**Waste management, green initiatives, and financial distress in heavily regulated environmental contexts: Evidence from the United Kingdom**

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**Abstract**

**Purpose**

This paper empirically examines the effects of waste management (*WM*) practices on financial distress (*FD*) in a heavily regulated environmental context and investigates the moderating role of green initiatives (*GINVs*) on the *WM*—*FD* relationship.

**Design/methodology/approach**

The study uses a sample of 1,667 firm years of UK-based companies from 2002 to 2021 and applies a panel regression analysis controlling for industry- and year-fixed effects. Data on *WM*, *GINVs*, and governance are sourced from LSEG (formerly known as Refinitiv Asset4 ESG), whereas financial data are collected from WorldScope. The study also adopts alternative measures for *FD* and *WM* practices and employs a two-stage least squares (*2SLS*) analysis and the Heckman selection model as robustness checks.

**Findings**

The findings reveal that *FD* levels decrease significantly when waste generation declines and waste recycling increases, suggesting that firms with better *WM* practices have lower *FD* levels. The results further show the moderating effect of *GINVs* on the link between waste generation and *FD* and suggest that increased *GINVs* are effective in reducing *FD* by mitigating waste levels. However, waste recycling and *GINVs* are found to have a substitutive effect on *FD*. The findings remain robust to the use of alternative measures and endogeneity issues.

**Originality/value**

This work is among the first to investigate the *WM*—*FD* nexus and highlights the importance of effective *WM* practices in improving the financial sustainability of UK firms. The study also extends prior research by testing the moderating impact of *GINVs* and suggests that firms need to carefully balance their green initiatives with waste recycling efforts to achieve optimal financial sustainability in a heavily regulated environmental context, such as the UK.

**Keywords** Waste management, Financial distress, Green initiatives, Climate change, Regulated environment, UK

**1. Introduction**

Climate change issues are complex and multidimensional, resulting from rapidly increasing carbon emissions and harmful chemicals, thus becoming a global threat to natural ecosystems and society (Konadu *et al.*, 2022; Uyar *et al.*, 2023). With increasing levels of waste around the globe, the situation has worsened even more (Gull *et al.*, 2022b; Gull *et al.*, 2024). As a major contributor to climate change, businesses are the main sources of increasing waste levels worldwide (Uyar *et al.*, 2023) and also play a key role in either protecting or harming the environment (Benjamin *et al.*, 2023). Therefore, implementing effective waste management (*WM*) practices that aim to mitigate waste generation and promote waste recycling has become one of the major environmental solutions for protecting the environment (Gull *et al.*, 2022a; Gull *et al.*, 2024) and achieving sustainability (Das *et al.*, 2019; Wijaya *et al.*, 2023).

Past research suggests that environmental performance practices, including *WM*, may improve profitability (Issa, 2023; Simionescu *et al.*, 2020), increase market value (Gull *et al.*, 2022a; Orazalin *et al.*, 2024), and reduce risks (Jia and Li, 2022). Although *WM* is an integral part of corporate environmental performance, its unique aspects can lead to distinct financial outcomes when compared to general environmental practices. In particular, *WM* practices are costly to implement and take a longer time to create stakeholder values (Gull *et al.*, 2024). Since proactive *WM* practices are more appealing to environmentally sensitive investors, resulting in different growth and market value than holistic environmental practices (Gull *et al.*, 2022a), *WM* can also lead to different financial results through market perceptions. In addition, unlike subjective environmental performance ratings determined by various rating agencies, *WM* metrics are actual, measurable, and objective indicators of environmental impacts (Gull *et al.*, 2024). Therefore, it is crucial to assess the financial consequences of waste generation and mitigation/recycling. Given that effective *WM* can reduce litigation costs, enhance corporate reputation, and mitigate operational risks (Gull *et al.*, 2022a; Gull *et al.*, 2024), *WM* is expected to result in positive financial results.

Because modern businesses face tremendous challenges when dealing with climate issues, adapting to volatile business environments, maintaining competitive advantages, and improving financial sustainability at the same time (Anton, 2024; Orazalin *et al.*, 2024), it is unclear whether and how *WM* influences financial risks (Agyei-Boapeah *et al.*, 2023). Financial distress (*FD*), which is defined as a firm’s inability to meet its financial obligations, has attracted a growing interest among scholars (Gerged *et al.*, 2023). In particular, related research (Agyei-Boapeah *et al.*, 2023; Boubaker *et al.*, 2020; Jia and Li, 2022; Orazalin *et al.*, 2023; Rahman *et al.*, 2023; Shahab *et al.*, 2018) has assessed the role of CSR/environmental performance in improving financial stability. However, the above/past investigations have mainly focused on the broader aspects of CSR/environmental performance. Given that a firm’s actual environmental performance also depends on waste generation and recycling, it is important to assess whether corporate *WM* practices influence *FD* levels. Although the role of sustainable *WM* practices in improving corporate sustainability has been recognized in the literature (Das *et al.*, 2019; Wijaya *et al.*, 2023), prior research has paid limited attention to whether *WM* practices have a financial risk-reducing effect. Thus, our work aims to fill this research gap by investigating whether *WM* practices affect *FD* risks.

While past research (Boubaker *et al.*, 2020; Gull *et al.*, 2022a; Simionescu *et al.*, 2020) has mainly focused on the direct effects of CSR/environmental performance on firm financial performance, the roles of corporate green initiatives (*GINVs*) in improving *WM* and mitigating *FD* risks, especially within heavily regulated environmental contexts have been largely neglected. Although corporate environmental efforts in the form of *GINVs* may enhance environmental sustainability (Anton, 2024; Molina-Azorín *et al.*, 2009; Radu and Francoeur, 2017) by improving *WM* practices (Simionescu *et al.*, 2020), more research is needed to assess whether environmental strategies, such as *GINVs*, affect environmental and economic outcomes (Uyar *et al.*, 2023). Given the roles of environmental initiatives and green practices in determining corporate sustainability (Albitar *et al.*, 2023; Wijaya *et al.*, 2023), new insights into the impacts of *GINVs* on *WM* and *FD* are necessary in order to assist key stakeholders in assessing the effectiveness and roles of firm-level environmental efforts/initiatives in reducing climate risks/treats and spurring sustainability (Uyar *et al.*, 2023). Hence, our work seeks to extend the environmental and *FD* literature by assessing whether *GINVs* moderate the *WM*—*FD* link.

We select the UK as a research context for two main reasons. First, the UK is one of the most heavily regulated environmental contexts in the world, with short- and long-term financial implications for businesses. In particular, the UK is among the first nations that recognized a climate emergency, supported the Paris Agreement, and set the goals/targets of achieving net-zero emissions by 2050. In 2008, the UK government adopted the Climate Change Act and updated it in 2019 by incorporating new targets (Albitar *et al.*, 2023), thus making the UK the first major economy in the world to create a legally binding commitment. However, given that UK firms are still major contributors to global warming, the UK, along with other nations, has to fight climate change for many years to come. Second, global investors are becoming increasingly concerned about firms’ environmental responsibility and financial stability (Jia and Li, 2022). Thus, it is worth investigating the economic consequences of *WM* and *GINVs* in the UK to inform and assist regulators and policymakers on these matters. Second, the market participants have witnessed a rising number of UK firms facing financial distress issues in recent years. For example, Wilko, one of the largest UK retailers, went into administration in August 2023 due to insolvency issues, shocking the market. This supports the notion that corporate *FD* has become a global issue, adversely affecting not only emerging economies but also developed nations (Gerged *et al.*, 2023).

Consequently, using a sample of 1,667 firm-years from UK firms from 2002 to 2021, this study explores the effects of *WM* practices on *FD* and tests the moderating role of *GINVs* from the stakeholder theory perspective. The results suggest that effective *WM* practices in the form of reduced waste generation and increased waste recycling lead to lower *FD* risks, thus supporting the stakeholder viewpoint. Further, the moderation analysis shows that improved *GINVs* weaken the adverse financial effects of waste generation, thus highlighting the importance of corporate green initiatives/strategies in shaping environmental and financial sustainability. Finally, the results show that while both waste recycling and *GINVs* reduce *FD* levels, the effect of waste recycling on *FD* is reduced when corporate engagement in *GINVs* increases. This evidence suggests that both operational waste recycling and strategic *GINVs* are equally important in mitigating financial risks and have a substitutive effect on *FD* levels. The findings remain robust to adopting alternative measures and performing the 2SLS and Heckman estimations to control for endogeneity concerns.

This work contributes to the environmental and *FD* literature in several respects. First, it extends available research (Boubaker *et al.*, 2020; Hsu and Chen, 2015; Molina-Azorín *et al.*, 2009; Shahab *et al.*, 2018) by empirically examining the impact of *WM* on *FD* in the regulated market, such as the UK. Although past studies (Jia and Li, 2022; Orazalin *et al.*, 2023) have extensively examined the link between CSR/environmental performance and *FD*, the impact of *WM* practices on *FD* is still largely unexplored. Using several *WM* proxies and relevant *FD* measures, the study suggests that effective *WM* practices are essential for ensuring financial sustainability. Second, this study is among the first to test whether *GINVs* moderate the link between *WM* and *FD*. Although few studies (Gull *et al.*, 2022a; Simionescu *et al.*, 2020; Wijaya *et al.*, 2023) have examined the effects of *WM* practices on firm performance, empirical evidence on the ability of *GINVs* to moderate the nexus between *WM* and *FD* is limited. The results suggest that a firm’s commitment to *GINVs* plays a key role in mitigating waste and reducing *FD* risks. Finally, the results provide new insights for executives and regulators concerned about climate-related risks/threats associated with increasing waste levels, and advise business entities to manage/mitigate their financial risks by proactively engaging in *WM* practices. The findings also suggest that firms seeking to achieve optimal financial sustainability need to carefully balance their green initiatives with their waste recycling efforts.

The remainder of the study is presented in four sections. Section 2 reviews related research and develops hypotheses. Section 3 discusses the research methodology. Section 4 presents and discusses the results. Section 5 concludes the paper.

**2. Theory, empirical literature review, and hypotheses development**

***2.1 Theoretical framework***

We explore the links among *GINVs*, *WM*, and *FD* from the stakeholder theory perspective. Within this theoretical framework, corporate commitment to environmental practices/initiatives can enhance financial sustainability by balancing/meeting the interests of all diverse stakeholders, including regulatory bodies, communities, customers, investors, and employees (Freeman, 1984). Specifically, firms’ abilities to promote sustainable development are associated with their relationships with influential stakeholders (Donaldson and Preston, 1995), and therefore, satisfying stakeholder needs/demands for environmental accountability results in the effective allocation and use of strategic resources, thereby improving financial results (Agyei-Boapeah *et al.*, 2023; Berman *et al.*, 1999; Deb *et al.*, 2023). Since firms with higher climate risks tend to face greater sanctions, lawsuits, and penalties, proactive *WM* can mitigate reputational damage and financial losses (Gull *et al.*, 2022a; Wijaya *et al.*, 2023). Further, effective *WM* indicates a commitment to environmental stewardship, which can reduce *FD* risks by building trust among stakeholders. Additionally, firms with improved *WM* practices may be perceived as financially stable by global investors due to the low possibility of environmental risks/threats (Gull *et al.*, 2024; Gull *et al.*, 2022b). Thus, the stakeholder viewpoint supports the development and implementation of proactive *WM* initiatives/practices to improve stakeholder relationships, enhance corporate image/reputation, and create favorable financing opportunities that may ultimately lead to lower *FD* risks (Jia and Li, 2022; Konadu *et al.*, 2022).

Stakeholder theory also provides insights into the effects of green initiatives on environmental performance and financial stability. In particular, the stakeholder view suggests that environmental/green initiatives, such as adopting green technologies, renewable energy systems, sustainable activities/practices, can reduce waste levels and disposal costs, thereby lessening the financial burden associated with environmental risks (Orazalin *et al.*, 2024). Such efforts demonstrate corporate commitment to climate issues and responsiveness to both financial and environmental stakeholder needs and eventually reduce operating and compliance costs, thus mitigating *FD* risks (Albitar *et al.*, 2023; Orazalin *et al.*, 2023). Proactive innovations, such as *GINVs*, are also effective strategies to enhance environmental accountability and financial sustainability because they can mitigate reputational risks and attract environmentally conscious stakeholders (Gull *et al.*, 2022a), which may ultimately lead to a reduction in *FD* levels. From the stakeholder theory perspective, related studies (Albitar *et al.*, 2023; Uyar *et al.*, 2023) suggest that the implementation of proactive environmental initiatives/strategies in the form of *GINVs* help firms mitigate climate risks/threats, foster stakeholder relationships, and improve financial performance. Hence, the stakeholder view suggests that eco-innovative firms are likely to have effective *WM* practices, which in turn may reduce *FD* risks.

***2.2 Empirical literature review and hypotheses development***

*2.2.1 Waste management and financial distress*

As mentioned earlier, stakeholder theory (Berman *et al.*, 1999; Donaldson and Preston, 1995) posits that improved *WM* activities/practices may eventually lead to reduced financial risks. In particular, given that stakeholders place more confidence and trust in firms that are actively pursuing environmental initiatives to reduce waste levels (Shahab *et al.*, 2022), enhancing actual environmental performance, such as *WM*, enables firms to establish/maintain positive stakeholder relationships, attract funding from environmentally responsible investors, reduce financial risks, and improve sustainability (Jia and Li, 2022; Orazalin *et al.*, 2023). Consistent with this view, prior research (Agyei-Boapeah *et al.*, 2023; Jia and Li, 2022) suggests that stakeholder-oriented firms can mitigate *FD* levels and ultimately improve financial stability by increasing their environmental engagement and enhancing environmental sustainability. Hence, the stakeholder view predicts that implementing effective environmental initiatives/strategies, including *WM* practices, would help businesses respond to stakeholder demands/expectations for sustainable development, gain/maintain competitive advantages, and ultimately enhance financial sustainability, thus suggesting that effective *WM* results in lower *FD*.

Empirically, available studies have mainly reported that greater CSR/environmental performance is linked to reduced financial constraints/risks. For example, Shahab *et al.* (2018) find that improved environmental performance serves as a risk-mitigating tool and significantly decreases *FD* levels in China. Similarly, Jia and Li (2022) document that Australian firms with higher environmental performance face lower *FD* probability. Other investigations (Agyei-Boapeah *et al.*, 2023; Boubaker *et al.*, 2020; Hsu and Chen, 2015; Orazalin *et al.*, 2023) have also revealed that improving CSR/environmental performance can reduce *FD* risks. Nevertheless, the above/prior studies have assessed the broader aspects of CSR and environmental performance without assessing the possible effects of specific WM performance indicators, such as waste generation and recycling, on *FD*. As for *WM,* Gull *et al.* (2022a) report that reduced waste production and improved waste recycling have a positive impact on firm performance. Other studies have also demonstrated that sustainable *WM* practices improve organizational performance (Simionescu *et al.*, 2020; Wijaya *et al.*, 2023). However, these studies have mainly focused on financial indicators, such as profitability and Tobin’s Q, without assessing *FD* risks. Therefore, we seek to extend the literature by exploring the *WM*—*FD* nexus. Based on stakeholder views and the above discussion, we expect that firms with better *WM* practices have lower *FD* levels in a heavily regulated environmental context, such as the UK. Hence, the following hypotheses are stated:

*H1a*: Waste generation increases financial distress.

*H1b*: Waste recycling reduces finance distress.

*2.2.2 Moderating role of green initiatives*

Past empirical studies assessing corporate environmental performance and financial stability have mainly investigated the direct impacts of CSR/environmental performance on *FD* levels (Agyei-Boapeah *et al.*, 2023; Jia and Li, 2022; Orazalin *et al.*, 2023; Shahab *et al.*, 2018). However, these investigations have not considered the possible moderating impact of *GINVs* on the *WM*—*FD* nexus. Proactive environmental innovations/strategies in the form of *GINVs* refer to the development of eco-designed products/services and the implementation of innovative technologies and sustainable processes/practices that aim to mitigate environmental impacts and improve resource efficiency (Ha *et al.*, 2024). These initiatives enable firms to reduce emissions and decrease waste levels while creating stakeholder values and gaining competitive advantages (Gull *et al.*, 2022a; Uyar *et al.*, 2023). According to the stakeholder viewpoint (Donaldson and Preston, 1995; Freeman, 1984), firms need to invest in climate-related projects and introduce environmental innovations aimed at enhancing environmental and financial sustainability in order to meet the interests/needs of a wide range of stakeholders. In this regard, *GINVs* serve as an effective environmental strategy to enhance environmental performance and improve financial outcomes (Albitar *et al.*, 2023; Gull *et al.*, 2022a).

Prior research suggests that *GINVs* can enhance environmental transparency (Radu and Francoeur, 2017), reduce carbon emissions (Konadu *et al.*, 2022), and prevent/mitigate excessive waste generation (Uyar *et al.*, 2023), thus creating sustainable values for organizational stakeholders. Additionally, *GINVs* may serve as an environmental strategy, influencing the link between environmental performance and financial results (Farza *et al.*, 2021; Ha *et al.*, 2024). As noted by past research (Albitar *et al.*, 2023; Amores-Salvadó *et al.*, 2014; Issa, 2023), eco-friendly green transformation initiatives offer several benefits, such as allocating efficiently economic resources, improving production and energy efficiency, mitigating environmental risks/threats, and ultimately enhancing corporate resilience to financial risks. Taking into account the importance of environmental innovations in shaping environmental and financial performance, we seek to extend the existing literature by testing how *GINVs* moderate the impacts of waste generation and recycling on *FD* risks in a heavily regulated environmental setting. Given the stakeholder view and the above discussion, we expect that corporate investments in *GINVs* are likely to influence the link between *WM* and *FD* levels. Accordingly, the following hypotheses are proposed:

*H2a*: Green initiatives moderate the link between waste generation and financial distress.

*H2b*: Green initiatives moderate the link between waste recycling and financial distress.

**3. Methodology**

*3.1 Sample and data*

The initial sample included 14,780 firm-years from all UK-listed firms with available ESG data covered by LSEG (formerly known as Refinitiv Asset4 ESG) from 2002 to 2021.[[1]](#footnote-1) Financial sector firms with 3,020 firm-years were removed from the dataset due to their unique reporting practices and specific regulatory environments. Then, 9,716 firm-years with missing waste generation data were eliminated, leaving the firms with at least five consecutive years of data. Finally, 377 firm-years with missing and insufficient data on other variables were dropped, resulting in the final sample of 1,667 firm-years. Data on waste generation and recycling, green initiatives, and board governance were retrieved from LSEG, whereas accounting characteristics were collected from the WorldScope database. Appendix 1 displays the industry-wide distribution of the final sample.

*3.2 Variables and measures*

To assess financial distress (FD), we employ Altman (1968)’s score (Z\_ALT), which is estimated in Equation (1). We then use the Z\_UK score model developed by Almamy *et al.* (2016) for the UK market and estimate it in Equation (2). By incorporating operating cash flows, this model extends Altman (1968)’s original Z-score and predicts UK firms’ financial health more accurately and effectively (Almamy *et al.*, 2016).

*Z\_ALT=1.2\*W+1.4\*R+3.3\*E+0.6\*M+0.999\*S*

(1)

*Z\_UK=1.484\*W+0.043\*R+0.390\*E+0.004\*M+0.424\*S+0.750\*CF*

(2)

where, W = working capital/total assets, R = retained earnings/total assets, E = earnings before interest and taxation/total assets, M = market value of equity/total liabilities, S = sales/total assets, and CF = cash flows from operating activities/total assets. Higher *Z\_UK* and *Z\_ALT* scores indicate decreased *FD* levels and increased financial stability, and vice versa.

Further, we measure waste management (*WM*) using several proxies. Specifically, following past research (Gull *et al.*, 2022b; Shahab *et al.*, 2022), waste generation (*WAST*) is measured as the ratio of the total waste generated to total assets. Higher *WAST* values indicate greater levels of waste. In addition, waste recycling (*WREC*), calculated as the ratio of waste recycled to total waste, is adopted to assess a firm’s waste mitigation efforts. In the robustness analysis, we also measure waste, calculated as the ratio of the total amount of waste to total sales, following Gull *et al.* (2022b).

Finally, we estimate green initiatives (*GINVs*) using extensive environmental data points from LSEG. Following past literature (Nadeem *et al.*, 2020; Orazalin *et al.*, 2024), we identify 21 environmental indicators, which reflect a firm’s initiatives/strategies to protect ecosystems, reduce, reuse, phase out or substitute emissions and/or toxic chemicals, and promote efficient use of natural resources by designing green products/services, adopting new environmental technologies, implementing renewable energy systems, and introducing environmentally sustainable activities/practices. Each indicator equals one if a firm has undertaken an associated initiative/strategy. We then assess *GINVs* by totaling the above 21 indicators to determine the *GINVs* score for each firm. Higher *GINVs* values indicate greater engagement in green transformation initiatives/strategies.[[2]](#footnote-2)

*3.3 Empirical model*

To test the hypotheses, the study employs the following panel-regression model:

*FDit=α+β1WMit+β2WMit\*GINVsit+β3GINVSit+βjControlsit+ɛit*

(3)

where, for firm *i* at time *t, FDit* represents financial distress (Z\_UK score)*, WM* represents either *WAST* or *WREC, GINVs* represent green initiatives, and *Controls*represent the control variables. Consistent with the moderation analysis approach used in past research (Albitar *et al.*, 2023; Uyar *et al.*, 2023), we estimate the *WM\*GINVS* variable, representing the interaction term between *WM* and *GINVs,* to test the moderating impact of *GINVs*.[[3]](#footnote-3) Following related studies (Boubaker *et al.*, 2020; Jia and Li, 2022; Rahman *et al.*, 2023; Shahab *et al.*, 2018), we also incorporate a set of control variables that may influence *FD*. These control variables include board size (*BSIZE*), board gender diversity (*BGDIV*), board independence (*BINDR*), firm age (*FAGE*), firm size (*SIZE*), profitability (*PROF*), leverage (*LVRG*), slack (*SLCK*), and capital intensity (*CPIN*). The study also controls for year and industry effects to account for variations across years and industries. To control heteroskedasticity, the study uses robust standard errors clustered at the firm-year level. Table 2 displays the definitions/measurements of all the variables.[[4]](#footnote-4)

**4. Results and discussion**

*4.1 Descriptive statistics*

Table 2 reports the descriptive results and correlation coefficients. On average, the *Z\_UK* and *Z\_ALT* scores for UK firms are 0.61 and 1.61, respectively. The average of the *GINVs* variable is 9.68. The mean values of *WAST* and *WREC* are 1.06 and 62.45%, respectively. Overall, the statistics of *WAST* and *WREC* are comparable with those of *WM*-related studies (Gull *et al.*, 2022a; Gull *et al.*, 2024; Uyar *et al.*, 2023). Regarding the control variables, the means of *BSIZE*, *BGDIV*, *BINDR*, *FAGE*, *SIZE*, *PROF*, *LVRG*, *SLCK*, and *CPIN* are 9.73, 20.30%, 61.63%, 38.05, 15.72, 0.07, 27.13%, 0.09, and 0.36, respectively. The statistics of the controls are generally consistent with those of recent UK-based studies (Albitar *et al.*, 2023; Gerged *et al.*, 2023; Mahran and Elamer, 2024). Further, Table 3 displays that the correlation coefficients among the independent variables do not exceed 0.700, implying no serious multicollinearity issues. The estimated variance inflation factors (VIFs) also verify that multicollinearity is not an issue in this study because the VIFs are far below the cut-off value of 10 (to conserve space, the VIFs are not reported but are available upon request).

*4.2 Regression results*

Table 4 displays the regression results for the links among waste management, green initiatives, and financial distress. As shown in Columns 1 and 3, *WAST* has a negative association with *Z\_UK* (*p* < 0.01) and *Z\_ALT* (*p* < 0.01), indicating that waste generation increases *FD* probability, consistent with *H1a*.[[5]](#footnote-5) In other words, firms with reduced levels of waste have lower *FD*. It also aligns with past investigations (Jia and Li, 2022; Shahab *et al.*, 2018) that better environmental performance leads to lower *FD* risks. Further, Columns 2 and 4 display that the coefficients of *WREC* are positive and significant (*p* < 0.01), implying that waste recycling decreases *FD* risks, consistent with *H1b.* This evidence suggests that firms highly committed to climate mitigation through increased waste recycling have lower *FD* levels. Taken together, the results from the regression analysis imply that firms with improved *WM* practices (reduced levels of waste generation and increased levels of recycled waste) exhibit lower *FD* risks. They also support the stakeholder view (Donaldson and Preston, 1995; Freeman, 1984; Jia and Li, 2022) in that effective environmental activities/practices, such as *WM*, help firms establish/maintain positive stakeholder relationships, enhance stakeholders’ trust, attract green investments, improve sustainability, and provide ‘shields’ against negative financial outcomes, thus resulting in lower *FD* risks.

Columns 1-4 (Table 5) further show that *GINVs* are positive and significant with *Z\_UK* (*p* < 0.01) and *Z\_ALT* (*p* < 0.01), indicating that green initiatives decrease *FD*. In other words, firms with increased eco-friendly green transformation initiatives have lower *FD* risks. Further, *WAST\*GINVs* is significantly positive with *Z\_UK* (*p* < 0.05) and *Z\_ALT* (*p* < 0.01), implying that *GINVs* positively moderate the *WAST*–*Z\_UK* and the *WAST*–*Z\_ALT* relationships, in line with *H2a*. As shown in Figures 1 and 2, the blue line (for lower *GINVs*) implies that as waste levels increase, the *Z\_UK* and *Z\_ALT* scores decrease, whereas the red line (for higher *GINVs*) indicates that improved *GINVs* neutralize the adverse financial effects of waste generation. These findings suggest that increased green initiatives are effective in reducing *FD* probability by mitigating waste levels. This is consistent with the notion that improved environmental performance achieved by effective corporate practices may lead to better financial outcomes (Deb *et al.*, 2023; Gull *et al.*, 2022b). In addition, this evidence corroborates the stakeholder viewpoint (Albitar *et al.*, 2023) that *GINVs* serve as an effective environmental strategy to reduce *FD* risks through a reduction in waste levels.

Finally, the interaction term *WREC\*GINVs* is negative and significant with *Z\_UK* (*p* < 0.01) and *Z\_ALT* (*p* < 0.01), indicating that the positive impact of waste recycling on Z\_UK is reduced when green initiatives are introduced. As displayed in Figures 3 and 4, the upward (for lower *GINVs*) and downward sloping (for higher *GINVs*) lines verify the moderating effect of *GINVs* on the relationship between *WREC* and *FD* risks. More specifically, while both waste recycling and green initiatives reduce *FD* levels, the effect of waste recycling on *FD* is less pronounced when proactive green initiatives are adopted. This evidence indicates that both waste recycling and green initiatives serve as substitutes and supports the viewpoint that certain corporate efforts/practices become more effective when others fail to improve organizational performance (Hussain *et al.*, 2021). This could be attributable to resource allocation complexities, conflicting sustainability-related priorities, and/or increased costs related to implementing both recycling practices and green initiatives simultaneously. Overall, the results suggest that although both operational recycling and strategic green initiatives are equally important in mitigating financial risks, firms need to carefully balance them to achieve optimal financial sustainability. As for the control variables, in line with past research (Ali *et al.*, 2023; Boubaker *et al.*, 2020; Jia and Li, 2022; Shahab *et al.*, 2018), board size, firm size, leverage, and capital intensity show a negative association with the *Z\_UK* and *Z\_ALT* scores, while gender diversity, firm age, profitability, and slack are positively related to the scores.

*4.3 Further analysis*

To verify the substitution effects of recycling practices and green initiatives, we further examine whether the relationship between waste generation and *FD* is also contingent on waste recycling. Hence, we estimate the effect of the interaction between *WAST* and *WREC* (*WAST*\**WREC*) on *FD*. The results in Table 6 show that *WAST*\**WREC* is positively associated with *Z\_UK* (*p* < 0.05) and *Z\_ALT* (*p* < 0.01), implying that waste recycling reduces the negative impact of waste generation on financial stability. In other words, when a firm engages in waste recycling, it can substantially reduce generated waste levels and, therefore, lower *FD* risks. Overall, this finding suggests that sustainable environmental practices, such as waste recycling, are vital to reducing waste levels and increasing financial sustainability.

*4.4 Robustness checks*

In this section, we perform several robustness tests to assess the validity of the main results. First, we use alternative measures for *FD* and waste generation and re-estimate the model. In particular, following (Agyei-Boapeah *et al.*, 2023; Shelih and Wang, 2023), we employ the *KZ\_IND* index, proposed by Kaplan and Zingales (1997), to assess *FD*. The *KZ\_IND* index is estimated as follows:

*KZ\_IND=-1.002\*CF+0.283\*M+3.139\*TD-39.368\*DIV-1.315\*C*

(4)

where, *CF* = cash flows from operating activities/total assets*t-1*, *M* = market value/total assets*t-1*, *TD* = total debt/total assets*t-1*, *DIV* = dividends/total assets*t-1*, and *C* = Cash/total assets*t-1*. High *KZ\_IND* values indicate increased *FD* levels, and vice versa.[[6]](#footnote-6) Following Gull *et al.* (2022b), we then measure waste generation as the ratio of the total amount of waste to total sales *(WSAL)*. Table 7 presents the regression results using the *KZ\_IND* (Panel A) and *WSAL* (Panel B) variables. The results are qualitatively similar to those reported in Table 4, verifying the robustness of the original findings. We also estimate the industry-adjusted *GINVs* score as an alternative measure, and the un-tabulated results support the original findings.

Second, we apply a two-stage least squares (*2SLS*) analysis to address endogeneity related to omitted variable bias. Following past research (Martínez-García *et al.*, 2022; Orazalin *et al.*, 2024), we adopt the industry mean (*WAST\_IND* and *WREC\_IND*) and lagged (*WAST\_LGD* and *WREC\_LGD*) values of *WAST* and *WREC* as instrumental variables. These instruments are more likely to influence *WAST* and *WREC* but are less likely to affect *FD* (Orazalin *et al.*, 2024). Table 8 shows that the primary findings are robust to omitted variable bias. Third, we employ the Heckman model (Heckman, 1979) to address sample selection bias. Consistent with past research (Orazalin *et al.*, 2024), we employ the industry mean values of *WAST* (*WAST\_IND*) and *WREC* (*WREC\_IND*) as exclusion restrictions. Table 9 demonstrates that the main findings are robust to sample selection bias.

Fourth, to verify the robustness of our main results, we perform an additional moderation analysis, introducing a dummy variable for *GINVs* as a moderator. Specifically, we estimate the average industry-adjusted *GINVs* score for each firm. We then create a dummy variable (*GINVs\_D)* coded one if the *GINVs* score exceeds the sample median, and zero otherwise. Table 10 reports the results, showing the moderating effects of the *GINVs\_D* variable. The coefficients of *WAST\*GINVs\_D* are positive whereas the coefficients of *WREC\*GINVs\_*D are negative, thus supporting our main conclusions. Finally, we employ the first and second lag values of the *WAST, WREC, GINVs*, and control variables to address possible endogeneity associated with causality. Appendix 2 shows that the results from this analysis are compatible with the main findings.

**5. Conclusion**

This study empirically investigates the link between waste management and financial distress and tests whether green initiatives moderate the given link in the UK context. We focus on the UK because it is one of the heavily regulated environments with short- and long-term cost and financial implications for corporations. The results reveal that financial distress likelihood decreases substantially when waste generation declines and waste recycling increases, suggesting that firms with better waste performance and management practices have lower levels of financial distress. Further, the moderation analysis demonstrates that increased green initiatives weaken the adverse financial effects of waste generation, thus demonstrating their importance in enhancing environmental and financial sustainability. The results also specify that while both waste recycling and green initiatives reduce financial distress, the impact of waste recycling on financial distress is reduced when green initiatives are introduced, suggesting that both climate mitigation efforts have a substitutive effect on financial sustainability. The findings are robust to using alternative measures and employing the 2SLS and Heckman estimations to control for potential endogeneity.

The findings of this work have several important implications for organizational stakeholders to promote green initiatives and enhance sustainability performance. Corporate executives and board members are encouraged to tackle climate risks/threats by implementing effective *WM* practices and introducing proactive green innovations, which may improve financial sustainability. They also need to carefully balance their green transformation initiatives with their waste recycling efforts to achieve optimal financial sustainability. Further, when creating a diversified and effective investment portfolio, global investors should carefully assess climate change issues and select firms with effective *WM* practices/policies, innovative environmental technologies, and eco-designed products/services. To ensure effective management and allocation of portfolio assets, it is also important to consider the fact that firm financial risks can be reduced by proactive green initiatives/strategies, reduced waste generation, and improved waste recycling. The findings also suggest that regulators and policymakers concerned about global ecological issues need to develop and introduce enforceable policies with specific targets for waste levels, green initiatives, and proactive environmental practices/strategies that aim to mitigate climate issues and promote sustainable development.

Our work is subject to several limitations. First, since it focuses on single-country data, its results and conclusions should be interpreted cautiously, especially in the context of developing economies. Future studies, therefore, could extend this work by investigating an international dataset with different financial and environmental regulatory contexts. Second, the sample includes publicly listed firms, making its findings less generalizable to small firms. Hence, future investigations could replicate this work by employing a sample of smaller business entities. Finally, like other empirical investigations with archival data, the proxies for waste, green initiatives, and financial distress may not reflect actual firm performance and practices. Thus, future research could include case studies and comprehensive interviews with key stakeholders to provide new insights.

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**Figures**

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**Figures 1-4.** Moderating effects of green initiatives

**Source:** Figures prepared by the authors.

**Table 1.** Variable definitions

|  |  |  |
| --- | --- | --- |
| **Variables** | **Symbol** | **Measurements** |
| Financial distress | FD | Almamy *et al.* (2016)’s Z\_UK score: 1.484\*Working capital/Total assets+0.043\*Retained earnings/Total assets+0.390\*Earnings before interest and taxation/Total assets+0.004\*Market value of equity/Total liabilities + 0.424\*Revenue/Total assets + 0.750\*Cash flows from operating activities/Total assets, developed exclusively for the UK market.Altman (1968)’s Z\_ALT score: 1.2\*Working capital/Total assets+1.4\*Retained earnings/total assets+3.3\*Earnings before interest and taxation/total assets+0.6\*Market value of equity/total liabilities+0.999\*Revenue/total assets. |
| Waste generation | WAST | The ratio of the total waste generated to total assets. |
| Waste recycling | WREC | The ratio of waste recycled to total waste.  |
| Green initiatives | GINVs | The score is based on 21 environmental indicators, which reflect a firm’s initiatives/strategies to protect ecosystems, reduce, reuse, phase out or substitute emissions and/or toxic chemicals, and promote efficient use of natural resources by designing green products/services, adopting new environmental technologies, implementing renewable energy systems, and introducing environmentally sustainable activities/practices. It therefore ranges from 0 to 21. |
| Board size | BSIZE | The total number of board directors. |
| Board gender diversity  | BGDIV | The proportion of female directors on boards. |
| Board independence | BINDR | The proportion of independent directors on boards. |
| Firm age | FAGE | The number of years the firm has been listed in LSEG.  |
| Firm size | SIZE | The natural log of total assets. |
| Profitability | PROF | Net income/total revenue. |
| Leverage | LVRG | Total liabilities/total assets\*100. |
| Slack | SLCK | The ratio of cash and cash equivalents to total assets. |
| Capital intensity | CPIN | The ratio of fixed assets to total assets. |

**Note(s):** This table presents the study variables.

**Source:** Table prepared by the authors.

**Table 2.** Descriptive Statistics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** |  **Obs.** |  **Mean** |  **Std. Dev.** |  **Min.** |  **Max.** |
|  Z\_UK | 1667 | 0.61 | 0.42 | -0.90 | 2.97 |
|  Z\_ALT | 1667 | 1.61 | 0.93 | -0.77 | 4.19 |
|  WAST | 1667 | 1.06 | 5.34 | 0.00 | 42.32 |
|  WREC | 1302 | 62.45 | 28.19 | 0.00 | 100.00 |
|  GINVs | 1667 | 9.68 | 3.58 | 0.00 | 19.00 |
|  BSIZE | 1667 | 9.73 | 2.36 | 3.00 | 18.00 |
|  BGDIV | 1667 | 20.30 | 13.40 | 0.00 | 66.67 |
|  BINDR | 1667 | 61.63 | 13.56 | 12.50 | 93.75 |
|  FAGE | 1667 | 38.05 | 17.57 | 2.00 | 57.00 |
|  SIZE | 1667 | 15.72 | 1.52 | 12.06 | 19.86 |
|  PROF | 1667 | 0.07 | 0.38 | -2.17 | 0.87 |
|  LVRG | 1667 | 27.13 | 16.11 | 0.00 | 68.15 |
|  SLCK | 1667 | 0.09 | 0.07 | 0.00 | 0.61 |
|  CPIN | 1667 | 0.36 | 0.28 | 0.00 | 0.99 |

**Note(s):** This table reports the descriptive statistics. All the study variables are defined in Table 1.

**Source:** Table prepared by the authors.

**Table 3.** Correlation matrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variables** | **Z\_UK** | **Z\_ALT** | **WAST** | **WREC** | **GINVs** | **BSIZE** | **BGDIV** | **BINDR** | **FAGE** | **SIZE** | **PROF** | **LVRG** | **SLCK** | **CPIN** |
| Z\_UK | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Z\_ALT | 0.85\*\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |
| WAST | -0.04\* | -0.15\*\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |
| WREC | 0.13\*\*\* | 0.14\*\*\* | -0.29\*\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |
| GINVs | -0.16\*\*\* | -0.08\*\*\* | 0.03 | 0.00 | 1.00 |  |  |  |  |  |  |  |  |  |
| BSIZE | -0.26\*\*\* | -0.18\*\*\* | -0.03 | -0.02 | 0.24\*\*\* | 1.00 |  |  |  |  |  |  |  |  |
| BGDIV | -0.06\*\* | -0.03 | -0.12\*\*\* | 0.18\*\*\* | 0.29\*\*\* | 0.02 | 1.00 |  |  |  |  |  |  |  |
| BINDR | -0.13\*\*\* | -0.07\*\*\* | -0.03 | -0.04 | 0.30\*\*\* | 0.11\*\*\* | 0.37\*\*\* | 1.00 |  |  |  |  |  |  |
| FAGE | 0.13\*\*\* | 0.22\*\*\* | -0.11\*\*\* | 0.15\*\*\* | 0.03 | 0.11\*\*\* | 0.01 | -0.03 | 1.00 |  |  |  |  |  |
| SIZE | -0.36\*\*\* | -0.23\*\*\* | -0.07\*\*\* | -0.04 | 0.52\*\*\* | 0.62\*\*\* | 0.15\*\*\* | 0.38\*\*\* | 0.08\*\*\* | 1.00 |  |  |  |  |
| PROF | 0.07\*\*\* | 0.22\*\*\* | -0.02 | 0.10\*\*\* | -0.02 | 0.07\*\*\* | -0.05\*\* | -0.03 | 0.04\* | 0.01 | 1.00 |  |  |  |
| LVRG | -0.46\*\*\* | -0.50\*\*\* | -0.11\*\*\* | -0.03 | 0.10\*\*\* | 0.14\*\*\* | 0.10\*\*\* | 0.08\*\*\* | -0.09\*\*\* | 0.23\*\*\* | -0.09\*\*\* | 1.00 |  |  |
| SLCK | 0.30\*\*\* | 0.13\*\*\* | 0.12\*\*\* | -0.10\*\*\* | -0.04\* | -0.02 | 0.05\*\* | 0.00 | -0.10\*\*\* | -0.07\*\*\* | -0.05\* | -0.13\*\*\* | 1.00 |  |
| CPIN | -0.44\*\*\* | -0.32\*\*\* | 0.19\*\*\* | -0.14\*\*\* | 0.08\*\*\* | 0.07\*\*\* | -0.09\*\*\* | -0.05\*\* | -0.13\*\*\* | 0.10\*\*\* | 0.02 | 0.23\*\*\* | -0.23\*\*\* | 1.00 |

**Note(s):** This table reports the correlation coefficients. All the study variables are defined in Table 1. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively.

**Source:** Table prepared by the authors.

**Table 4.** The impact of waste management on financial distress

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
|  | **Z\_UK** | **Z\_UK** | **Z\_ALT** | **Z\_ALT** |
| WAST | -0.009\*\*\* |  | -0.041\*\*\* |  |
|  | (-6.46) |  | (-7.50) |  |
| WREC |  | 0.003\*\*\* |  | 0.005\*\*\* |
|  |  | (7.02) |  | (5.57) |
| GINVs | 0.009\*\*\* | 0.008\*\* | 0.026\*\*\* | 0.021\*\*\* |
|  | (3.07) | (2.33) | (3.81) | (2.71) |
| BSIZE | -0.016\*\*\* | -0.014\*\*\* | -0.040\*\*\* | -0.031\*\*\* |
|  | (-4.25) | (-3.52) | (-4.56) | (-3.41) |
| BGDIV | 0.002\*\* | 0.002\*\*\* | 0.011\*\*\* | 0.010\*\*\* |
|  | (2.32) | (2.59) | (5.27) | (4.64) |
| BINDR | -0.001\* | -0.001 | -0.001 | 0.000 |
|  | (-1.74) | (-1.31) | (-0.74) | (0.07) |
| FAGE | 0.002\*\*\* | 0.002\*\*\* | 0.007\*\*\* | 0.008\*\*\* |
|  | (4.68) | (4.67) | (6.50) | (6.86) |
| SIZE | -0.075\*\*\* | -0.080\*\*\* | -0.107\*\*\* | -0.118\*\*\* |
|  | (-8.27) | (-8.00) | (-5.50) | (-5.56) |
| PROF | 0.087\*\*\* | 0.072\*\*\* | 0.507\*\*\* | 0.464\*\*\* |
|  | (4.77) | (4.10) | (10.94) | (10.35) |
| LVRG | -0.007\*\*\* | -0.007\*\*\* | -0.021\*\*\* | -0.021\*\*\* |
|  | (-11.95) | (-10.99) | (-17.78) | (-17.16) |
| SLCK | 0.907\*\*\* | 1.035\*\*\* | 0.711\*\* | 1.053\*\*\* |
|  | (5.94) | (5.66) | (2.56) | (3.33) |
| CPIN | -0.391\*\*\* | -0.370\*\*\* | -0.263\*\*\* | -0.245\*\*\* |
|  | (-10.02) | (-8.74) | (-3.45) | (-3.05) |
| Year FE | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes |
| Constant | 2.362\*\*\* | 2.507\*\*\* | 4.509\*\*\* | 4.710\*\*\* |
|  | (17.10) | (19.14) | (13.99) | (15.38) |
| Observations | 1667 | 1302 | 1667 | 1302 |
| Adj. R-sq. | 0.492 | 0.564 | 0.474 | 0.531 |

**Note(s):** This table reports the effects of waste management (*WM*) practices on financial distress (*FD*). Robust *t-statistics* are presented in parentheses. All the study variables are defined in Table 1. \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

**Source:** Table prepared by the authors.

**Table 5.** The moderating role of green initiatives on the waste management—financial distress nexus

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
|  | **Z\_UK** | **Z\_UK** | **Z\_ALT** | **Z\_ALT** |
| WAST | -0.019\*\*\* |  | -0.091\*\*\* |  |
|  | (-4.40) |  | (-5.36) |  |
| WAST\*GINVs | 0.001\*\* |  | 0.005\*\*\* |  |
|  | (2.18) |  | (3.08) |  |
| WREC |  | 0.007\*\*\* |  | 0.012\*\*\* |
|  |  | (7.30) |  | (5.39) |
| WREC\*GINVs |  | -0.001\*\*\* |  | -0.001\*\*\* |
|  |  | (-5.14) |  | (-3.57) |
| GINVs | 0.008\*\*\* | 0.035\*\*\* | 0.023\*\*\* | 0.065\*\*\* |
|  | (2.88) | (5.37) | (3.44) | (3.91) |
| BSIZE | -0.016\*\*\* | -0.014\*\*\* | -0.039\*\*\* | -0.031\*\*\* |
|  | (-4.22) | (-3.56) | (-4.52) | (-3.44) |
| BGDIV | 0.002\*\* | 0.003\*\*\* | 0.010\*\*\* | 0.011\*\*\* |
|  | (2.27) | (3.17) | (5.15) | (5.01) |
| BINDR | -0.001\* | -0.001 | -0.001 | 0.000 |
|  | (-1.69) | (-1.33) | (-0.61) | (0.08) |
| FAGE | 0.002\*\*\* | 0.002\*\*\* | 0.006\*\*\* | 0.008\*\*\* |
|  | (4.55) | (4.59) | (6.17) | (6.79) |
| SIZE | -0.076\*\*\* | -0.083\*\*\* | -0.115\*\*\* | -0.124\*\*\* |
|  | (-8.32) | (-8.39) | (-5.65) | (-5.76) |
| PROF | 0.086\*\*\* | 0.074\*\*\* | 0.499\*\*\* | 0.468\*\*\* |
|  | (4.67) | (4.22) | (10.74) | (10.50) |
| LVRG | -0.007\*\*\* | -0.006\*\*\* | -0.022\*\*\* | -0.021\*\*\* |
|  | (-12.19) | (-10.58) | (-18.75) | (-16.83) |
| SLCK | 0.893\*\*\* | 1.020\*\*\* | 0.637\*\* | 1.028\*\*\* |
|  | (5.84) | (5.54) | (2.33) | (3.23) |
| CPIN | -0.391\*\*\* | -0.388\*\*\* | -0.259\*\*\* | -0.275\*\*\* |
|  | (-10.04) | (-9.25) | (-3.46) | (-3.41) |
| Year FE | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes |
| Constant | 2.381\*\*\* | 2.265\*\*\* | 4.608\*\*\* | 4.317\*\*\* |
|  | (17.04) | (16.98) | (13.72) | (13.96) |
| Observations | 1667 | 1302 | 1667 | 1302 |
| Adj. R-sq. | 0.493 | 0.573 | 0.482 | 0.536 |

**Note(s):** This table reports the moderating role of green initiatives (*GINVs*) on the link between waste management (*WM*) practices and financial distress (*FD*). Robust *t-statistics* are presented in parentheses. All the study variables are defined in Table 1. \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

**Source:** Table prepared by the authors.

**Table 6.** The moderating role of waste recycling on the waste generation—financial distress nexus

|  |  |  |
| --- | --- | --- |
|  | **(1)** | **(2)** |
|  | **Z\_UK** | **Z\_ALT** |
| WAST | -0.006\*\* | -0.034\*\*\* |
|  | (-2.04) | (-4.22) |
| WAST\*WREC | 0.001\*\* | 0.001\*\*\* |
|  | (2.00) | (3.53) |
| WREC | 0.003\*\*\* | 0.004\*\*\* |
|  | (6.45) | (4.50) |
| GINVs | 0.008\*\* | 0.020\*\*\* |
|  | (2.31) | (2.69) |
| Controls | Included | Included |
| Year/Industry FE | Yes | Yes |
| Observations | 1302 | 1302 |
| Adj. R-sq. | 0.565 | 0.542 |

**Note(s):** This table reports the moderating role of waste recycling (*WREC*) on the link between waste generation (*WAST*) and financial distress (*FD*). Robust *t-statistics* are presented in parentheses. All the study variables are defined in Table 1. \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

**Source:** Table prepared by the authors.

**Table 7.** Robustness tests: alternative measures

|  |
| --- |
| ***Panel A: Alternative measure of financial distress*** |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
|  | **KZ\_IND** | **KZ\_IND** | **KZ\_IND** | **KZ\_IND** |
| WAST | 0.012\* | 0.080\*\*\* |  |  |
|  | (1.72) | (2.97) |  |  |
| WAST\*GINVs |  | -0.007\*\* |  |  |
|  |  | (-2.27) |  |  |
| WREC |  |  | -0.001 | -0.011\*\* |
|  |  |  | (-0.81) | (-2.41) |
| WAST\*GINVs |  |  |  | 0.001\*\* |
|  |  |  |  | (2.38) |
| GINVs | -0.047\*\*\* | -0.043\*\*\* | -0.047\*\* | -0.107\*\*\* |
|  | (-3.12) | (-2.85) | (-2.56) | (-3.75) |
| Controls | Included | Included | Included | Included |
| Year/Industry FE | Yes | Yes | Yes | Yes |
| Observations | 1667 | 1667 | 1302 | 1302 |
| Adj. R-sq. | 0.306 | 0.311 | 0.330 | 0.332 |
| ***Panel B: Alternative measure of waste management*** |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
|  | **Zscore\_UK** | **Zscore\_UK** | **Z\_score** | **Z\_score** |
| WSAL | -0.005\*\*\* | -0.007\*\*\* | -0.020\*\*\* | -0.040\*\*\* |
|  | (-7.95) | (-4.86) | (-8.65) | (-5.87) |
| WSAL\*GINVs |  | 0.001\* |  | 0.002\*\*\* |
|  |  | (1.76) |  | (3.30) |
| GINVs | 0.009\*\*\* | 0.008\*\*\* | 0.024\*\*\* | 0.022\*\*\* |
|  | (2.89) | (2.82) | (3.51) | (3.25) |
| Controls | Included | Included | Included | Included |
| Year/Industry FE | Yes | Yes | Yes | Yes |
| Observations | 1667 | 1667 | 1667 | 1667 |
| Adj. R-sq. | 0.495 | 0.495 | 0.480 | 0.486 |

**Note(s):** This table reports the links among green initiatives (*GINVs*), waste management (*WM*), and financial distress (*FD*) based on the alternative measures of *FD* (Panel A) and *WM* (Panel B). Robust *t-statistics* are presented in parentheses. All the study variables are defined in Table 1. \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

**Source:** Table prepared by the authors.

**Table 8.** Robustness tests: 2SLS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **1st stage** | **2nd stage** | **2nd stage** | **1st stage** | **2nd stage** | **2nd stage** |
|  | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
|  | **WAST** | **Z\_UK** | **Z\_ALT** | **WREC** | **Z\_UK** | **Z\_ALT** |
| WAST\_LGD | 0.935\*\*\* |  |  |  |  |  |
|  | (25.05) |  |  |  |  |  |
| WAST\_IND | 0.210\*\* |  |  |  |  |  |
|  | (2.39) |  |  |  |  |  |
| WREC\_LGD |  |  |  | 0.839\*\*\* |  |  |
|  |  |  |  | (40.36) |  |  |
| WREC\_IND |  |  |  | 0.335\*\*\* |  |  |
|  |  |  |  | (4.90) |  |  |
| WAST |  | -0.018\*\*\* | -0.094\*\*\* |  |  |  |
|  |  | (-3.86) | (-6.16) |  |  |  |
| WAST\*GINVs |  | 0.001\*\* | 0.006\*\*\* |  |  |  |
|  |  | (1.98) | (3.66) |  |  |  |
| WREC |  |  |  |  | 0.011\*\*\* | 0.018\*\*\* |
|  |  |  |  |  | (5.45) | (3.83) |
| WREC\*GINVs |  |  |  |  | -0.001\*\*\* | -0.001\*\*\* |
|  |  |  |  |  | (-4.30) | (-3.00) |
| GINVs |  | 0.007\*\* | 0.019\*\* |  | 0.052\*\*\* | 0.089\*\*\* |
|  |  | (2.01) | (2.45) |  | (4.62) | (3.43) |
| Controls | Included | Included | Included | Included | Included | Included |
| Year/Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1432 | 1432 | 1432 | 1099 | 1099 | 1099 |
| Adj. R-sq. | 0.931 | 0.491 | 0.484 | 0.845 | 0.582 | 0.544 |

**Note(s):** This table reports the links among green initiatives (*GINVs*), waste management (*WM*), and financial distress (*FD*) based on a two-stage least squares (*2SLS*) analysis. Robust *t-statistics* are presented in parentheses. All the study variables are defined in Table 1. \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

**Source:** Table prepared by the authors.

**Table 9.** Robustness tests: the Heckman model

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
|  | **Z\_UK** | **Z\_ALT** | **Z\_UK** | **Z\_ALT** |
| WAST | -0.016\*\*\* | -0.092\*\*\* |  |  |
|  | (-3.06) | (-7.37) |  |  |
| WAST\*GINVs | 0.001\* | 0.006\*\*\* |  |  |
|  | (1.69) | (4.64) |  |  |
| WREC |  |  | 0.010\*\*\* | 0.017\*\*\* |
|  |  |  | (5.08) | (3.73) |
| WREC\*GINVs |  |  | -0.000\*\*\* | -0.001\*\* |
|  |  |  | (-2.62) | (-2.53) |
| GINVs | 0.007 | 0.030\*\*\* | 0.022\*\* | 0.054\*\* |
|  | (1.63) | (2.97) | (2.23) | (2.31) |
| Controls | Included | Included | Included | Included |
| Mills ratio | 0.232\*\*\* | 0.591\*\*\* | 0.151\*\*\* | 0.101 |
|  | (3.32) | (3.66) | (2.81) | (0.80) |
| Year/Industry FE | Yes | Yes | Yes | Yes |
| Observations | 1667 | 1667 | 1302 | 1302 |
| Wald Chi2 | 0.000\*\*\* | 0.000\*\*\* | 0.000\*\*\* | 0.000\*\*\* |

**Note(s):** This table reports the links among green initiatives (*GINVs*), waste management (*WM*), and financial distress (*FD*) based on the Heckman selection model. Robust *t-statistics* are presented in parentheses. All the study variables are defined in Table 1. \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

**Source:** Table prepared by the authors.

**Table 10.** Robustness tests: moderation analysis using a dummy variable

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
|  | **Z\_UK** | **Z\_UK** | **Z\_ALT** | **Z\_ALT** |
| WAST | -0.011\*\*\* |  | -0.049\*\*\* |  |
|  | (-8.34) |  | (-8.72) |  |
| WAST\*GINVs\_D | 0.008\*\*\* |  | 0.032\*\*\* |  |
|  | (3.01) |  | (3.07) |  |
| WREC |  | 0.004\*\*\* |  | 0.007\*\*\* |
|  |  | (8.16) |  | (6.11) |
| WREC\*GINVs\_D |  | -0.003\*\*\* |  | -0.004\*\*\* |
|  |  | (-4.68) |  | (-2.94) |
| GINVS\_D | 0.006 | 0.189\*\*\* | 0.047 | 0.320\*\*\* |
|  | (0.33) | (3.89) | (1.11) | (2.67) |
| Controls | Included | Included | Included | Included |
| Year/Industry FE | Yes | Yes | Yes | Yes |
| Observations | 1667 | 1302 | 1667 | 1302 |
| Adj. R-sq. | 0.491 | 0.571 | 0.476 | 0.533 |

**Note(s):** This table reports the links among green initiatives (*GINVs*), waste management (*WM*), and financial distress (*FD*) using an additional moderation analysis. *GINVs\_D* is a dummy variable and used as a moderator. Robust *t-statistics* are presented in parentheses. All the study variables are defined in Table 1. \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

**Source:** Table prepared by the authors.

**Appendix 1.** Sample distribution by industry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Industry** | **Companies** | **Observations** | **Percent (%)** | **Cumulative (%)** |
| Basic Materials | 21 | 198 | 11.88 | 11.88 |
| Consumer Discretionary | 53 | 388 | 23.28 | 35.15 |
| Consumer Staples | 18 | 167 | 10.02 | 45.17 |
| Energy | 10 | 95 | 5.70 | 50.87 |
| Health Care | 8 | 79 | 4.74 | 55.61 |
| Industrials | 45 | 441 | 26.45 | 82.06 |
| Real Estate | 22 | 186 | 11.16 | 93.22 |
| Telecommunications | 4 | 36 | 2.16 | 95.38 |
| Utilities | 8 | 77 | 4.62 | 100.00 |
| Total | 189 | 1667 | 100.00 |  |

**Note(s):** This table reports the sample distribution by industry. The final sample includes 1,667 firm-year observations from 189 UK-based companies operating in nine different industries.

**Source:** Table prepared by the authors.

**Appendix 2.** Robustness tests: lag values

|  |
| --- |
| **Panel A: The first lag values of the independent and moderating variables** |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
|  | **Z\_UK** | **Z\_UK** | **Z\_ALT** | **Z\_ALT** |
| WAST *t-1* | -0.017\*\*\* |  | -0.093\*\*\* |  |
|  | (-3.74) |  | (-4.91) |  |
| WAST *t-1*\*GINVs *t-1* | 0.001\* |  | 0.006\*\*\* |  |
|  | (1.96) |  | (3.16) |  |
| WREC *t-1* |  | 0.008\*\*\* |  | 0.015\*\*\* |
|  |  | (7.45) |  | (5.78) |
| WREC *t-1*\*GINVs *t-1* |  | -0.001\*\*\* |  | -0.001\*\*\* |
|  |  | (-5.38) |  | (-4.02) |
| GINVs *t-1* | 0.007\*\* | 0.038\*\*\* | 0.023\*\*\* | 0.077\*\*\* |
|  | (2.19) | (5.39) | (3.07) | (4.17) |
| Controls *t-1* | Included | Included | Included | Included |
| Year | Yes | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes | Yes |
| Observations | 1432 | 1120 | 1432 | 1120 |
| Adj. R-sq. | 0.456 | 0.546 | 0.427 | 0.488 |
| **Panel B: The second lag values of the independent and moderating variables** |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
|  | **Z\_UK** | **Z\_UK** | **Z\_ALT** | **Z\_ALT** |
| WAST *t-2* | -0.022\*\*\* |  | -0.110\*\*\* |  |
|  | (-4.80) |  | (-6.91) |  |
| WAST *t-2*\*GINVs *t-2* | 0.001\*\*\* |  | 0.008\*\*\* |  |
|  | (2.72) |  | (4.56) |  |
| WREC *t-2* |  | 0.008\*\*\* |  | 0.014\*\*\* |
|  |  | (6.65) |  | (4.99) |
| WREC *t-2*\*GINVs *t-2* |  | -0.001\*\*\* |  | -0.001\*\*\* |
|  |  | (-5.00) |  | (-3.72) |
| GINVs *t-2* | 0.007\* | 0.038\*\*\* | 0.025\*\*\* | 0.080\*\*\* |
|  | (1.86) | (5.07) | (3.01) | (4.14) |
| Controls *t-2* | Included | Included | Included | Included |
| Year | Yes | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes | Yes |
| Observations | 1251 | 973 | 1251 | 973 |
| Adj. R-sq. | 0.457 | 0.539 | 0.417 | 0.466 |

**Note(s):** This table reports the links among green initiatives (*GINVs*), waste management (*WM*), and financial distress (*FD*) based on the first and second lag values of the independent, moderating, and control variables. Robust *t-statistics* are presented in parentheses. All the study variables are defined in Table 1. \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

**Source:** Table prepared by the authors.

1. Our dataset starts in 2002, when environmental data became available, and ends in 2021 because data on *GINVs* and *WM* were not available for the majority of firms beyond this year at the time of data collection. [↑](#footnote-ref-1)
2. We also estimate the industry-adjusted *GINVs* score to use it as an alternative measure in the robustness analysis. [↑](#footnote-ref-2)
3. As a robustness test, we also perform an additional moderation analysis using a dummy variable for *GINVs* as a moderator. [↑](#footnote-ref-3)
4. We also winsorized all the continuous variables at the 1% and 99% levels to mitigate the effects of potential outliers. [↑](#footnote-ref-4)
5. We use the *Z\_UK* and *Z\_ALT* scores as *FD* measures. Hence, the higher the scores, the lower the *FD* levels. [↑](#footnote-ref-5)
6. We therefore expect the coefficients of *WAST*, *WREC*, and their interactions with *GINVs* to have opposite signs. [↑](#footnote-ref-6)