically, the results indicate that circular economy entrepreneurship positively influences both sustainability goals of business performance (β = 0.296, t = 4.760, $p < 0.001$) and cleaner production (β = 0.240, t = 3.889, $p < 0.001$), confirming Hypotheses 1 and 2, respectively. Additionally, cleaner production was found to have a significant positive impact on sustainability goals of business performance (β = 0.172, t = 3.253, $p < 0.010$), supporting Hypothesis 3. These results highlight the pivotal role of circular economy practices in achieving sustainability outcomes through resource optimization and innovation. Further, cleaner production demonstrated a mediating effect between circular economy entrepreneurship and sustainability goals of business performance (β = 0.368, t = 9.531, $p < 0.05$), confirming Hypothesis 4. This mediation is reinforced by confidence intervals ([CI2.5% = 0.012, CI97.5% = 0.182]), which exclude zero. Hypotheses 1–4 were further verified.

Table 5. Hypotheses testing results.

Path	Coefficient	*t*-Statistics	CI2.5%	CI97.5%	*p*-Value	Result
H1: CEE → SGBP	0.296 ***	4.760	0.189	0.435	0.000	Supported
H2: CEE → CP	0.240 ***	3.889	0.123	0.367	0.000	Supported
H3: CP → SGBP	0.172 **	3.253	0.065	0.272	0.001	Supported
H4: CEE → CP → SGBP	0.041 *	2.319	0.012	0.182	0.020	Supported
H5: CEE x GGS → CP	0.130 **	2.965	0.047	0.220	0.003	Supported
H6: CEE x GGS → SGBP	0.124 *	2.489	0.014	0.213	0.013	Supported
H7: CP x GGS → SGBP	−0.125 **	2.788	−0.220	−0.042	0.005	Supported

Note(s): circular economy entrepreneurship (CEE), cleaner production (CP), green government subsidy (GGS), sustainability goals of business performance (SGBP), confidence intervals (CIs), * $p \leq 0.050$, ** $p \leq 0.010$, *** $p \leq 0.001$.

Moderating effects of green government subsidies were also evaluated. Table 5 provides evidence supporting Hypothesis 5, where green government subsidies positively moderated the relationship between circular economy entrepreneurship and cleaner production (β = 0.130, $p < 0.010$). Similarly, Hypothesis 6 is supported, showing a positive moderation effect of green government subsidies on the relationship between circular economy entrepreneurship and sustainability goals of business performance (β = 0.124, $p < 0.05$). Figures 3 and 4 depict these moderations, highlighting that higher subsidies amplify the positive influence of circular economy entrepreneurship.

Interestingly, Hypothesis 7 reveals a contrasting dynamic, with green government subsidies negatively moderating the link between cleaner production and sustainability goals of business performance (β = −0.125, $p < 0.010$). Figure 5 illustrates this interaction, where the relationship between cleaner production and sustainability goals is stronger under lower subsidy levels, suggesting the potential for diminishing returns from high subsidies. These shows the nuanced impacts of policy interventions in advancing sustainable practices. Taken together, the results indicate that circular economy entrepreneurship and cleaner production are vital for achieving sustainability goals. However, the interplay of external subsidies must be carefully managed to optimize their positive effects without undermining intrinsic sustainability efforts.

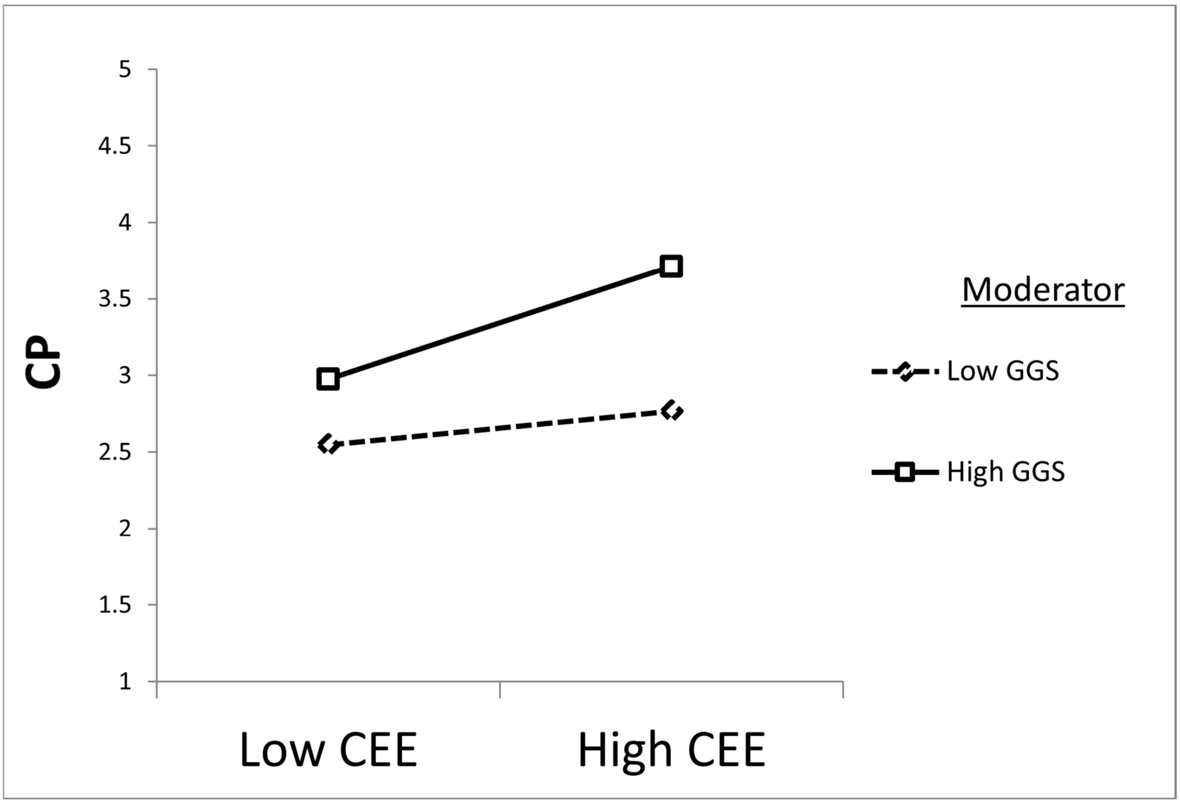

Figure 3. Moderating effect of green government subsidy (GGS) on circular economy entrepreneurship (CEE) and cleaner production (CP).

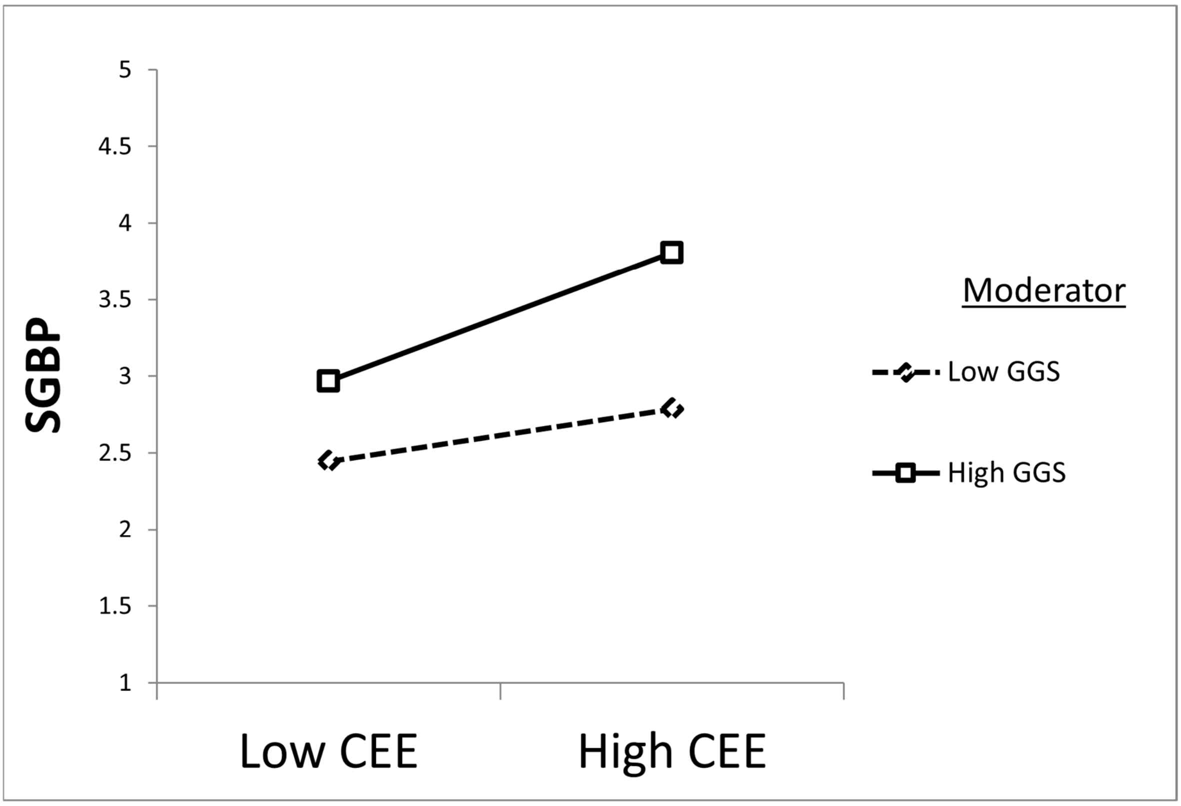

Figure 4. Moderating effect of green government subsidy (GGS) on circular economy entrepreneurship (CEE) and sustainability goals of business performance (SGBP).

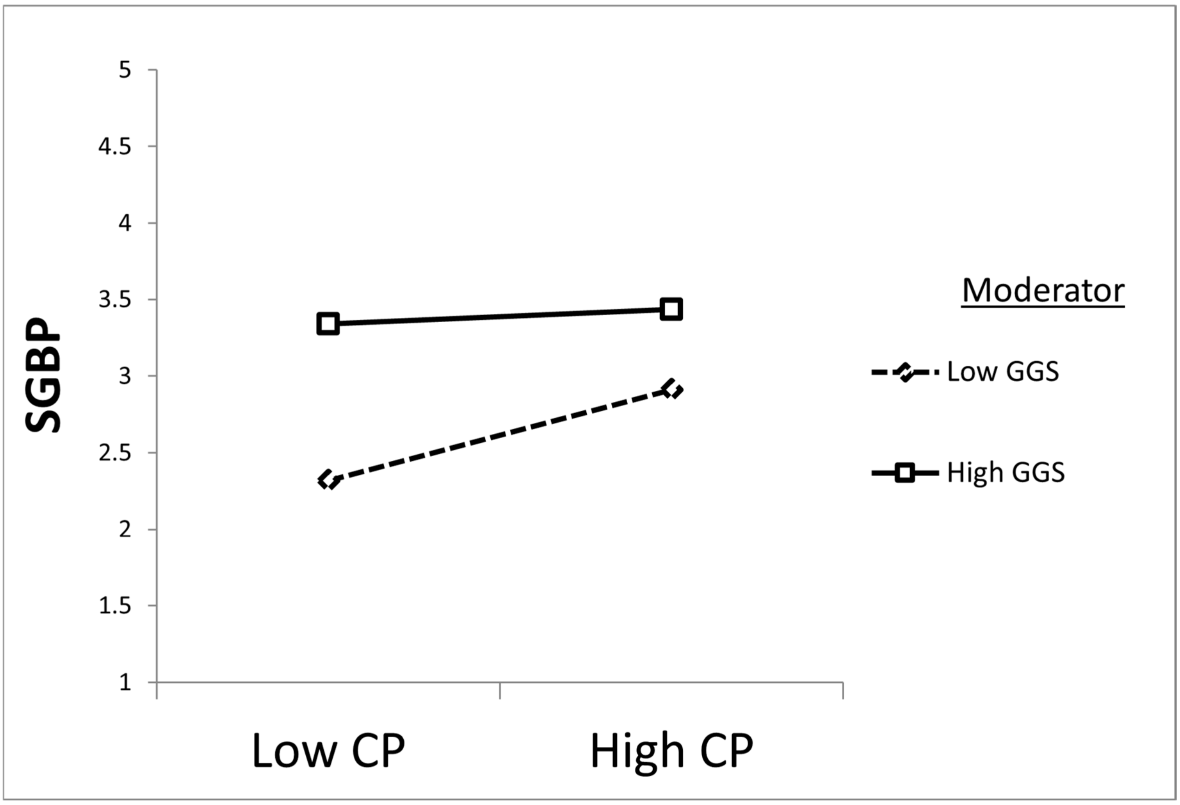

Figure 5. Moderating effect of green government subsidy (GGS) on cleaner production (CP) and sustainability goals of business performance (SGBP).

5. Discussion and Implications

5.1. Discussion of Key Findings

This study offers empirical evidence on how circular economy entrepreneurship, cleaner production, and green government subsidies collectively shape sustainability-oriented business performance. The findings confirm that circular economy entrepreneurship significantly contributes to achieving sustainability goals (H1), supporting earlier research on the role of entrepreneurial innovation in sustainable development to gain competitive advantage [18,122]. The circular economy model—centered on resource efficiency, waste minimization, and innovative business models—has emerged as a strategic framework for firms aiming to enhance both environmental and competitive performance [3]. Consistent with García-Quevedo et al. [58], this study reveals that firms engaging in circular economy practices are better positioned to gain competitive advantages through improved resource utilization and environmental responsibility.

Beyond this direct effect, the results show that circular economy entrepreneurship also exerts an indirect impact on sustainability performance through cleaner production (H2), highlighting the mediating role of resource optimization and technological innovation. The significant positive influence of cleaner production on sustainability goals (H3) aligns with Semlali et al. [62], who observed that firms adopting cleaner production practices experience enhanced environmental and economic outcomes. Despite the financial and technical barriers to cleaner production adoption [65], the findings emphasize that overcoming these challenges—especially through innovation and policy support—can lead to substantial gains in sustainable performance.

Furthermore, cleaner production is found to mediate the relationship between circular economy entrepreneurship and sustainability performance (H4), illustrating how operational practices translate strategic intentions into tangible outcomes. This aligns with earlier studies [62,65], which note that institutional pressures compel firms to adopt responsible environmental practices. Cleaner production thus acts as a crucial link, enabling firms to minimize environmental harm while enhancing efficiency [60]. This finding reinforces the view that the realization of sustainability goals depends not just on strategic orientation, but also on the operational integration of environmentally sound practices.

This study also underscores the role of green government subsidies as a contextual enabler. These subsidies significantly strengthen the relationship between circular economy entrepreneurship and cleaner production (H5), affirming earlier research that financial incentives and policy support are vital for fostering green innovation [123]. Additionally, green subsidies enhance the effect of circular economy entrepreneurship on sustainability performance (H6), consistent with Qin et al. [124], who emphasized the role of government interventions in creating long-term sustainable advantages.

Unexpectedly, this study finds a negative moderating effect of green government subsidies on the relationship between cleaner production and sustainability performance (H7). This suggests that excessive reliance on external funding may reduce firms' intrinsic motivation for sustainability. Through an institutional theory lens, this could reflect a shift from proactive strategies to compliance-driven behavior [28,34], potentially leading to symbolic adoption of sustainability practices rather than substantive integration [35]. Thus, while subsidies can catalyze initial adoption, lasting impact may require strengthening firms' internal capabilities and long-term commitment to cleaner production.

Lastly, this study highlights that firm-specific characteristics—such as size, ownership, and industry—affect sustainability practices in emerging economies. This supports findings by Khaled et al. [70], suggesting that institutional contexts and stakeholder pressures influence the rigor and scope of sustainability adoption. Variations in sustainability engagement reflect differences in legitimacy concerns, competitive dynamics, and sector-specific expectations.

In sum, this study contributes to the circular economy and sustainability literature by revealing how entrepreneurial initiatives, production practices, and institutional support interact to drive sustainable performance. By integrating institutional, financial, and environmental perspectives, this study offers actionable insights for policymakers, managers, and entrepreneurs navigating sustainability transitions in emerging markets.

5.2. Theoretical Implications

This study contributes to institutional theory by demonstrating how external institutional pressures—such as green government subsidies, cleaner production initiatives, and circular economy entrepreneurship—shape firms' sustainability-oriented business performance. Institutional theory emphasizes that organizations are shaped by regulatory frameworks, societal expectations, and normative standards, which compel them to adopt sustainable practices to gain legitimacy [28,29]. This research shows that green government subsidies act as both coercive and normative mechanisms, simultaneously enforcing and reinforcing sustainable production practices as industry norms. Firms that align with these institutional forces not only enhance environmental performance but also secure long-term competitive advantages in sustainability-driven markets.

A key theoretical contribution lies in expanding the understanding of hybrid legitimacy within institutional theory. Rather than conforming to a single institutional logic, firms are seen navigating multiple, and often conflicting, institutional expectations to achieve broader societal acceptance. Circular economy entrepreneurship emerges as a strategic mechanism through which organizations respond to diverse stakeholder demands while embedding sustainability into their operations [5,38,39]. Supporting this view, Kahupi et al. [37] found that firms often adopt circular economy initiatives in response to regulatory and normative pressures, reinforcing the critical role of institutional mechanisms in driving sustainable transformations.

Furthermore, this study illustrates the process of institutional isomorphism, where firms operating in similar regulatory contexts adopt comparable sustainability practices to maintain legitimacy. As noted by Krell et al. [34], this results in increased homogeneity across firms, contributing to the widespread diffusion of sustainability-oriented business models. The findings reaffirm that institutional constraints and enablers frequently outweigh internal strategic discretion in shaping sustainability agendas.

Importantly, this research identifies a paradoxical effect within institutional mechanisms. While green government subsidies strengthen the relationship between circular economy entrepreneurship and cleaner production, they weaken the link between cleaner production and sustainability performance. This unexpected moderation effect highlights an important gap in the literature. From an institutional perspective, it suggests that excessive dependence on external incentives can undermine intrinsic motivations for sustainability. This supports the concept of institutional decoupling, where organizations symbolically adopt sustainability practices to meet legitimacy expectations without achieving meaningful operational integration [28,35]. Consequently, this study underscores the need to design policy mechanisms that foster both compliance and authentic engagement with sustainability objectives.

Additionally, this research contributes to theoretical discourse on the circular economy as a transformative framework. Rather than being a mere tool for resource efficiency, the circular economy represents a systems-based model that promotes sustainable value creation through waste minimization, material reuse, and closed-loop supply chains [44,125]. In sum, this study extends institutional theory by clarifying how external regulatory, normative, and cultural pressures influence firm behavior in sustainability contexts. It reveals the dual role of institutional mechanisms as both enablers and potential inhibitors of substantive change. By highlighting the complex interactions between circular economy entrepreneurship, cleaner production, and institutional support, this study deepens our theoretical understanding of how firms internalize sustainability as a core strategic imperative in the face of evolving institutional expectations.

5.3. Managerial Implications

The findings of this study offer important managerial insights for businesses, policymakers, and industry stakeholders aiming to advance sustainability through circular economy entrepreneurship, cleaner production, and green government subsidies. As firms encounter growing regulatory demands and consumer expectations, it is imperative that managers embed circular economy principles into strategic planning to secure long-term competitiveness and environmental stewardship.

From a business perspective, adopting circular economy models yields notable advantages, including improved resource efficiency, cost reduction, and enhanced brand image [126]. Leading firms such as IKEA and Philips exemplify this approach by integrating product take-back schemes, recycled materials, and durable product designs—initiatives that combine environmental sustainability with market differentiation [127–131]. Turkish textile manufacturers, similarly, have implemented closed-loop recycling systems to meet sustainability demands in export markets [18,61,132].

To operationalize sustainability, managers should adopt a structured approach that includes (1) establishing clear goals aligned with circular economy principles, (2) investing in cleaner production technologies, (3) training staff in eco-innovation, and (4) using sustainability metrics for performance monitoring [72,133–135]. These actions not only ensure regulatory compliance but also create pathways for innovation, resource optimization, and access to green financing.

For policymakers, the design of green subsidies and regulatory frameworks should aim to foster long-term sustainability rather than short-term compliance. While financial incentives are essential for reducing initial investment barriers [126,136], performance-based policies that reward sustained improvement are more effective. Collaboration through public–private partnerships can amplify these efforts [137]. Importantly, policy instruments must reflect firm size. SMEs, often constrained by limited resources, require simplified access to financing, tax relief, and targeted training, whereas large firms may respond better to regulations that encourage transparent sustainability reporting and investment in circular supply chains.

Entrepreneurial firms—especially in emerging economies—should prioritize interorganizational collaboration. Partnerships with larger companies can enable knowledge sharing, technological adoption, and the scaling of circular models [138]. Active participation in industry networks can also facilitate best practice exchange and promote sector-level solutions. Enhancing supply chain coordination is equally vital, as cleaner production methods applied across networks can lead to substantial gains in efficiency and waste reduction [139]. Recognizing the financial and technical hurdles SMEs face, institutional support mechanisms must be tailored accordingly. Sector-specific guidance—particularly for industries like textiles, food processing, electronics, and automotive manufacturing—can ensure that sustainability practices remain relevant and feasible across diverse contexts [135].

Additionally, this study's findings underscore the predictive relevance of the proposed model, supported by positive Q^2 values. This affirms that the model is not only explanatory but also practically applicable [103], guiding firms toward improved environmental and operational outcomes. It highlights the strategic value of the model for decision-making, especially for firms seeking sustainable competitive advantage in dynamic markets [140].

In conclusion, achieving sustainability through circular economy entrepreneurship, cleaner production, and policy support requires coordinated efforts from businesses, regulators, and industry actors. Managers must integrate sustainability into business fundamentals, while policymakers should incentivize continuous improvement and capacity-building. Systemic collaboration will be key to creating a resilient, inclusive, and resource-efficient industrial ecosystem.

5.4. Limitations and Future Research Directions

This study offers significant insights into how circular economy entrepreneurship, cleaner production, and green government subsidies contribute to business sustainability; however, several limitations must be acknowledged. The generalizability of the findings is constrained by industry- and region-specific differences in regulatory settings, market conditions, and cultural orientations toward sustainability [126]. This study may not fully capture the complex, dynamic interactions among the key constructs, particularly the long-term effects of sustainability strategies on firm performance, as benefits like resource efficiency and brand reputation often accrue gradually. Additionally, data constraints may have limited the ability to reflect firm-level heterogeneity and external moderators, such as technological shifts and evolving policies. To advance this research stream, future studies should employ longitudinal and comparative designs across various sectors and institutional contexts, integrate qualitative methods to uncover the contextual drivers behind firms' sustainability transitions, and explore the enabling role of emerging digital technologies—such as AI and blockchain—in supporting cleaner production and circular economy implementation [141,142]. These approaches will enrich our understanding of sustainable entrepreneurship's evolving impact on organizational outcomes.

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