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## Does waste management affect firm performance? International evidence

Ammar Ali Gull,<sup>a, b,\*</sup> Muhammad Atif,<sup>c</sup> Tanveer Ahsan,<sup>d</sup> Imen Derouiche<sup>e</sup>

<sup>a</sup> Ecole Supérieure des Sciences Commerciales d'Angers (ESSCA), Lyon, France.

<sup>b</sup> International School, Vietnam National University, Hanoi, Vietnam.

<sup>c</sup> Department of Accounting and Corporate Governance, Macquarie Business School, Macquarie University, Sydney, Australia.

<sup>d</sup> Rennes School of Business, Rennes, France.

<sup>e</sup> Department of Economics and Management (FDEF), University of Luxembourg, Luxembourg City, Luxembourg.

### Abstract

This study examines an important yet underexplored aspect of firms' sustainability practices, i.e., waste management, in order to analyze its impact on financial performance. Although the extant literature has focused on various aspects of sustainability, the impact of waste management, which has disastrous consequences for the climate and firm performance, remains largely unexplored. Thus, using the 2002–2019 data of listed firms from 41 countries, we found a significantly negative (positive) relationship between waste generation (recycling) and financial performance. Our findings are robust to alternative variables, sub-sample analysis, and identification strategies. Moreover, a channel analysis showed that this relationship is influenced by operating costs, ESG performance-based compensation, industry nature, the Paris agreement on climate change, and the global financial crisis. Overall, the findings suggest that environmental initiatives are beneficial for firms and present important policy implications for regulators and firms.

**Keywords:** waste management; waste generation; waste recycling; firm performance; environmental protection.

**JEL codes:** G30, G34

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\*Corresponding author: Ecole Supérieure des Sciences Commerciales d'Angers (ESSCA), 4 Pont Pasteur, 69007 Lyon, France. Phone: +33 (0)4 78 78 94 37.

Email addresses: A. A. Gull (ammarshaukit@gmail.com & ammar\_ali.gull@essca.fr), M. Atif (muhammad.atif@mq.edu.au), T. Ahsan (tanveer.ahsan@rennes-sb.com), I. Derouiche (Imen.derouiche@uni.lu).

## **1. Introduction**

The generation of solid waste worldwide has had negative impacts, including an increase in ground-level temperatures, due to greenhouse gas emissions and the leaching of toxic chemicals from landfills (Prado-Lorenzo and García-Sánchez, 2010). For instance, a recent report stated that global waste generation has exceeded 2 billion tons per year and it is expected to reach 3.4 billion tons by 2050. Meanwhile, recycling rates are not expected to increase (World Bank, 2019; Clifford, 2021). Hence, worldwide waste management has become vital for preserving the climate.

At the firm level, waste generation and low levels of toxic waste recycling have increased the use of raw materials in production processes. This has increased energy consumption and carbon emissions, thus raising production costs and damaging the environment (Alam et al., 2019). Over the last two decades, an increasing number of firms have started to implement voluntary environmental initiatives (e.g., waste reduction and recycling) in their business models and processes (Eccles et al., 2014), since they are major contributors to waste generation due to their large-scale production. These initiatives have not only reduced the negative impact of business practices on society and the climate, but they have also supported the firms in achieving a competitive advantage and long-term business sustainability (Eccles et al., 2014; Atif et al., 2021). Prior research has revealed that meeting the needs of stakeholders can create shareholder value through long-term approaches toward intertemporal gains and active stakeholder management (Eccles et al., 2014). In this regard, waste management provides an opportunity to integrate a firm's competitive strategy, with a focus on long-term financial performance and the greater good of society. However, because the extant literature has largely ignored the waste management perspective and its impact on firm performance, the present study aims to fill this void by using a cross-country setting.

Specifically, previous studies have had inconclusive findings on the relationship between environmental corporate social responsibility (CSR) and firm performance. On the one hand, some of the literature has revealed a negative relationship, arguing that the allocation of firms' scarce resources away from business operations can result in lower financial performance (e.g., Brown et al., 2006). For instance, Walley and Whitehead (1994) and Telle (2006) found a negative relationship between firms' environmental management and financial performance. On the other hand, some studies, including Hart (1995), Porter and Van der Linde (1995), Gallego-Álvarez et al. (2015), Lee et al. (2015), and Awaysheh et al. (2020), concurred that firms can achieve better financial outcomes when implementing environmentally friendly initiatives, which is in line with stakeholder theory (Donaldson and

Preston, 1995).<sup>1</sup> These studies also showed that firms can help tackle climate change through environmental initiatives (e.g., waste reduction and recycling), while creating new business opportunities and increasing stakeholders' trust, thus leading to better financial performance. Furthermore, such environmentally friendly initiatives may also be driven by the ethical sense of "doing the right thing" for society, while acknowledging that firms' coexistence in society enables them to attain increased trust from society itself (Joyner and Payne, 2002). Consequently, the move toward good ethics can lead to better firm performance (Stodder, 1998; Joyner and Payne, 2002). Based on these arguments, the link between waste generation and firm performance is expected to be negative, given the adverse consequences of waste for stakeholders. However, the present study empirically examines a novel perspective on environmental performance in a cross-country setting, i.e., waste management, which is an underexplored area. We also measure firm performance using accounting and market-based measures such as return on assets (*ROA*) and Tobin's Q (*TQ*). Additionally, waste generation and recycling are measured by using the natural log of total waste produced in tons and the proportion of waste recycled, respectively.

Based on a sample of 14,601 firm-year observations from 2002 to 2019 across 41 countries, we found a significantly negative (positive) association between waste generation (recycling) and firm performance. This finding suggests that firms are actively focusing on the environment by reducing waste generation and improving recycling in order to obtain better performance. Our results are also consistent when using sub-components of waste (i.e., hazardous and non-hazardous), alternative measures of waste and firm performance, and a sub-sample analysis. As for our channel analysis, it showed that the waste management-financial performance relationship is affected by operating costs, environmental, social, and governance (hereafter, ESG) performance-based compensation policies, industry nature, the Paris agreement on climate change, and the global financial crisis.

It should be noted that our results may face potential endogeneity bias, due to reverse causality. For instance, firms that are already performing better may have better environmental initiatives or vice versa. This causality suggests that our results are spurious. In order to address this concern, we used three identification strategies. First, we employed propensity score matching (PSM) to identify firms with high waste generation and recycling, which are indistinguishable based on other firm-level characteristics. In the post-matching

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<sup>1</sup> Several studies (e.g., Graves and Waddock, 1999; Qiu et al., 2016) found no evidence that environmentally responsible firms experience significantly better or worse financial performance.

process, we found that waste generation (recycling) had a significant negative (positive) association with firm performance. Second, we used the lagged independent variables approach to tackle the issue of reverse causality, since it is highly unlikely that the current year's financial performance will have any impact on the level of waste produced or recycled in the previous year. Our results were still similar to the main findings. Third, we applied the instrumental variable (IV) approach by using two-stage least squares (2SLS) in order to extract the exogenous components of waste generation and recycling. We observed a negative (positive) relationship between waste generation (recycling) and firm performance. Taken together, our identification strategies imply that waste generation (recycling) has a negative (positive) causal effect on firm performance.

Overall, this study makes two important contributions. First, it contributes to the strand of literature examining the impact of environmental performance on firm performance. The extant literature has focused on different aspects of environmental initiatives, including renewable energy consumption (Atif et al., 2021), firms' sustainable investment (Atif et al., 2020), carbon performance (Busch and Lewandowski, 2018), research and development intensity (Banerjee and Gupta, 2019), and CSR (Mishra and Suar, 2010; Eccles et al., 2014). By extending the extant literature, the present study examines a unique aspect of environmental initiatives, i.e., waste management and firm performance. Our study also responds to recent calls for researchers to focus on various dimensions/sub-dimensions of the sustainability pillars (Hussain et al., 2018; García-Sánchez et al., 2021) and analyze waste management. This is an important dimension in sustainability, given the role played by firms in the exponential increase in waste generation, which has dire consequences for the climate (World Bank, 2019).

Second, our study contributes to the literature by examining the firm-level determinants of financial performance. Based on a cross-country setting, we provide novel evidence that waste management is largely ignored as a determinant of firm performance. We also distinguish the channel through which waste management initiatives affect firm performance. Additionally, a more pronounced role is played by operating costs, ESG performance-based compensation, industry nature, the Paris agreement on climate change, and the global financial crisis. Our study overcomes the limitation of potential endogeneity by exploiting a PSM and IV design in order to examine the causal effect of waste management on firm performance. Moreover, our study provides insights for policymakers regarding the business and social case for waste management at the firm level. Given the global focus on sustainability, our empirical evidence can inform regulators' decision-making

across countries regarding the development of sustainability initiatives, which are beneficial to both society and corporations. Our cross-country findings can also be a starting point for formulating sustainable policies in different countries.

The remainder of this study is structured as follows. Section 2 presents a review of the relevant literature and hypotheses, while Section 3 discusses the research design. Section 4 reports the empirical results, robustness checks, and identification strategies, after which Section 5 presents the conclusion.

## **2. Theoretical framework and hypothesis development**

### **2.1. Theoretical framework**

Stakeholders' orientation theory (Clarkson, 1995; Donaldson and Preston, 1995) argues that the group interest of all stakeholders is embodied in firms' long-term strategies. As a result of globalization, firms are under immense scrutiny from stakeholders, including customers, employees, society, regulators, and investors. In cases of mistrust between firms and stakeholders, some firms may lose their customer base, experience reductions in employee productivity, and face legal issues, all of which may directly affect firm performance (Lee, 2008). This also suggests that long-term relationships with stakeholders have become critical for firms' success (Clarkson, 1995). Hence, to avoid stakeholder-inflicted costs, firms must focus on establishing a stable relationship with stakeholders by devising policies that cater to their expectations (McVea and Freeman, 2005; Kabir et al., 2021). Of direct relevance to our study is the fact that the waste management practices of a firm have an impact on the environment, thereby affecting all stakeholders. In this regard, firms must cater to the expectations (i.e., sustainable business practices) of stakeholders.

A strand of studies has reported a positive effect of environmental initiatives on firm performance, including Porter and Van der Linde (1995), Hart (1997), Mishra and Saur (2010), and Gallego-Álvarez et al. (2015). These studies also indicated that firms can be financially competitive by pursuing new business opportunities, while undertaking environmental initiatives to tackle climate change (e.g., waste generation and recycling).<sup>2</sup> In a similar vein, Horváthová (2010), Endrikat et al. (2014), and Busch and Lewandowski (2018), based on meta-analytic reviews, concluded that the relationship between environmental

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<sup>2</sup> However, several studies (Graves and Waddock, 1999; Qiu et al., 2016) have reported no relationship between environmental responsibility and firm performance.

performance and firm performance is typically positive. In addition, these studies highlighted the importance and benefits of stakeholders' orientation for firms.

However, several studies have argued that firms' allocation of resources for social initiatives can result in a lack of available funds for primary business operations, which can lead to poor firm performance (Walley and Whitehead, 1994; Telle, 2006). These studies are in line with the traditional view of firms' profitability, i.e., the main purpose of business is profit-making, while serving shareholders' wealth maximization agendas (e.g., Berle, 1931; Friedman, 1970). This line of literature also argued that management should work within the scope of shareholders' orientation. However, given firms' global operations and the coexistence of firms in society, it makes more sense for firms to "do the right thing" for society, as this will enable them to attain wider trust from society itself (Joyner and Payne, 2002). Moreover, establishing trust and relationships with stakeholders will enable firms to avoid stakeholder-inflicted costs. Overall, stakeholders' orientation can lead to long-term shareholder wealth (e.g., Eccles et al., 2014).

## **2.2. Hypotheses development**

The relationship between environmental performance and financial performance is mainly driven by the alignment of societal and firm goals, in which environmental performance is considered as a tool for strengthening the firm-stakeholder relationship (Waddock and Graves, 1997). It can also be explained by at least three reasons.

First, consumers in contemporary society are well aware of firms' manufacturing operations and the related responsibility issues arising from such operations (Delmas and Grant, 2014; Nadeem et al., 2020). In addition, consumers usually assign a higher value to products from companies with good citizenship (Turban and Greening, 1997; Greening and Turban, 2000; Maignan and Ferrell, 2001). Hence, the engagement of firms' discretionary citizenship toward society (e.g., waste reduction and recycling) can positively influence stakeholders, including consumers and employees (Teoh and Shiu, 1990; Mishra and Suar, 2010). For instance, firms' environmental commitment can contribute to employees' job satisfaction, reduce turnover, and invoke positive reactions (Riordan et al., 1997). Firm-level initiatives toward ESG performance-based compensation that aim to shape management behavior may also influence firms' environmental orientation (Velte, 2016). This implies that ESG performance-based incentives may enhance management focus on environmental orientation, and motivate employees to work more efficiently and effectively, thereby contributing to firms' operations and resulting in better performance (Huselid, 1995).

Furthermore, firms' initiatives aimed at tackling social challenges can increase their products' value through customer loyalty, resilience, internal strength, and positive brand information (Sen et al., 2006).

Second, firms' environmental initiatives transmit the idea that they are "doing the right thing" without external pressure, and they act as firms' acknowledgment that they can coexist with society and operate within the sphere of ethical behavior (Joyner and Payne, 2002). By implementing such initiatives, firms not only avoid the legal consequences of environmental irresponsibility, but they also attain higher levels of trust from society. Consequently, the turn toward good ethics can lead to good firm performance (Stodder, 1998; Joyner and Payne, 2002).

Third, in response to the increased attention on environmental protection by societies around the world, firms are taking proactive actions to reduce emissions by producing environmentally friendly products and implementing new business processes in order to pursue long-term sustainability (Mishra and Suar, 2010; Nadeem et al., 2020). The emission-reducing actions taken by firms have included: (1) product technology, i.e., using recycled raw materials that save resources in the production process; (2) process technology, i.e., using efficient production systems, resulting in lower waste generation; (3) management systems, which embed these activities within the organizational culture; and (4) environmental auditing. Prior evidence has suggested that environmental commitments and initiatives can result in higher profitability, growth, reputation, and market value (Klassen and McLaughlin, 1996). Taken together, the aforementioned discussion suggests that improved ethical and social compliance, combined with embracing the opportunities that arise as a result of the pivot toward an environmentally friendly orientation, can result in better firm performance.

It has also been found that firms' irresponsible business practices can agitate stakeholders. For instance, a higher level of waste generation, with minimal recycling at the firm level, can offend stakeholders. In this regard, some firms may have to face the wrath of stakeholders, including boycotts of or reductions in purchases of the firms' products (Hayes and Pereira, 1990), legal actions against the firm (Greeno, 1992), poor employee contributions, and negative information about the firms' practices (Clair et al., 1995). These consequences are more likely to negatively affect firm performance.

Finally, the literature on the impact of environmental performance on firm performance has been somewhat inconclusive, with the majority finding either a positive or neutral impact. Based on the aforementioned discussion, we posit that the relationship between waste generation (recycling) and firm performance is more likely to be negative

(positive), given the negative impact of waste generation on climate and society. Hence, we present the following hypotheses:

*H1: Waste generation is negatively associated with firm performance.*

*H2: Waste recycling is positively associated with firm performance.*

### **3. Data and methodology**

#### **3.1. Sample**

In order to test the prediction that waste management is associated with firm performance, we began by collecting data on firms' waste management practices (i.e., waste generation and recycling) from Thomson Reuters' Asset4. Information regarding corporate governance variables was sourced from BoardEx, while the data concerning firm-level economic indicators was obtained from WorldScope. We then matched the data from all of the sources by using common identifiers (i.e., ISIN codes), and excluded firm-year observations with missing data to perform the analysis. In line with extant studies (e.g., Chen et al., 2015; El Ghouli and Zheng, 2016; Saeed et al., 2022), we also dropped small countries from our sample.<sup>3</sup> This resulted in an unbalanced panel of 14,601 firm-year observations, representing 2,284 unique firms from 41 countries over the 2002–2019 period.<sup>4</sup>

Table 1 presents the distribution of the sample and main variables (i.e., *ROA*, *TQ*, and waste generation) by country and year. Panel A shows that the vast majority of the observations in our sample belonged to Japan (2,837), the United Kingdom (1,560), and the United States (1,525). The average value of *ROA* (*TQ*) across the sample countries ranged from 0.031 (0.976) to 0.132 (3.174). Among the sample countries, Denmark had the highest *ROA* and *TQ* values, whereas Greece and Hungary had the lowest. In regard to waste, Panel A shows that, on average, the lowest and highest amounts of waste were generated by New Zealand (7.915) and Russia (14.824), respectively. Panel B demonstrates an increasing trend in the number of observations throughout the sample period. Specifically, the average value of *ROA* and *TQ* shows an increasing trend between 2002 and 2006, a decreasing trend during the global financial crisis (i.e., 2007–2009), and a mixed trend during the post-financial crisis period (i.e., 2010–2019). The yearly average of waste produced by the sample firms ranged

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<sup>3</sup> We required each country to have at least 30 firm-year observations in order to be included in the final sample. The rationale behind this was to have enough observations from each country to make the analysis meaningful.

<sup>4</sup> Our sample period started from 2002, since waste data was not available for earlier years, and ended in 2019 to avoid the impact of the COVID-19 pandemic. This may have had a significant impact on the level of waste produced and recycling, due to the decreased economic activity from the lockdowns and other protective measures.

between 10.166 (2009) and 11.139 (2003), with a slight decrease during the post-financial crisis period. Figure 1 presents the average waste generation and firm performance (*ROA*) over time, which indicates a negative relationship between waste generation and firm performance.

[Insert Table 1 here]

[Insert Figure 1 here]

### 3.2. Measurement of main variables

Our main variable of interest was firm performance. In prior literature (Qiu et al., 2016; Hussain et al., 2018; Atif et al., 2021; Nadarajah et al., 2021; Usman et al., 2022), firm performance was proxied using accounting or market-based measures such as *ROA*, return on sales (*ROS*), return on equity (*ROE*), and *TQ*. However, we focused on both accounting and market-based measures of firm performance. In the main analysis, we measured *ROA* as net income or loss divided by total assets and *TQ* as the ratio of the sum of market capitalization and total assets, minus the book value of shareholders' equity and divided by total assets. In addition to our primary measures of firm performance, under the robustness analysis, we used *ROS*, *ROE*, and stock price (*SP*), measured as net income or loss divided by total sales, net income or loss divided by total equity, and year-end stock price, respectively.

Our independent variable of interest was waste management, which includes waste generation and recycling. Benjamin et al. (2020) measured waste as the total volume of waste generated, which includes both hazardous and non-hazardous waste (in tons). In the main analysis, we measured waste (*WASTE*) as the natural logarithm of the total waste (both hazardous and non-hazardous) produced in tons (Shahab et al., 2022). We then focused on another aspect of waste management neglected in previous literature (Benjamin et al., 2020), i.e., waste recycling (*R\_WASTE*), which is measured as the ratio of recycled waste to total waste produced. We also focused on sub-components of waste, i.e., hazardous waste (*H\_WASTE*) and non-hazardous waste (*NH\_WASTE*), which are measured as the natural logarithm of the hazardous and non-hazardous waste produced in tons, respectively.<sup>5</sup> We then introduced two additional measures of waste into our robustness analysis, i.e., the ratio of the

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<sup>5</sup> Hazardous waste refers to waste that poses substantial or potential threats to public health or the environment. It generally exhibits one or more of the following characteristics: being ignitable (e.g., flammable), oxidizing, corrosive, toxic, and radioactive. Non-hazardous waste is waste that poses no risk of injury or infections (e.g., paper, wood, scrap metals, tailings, and plastics).

total waste to total assets (*WASTE\_ASSETS*) and the ratio of the total waste to sales (*WASTE\_SALES*).

### 3.3. Empirical models

In this section, we describe the models used to examine the impact of waste management on firm performance. Equations (1) and (2) specifically test H1 and H2 by using ordinary least squares (OLS) regressions:

$$Performance_{i,t} = \beta_0 + \beta_1(WASTE)_{i,t,c} + \beta_2(Controls)_{i,t,c} + \beta_3(industry)_i + \beta_4(year)_t + \beta_5(country)_c + \varepsilon_{i,t,c} \quad (1)$$

$$Performance_{i,t} = \beta_0 + \beta_1(R\_WASTE)_{i,t,c} + \beta_2(Controls)_{i,t,c} + \beta_3(industry)_i + \beta_4(year)_t + \beta_5(country)_c + \varepsilon_{i,t,c} \quad (2)$$

where *Performance* represents our proxies for firm performance, i.e., *ROA*, *TQ*, *ROE*, *ROS*, and *SP*. *WASTE* refers to several measures of waste, including total waste (*WASTE*), hazardous waste (*H\_WASTE*), non-hazardous waste (*NH\_WASTE*), the waste to assets ratio (*WASTE\_ASSETS*), and the waste to sales ratio (*WASTE\_SALES*). *R\_WASTE* is the waste recycling ratio. In line with prior studies (Qiu et al., 2016; Hussain et al., 2018; Atif et al., 2021; Issa et al., 2021; Nadarajah et al., 2021), *Controls* is a vector of the control variables that may also influence firm performance. These variables include board size (*B\_SIZE*), board independence (*B\_IND*), board gender diversity (*F\_PRO*), separation of the CEO and board chair role (*SEPARATE*), research and development intensity (*R&D*), capital intensity (*CAP\_INT*), cash flows (*NCF*), financial leverage (*LEVERAGE*), financial crisis (*CRISIS*), institutional ownership (*INST\_OWN*), state ownership (*STATE\_OWN*), and firm size (*SIZE*). We also controlled for industry, year, and country effects. The definitions of all of the variables are given in Appendix 1.

To test H1, we focused on the coefficient  $\beta_1$  of Equation (1). In this case, if waste generation is negatively associated with firm performance, then the coefficient on *WASTE* ( $\beta_1$ ) should be negatively and statistically significant. To test H2, we focused on the coefficient  $\beta_1$  of Equation (2). In this regard, if waste recycling is positively associated with firm performance, then the coefficient on *R\_WASTE* ( $\beta_1$ ) should be positive and statistically significant.

## 4. Results

### 4.1. Univariate analysis

Table 2 reports the summary statistics for all of the variables. The average value of *ROA* and *TQ* was 0.075 and 1.581, respectively. Concerning waste management, the mean value of total waste (*WASTE*) and recycled waste (*R\_WASTE*) was 10.693 and 0.623, respectively. As for the corporate governance variables, we found that the average board size (*B\_SIZE*), the proportion of independent directors (*B\_IND*), and the proportion of female directors (*F\_PRO*) was 2.375, 0.714, and 0.147, respectively. Moreover, one third (33.5%) of the sample firms did not have a dual leadership structure (*SEPARATE*). In regard to the other control variables, Table 2 shows that the average research and development intensity (*RD\_INT*) was 0.021, the mean value of capital intensity (*CAP\_INT*) was 0.107, the average level of cash flow (*NCF*) was 15.258, and the average level of financial leverage (*LEVERAGE*) was 0.255. On average, 11.3% of the sample observations were from the global financial crisis (*CRISIS*). Moreover, institutions that owned (*INST\_OWN*) more than 5% equity consisted of 36.1% of the sample firms, firms in which the state owned (*STATE\_OWN*) more than 5% equity made up 11% of the sample observations, and the average firm size (*SIZE*) was 17.928.

**[Insert Table 2 here]**

Finally, Table 3 presents the correlation coefficients for all of the variables in the regression analysis. The highest correlation (0.616) was between the *ROA* and *TQ* because both are measures of firm performance, while total assets were used in the calculation of both variables. Prior studies (Abid et al., 2021; Atif et al., 2021; Nadarajah et al., 2021) have suggested that a correlation coefficient greater than 0.5 may imply a multicollinearity issue. In this regard, we used the *ROA* and *TQ* in separate regressions throughout this study in order to avoid this issue. Furthermore, the correlation coefficients, among other variables, were lower than the typical threshold of 0.5. We also calculated the variance inflation factors (VIF) for all of the variables. The results showed that the highest VIF value was 5.51, while the average value was 1.75, thus suggesting that multicollinearity was not a problem (Farooq et al., 2022).

**[Insert Table 3 here]**

## 4.2. Hypotheses testing

Table 4 presents the regression results for the impact of waste management practices, such as waste produced (*WASTE*) and waste recycled (*R\_WASTE*), on firm financial performance (i.e., *ROA* and *TQ*), after controlling for board characteristics, ownership structure, firms' economic conditions, and country, firm, and year fixed effects. Models 1 and 2 constitute the results of H1 testing in which we examined the effect of *WASTE* on *ROA* and *TQ*, respectively. The coefficient on *WASTE* was negatively and statistically significant at the 1% level in both models, indicating that higher levels of waste produced are associated with lower financial performance. Thus, H1 is supported.<sup>6</sup> As for the economic significance of the level of waste produced on financial performance, it is also important. For example, an increase in *WASTE* by one (sample) standard deviation (see Table 2) decreased the *ROA* and *TQ* by approximately 0.038 [ $WASTE (2.9) \times -0.001 / ROA (0.075) = -0.038$ ] and 0.051 [ $WASTE (2.9) \times -0.028 / TQ (1.581) = -0.051$ ], respectively.

In order to test H2, we investigated the link between recycled waste (*R\_WASTE*) and firm performance, the results of which are shown in Models 3 and 4. The coefficient on *R\_WASTE* was positive and statistically significant at the 1% level in both models, suggesting that higher levels of waste recycled are associated with higher financial performance. Hence, H2 is supported. Regarding the economic significance of the level of waste recycled on financial performance, it is also important. For example, an increase in *R\_WASTE* by one (sample) standard deviation (see Table 2) increased the *ROA* and *TQ* by approximately 0.39% [ $R\_WASTE (0.293) \times 0.001 / ROA (0.075) = 0.0039$ ] and 0.02% [ $R\_WASTE (0.293) \times 0.001 / TQ (1.581) = 0.0002$ ], respectively.

In addition, *B\_SIZE*, *F\_PRO*, *SEPARATE*, and *NCF* had a significant positive relationship with financial performance. Conversely, *RD\_INT*, *CAP\_INT*, *LEVERAGE*, *CRISIS*, *INST\_OWN*, *STATE\_OWN*, and *SIZE* had a significant negative relationship with financial performance. Our results are largely consistent with the extant literature, which

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<sup>6</sup> We are grateful to the anonymous reviewer for suggesting that we include discretionary accruals, as an additional control variable in our regression estimates, since financial performance may be subject to earnings management. Our main findings hold even after controlling for discretionary accruals, and these results are available from the corresponding author upon request. However, we did not control for discretionary accruals in the manuscript because the inclusion of such accruals in the regression estimates could have significantly reduced our sample size.

found that environmental initiatives are beneficial for both firms and society (e.g., Mishra and Suar, 2010; Boulouta, 2013; McGuinness et al., 2017).<sup>7</sup>

**[Insert Table 4 here]**

### **4.3. Robustness analysis**

We also re-performed our baseline analysis and found robust evidence that waste management can impact financial performance. We also considered whether our main results remain robust when using: (1) sub-components of waste as independent variables; (2) alternative measures of waste; (3) alternative measures of firm performance; (4) sub-samples of the G10 vs. the rest of the sample countries (i.e., non-G10); and (5) sub-samples of high corporate governance quality (i.e., high CG) and low corporate governance quality (i.e., low CG) firms. We also excluded dominating countries from the sample in order to perform the robustness analysis. Additionally, we used the same control variables as in the baseline regressions and included industry, year, and country fixed effects. The results are reported in Table 5.

Panel A reports the results when the independent variables are sub-components of waste, i.e., hazardous waste (*H\_WASTE*) and non-hazardous waste (*NH\_WASTE*). Hazardous waste is a form of waste that has the potential to be substantially harmful to human health and the environment. It includes solvent-based paints, pesticides, chemicals, batteries, and gases. Non-hazardous waste is a form of waste that does not cause any significant harm to human health or the environment. It includes clean glass and plastic, paper, and cardboard. Arguably, capital market participants, regulators, and other stakeholders may react more negatively to higher levels of hazardous waste produced than non-hazardous waste. In order to test this proposition, we examined the association between both components of waste (i.e., *H\_WASTE* & *NH\_WASTE*) and financial performance. The results showed that the coefficient on *H\_WASTE* and *NH\_WASTE* was negatively and statistically significant at the 1% level under all specifications, indicating that higher levels of waste produced are

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<sup>7</sup> We are grateful to guest editor Prof. Sabri Boubaker for suggesting examination of the impact of waste management on firm risk. We examined the impact of waste management on risk proxied by the standard deviation of earnings before interest, taxes, depreciation, and amortization (*EBITDA*). The results of this analysis are reported in Appendix 2. Specifically, the level of waste produced (recycled) is positively (negatively) associated with risk. These results are not only consistent with the interpretation of our main findings, but they also imply that higher levels of waste produced (recycled) can increase (decrease) risk, which may negatively (positively) impact financial performance.

associated with lower firm performance (irrespective of the nature of the waste), thus validating our main findings.

In Panel B, we ensured that our results were not subject to measurement issues. We also followed prior studies (Benjamin et al., 2020; Shahab et al., 2022) and used the waste to assets ratio (*WASTE\_ASSETS*) and the waste to sales ratio (*WASTE\_SALES*) as alternative measures to perform this analysis. We found that the coefficients of the alternative measures of waste (i.e., *WASTE\_ASSETS* & *WASTE\_SALES*) remained negatively and statistically significant across all the models, confirming that our results are not sensitive to measurement issues.

In Panel C, we tested the sensitivity of our main findings by using alternative measures of financial performance, i.e., *ROS*, measured as net income or loss divided by total sales; *ROE*, measured as net income or loss divided by total equity; and *SP*<sup>8</sup> (*SP*), proxied through year-end stock price. According to the results, *WASTE* (*R\_WASTE*) was negatively (positively) and significantly associated with all proxies of financial performance. These results also affirmed our main findings, i.e., firms generating (recycling) higher levels of waste tend to experience a decrease (increase) in financial performance. Taken together, our analysis suggests that our main findings are not driven by any specific measure of financial performance.

In Panel D, we performed an alternate sample analysis because our sample was mainly dominated by three countries: Japan (19.4% of our observations), the United Kingdom (10.7% of our observations), and the United States (10.4% of our observations). Collectively, 40.5% of the sample firms belonged to these countries. To ensure that the findings of the main analysis were not driven by the presence of these countries in our sample, we re-estimated Equations (1) and (2) to examine the association between waste management and financial performance by using an alternate sample. The results were qualitatively similar to those reported in the main analysis (i.e., Table 4), thus confirming that our results were not sensitive to alternate sample composition.

In Panel E, we performed a sub-sample analysis by dividing the sample into G10 and non-G10 countries, since more than 60% of the firms belonged to G10 countries. To ensure that the findings of the main analysis were not due to the inclusion of G10 countries in the sample, we re-estimated Equations (1) and (2) to examine the association between waste management and financial performance by using these sub-samples. According to the results,

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<sup>8</sup> We are grateful to the anonymous reviewer for this suggestion.

the level of waste produced (recycled) was negatively (positively) associated with financial performance in both sub-samples, suggesting that the association between waste management and financial performance was not driven by the inclusion of G10 countries in our sample. Hence, our results are generalizable across G10 and non-G10 countries.

Finally, in Panel F, we addressed the concern that our results were not driven by firm-level CG quality. Following Saeed et al. (2022), we re-estimated Equations (1) and (2) after dividing our sample into high CG and low CG firms. Specifically, firms were assigned to the high (low) CG sample if their Asset4<sup>9</sup> corporate governance performance score was higher (lower) than the sample average. Based on the results, higher levels of waste produced (recycled) were negatively (positively) and significantly associated with financial performance in both sub-samples. Hence, our results are not subject to firm-level CG quality.

**[Insert Table 5 here]**

#### **4.4. Exploring channels**

In Table 4, we found that waste management impacted the financial performance of the sample firms. To further explore the plausible channels through which waste management affects financial performance, we performed several analyses based on the following: (1) the firms' operating costs<sup>10</sup>; (2) the ESG performance-based compensation policy; (3) the nature of the industry; (4) global environmental initiatives, e.g., the Paris agreement on climate change; and (5) the global financial crisis. The results are reported in Table 6.

Waste management (i.e., waste generation and recycling) most likely impacts financial performance through its effect on firms' operating and production costs. Moreover, a higher level of waste produced most likely increases firms' operating costs, due to additional expenditures on the disposal of waste. As a result, firms' production costs will increase, which may negatively impact financial performance. Alternatively, higher levels of waste recycled most likely decreases firms' operating costs because of the use of recycled materials in the production process. Consequently, production costs will decrease, which may positively impact financial performance.

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<sup>9</sup> The Thomson Reuters 2017 report on ESG scores stated that the Asset4 corporate governance score is based on 54 indicators of corporate governance practices related to the management, shareholders, and CSR strategy of the company. The weight of the corporate governance pillar's score in the overall ESG score was 30.5%.

<sup>10</sup> We are grateful to editor Prof. Sushanta K. Mallick for this suggestion.

In order to empirically test whether waste management practices influence financial performance through operating costs, we created two new variables, i.e., *WASTE X OP\_COST* and *R\_WASTE X OP\_COST*, which are the interaction terms between the level of waste produced, the level of waste recycled, and firms' operating costs, respectively. We then added *OP\_COST*, *WASTE X OP\_COST*, and *R\_WASTE X OP\_COST* to our main empirical models and re-estimated Equations (1) and (2). The results of this analysis, as reported in Columns 1–4 of Table 6 (Panel A), demonstrate that the coefficient on *WASTE X OP\_COST* (*R\_WASTE X OP\_COST*) is negatively (positively) significant for *ROA* and *TQ*, suggesting that waste management practices can affect financial performance through operating costs.

The presence of sustainability or ESG performance-based compensation policies demonstrates the commitment of firms to shape the behavior of management in response to the increasing demands of shareholders, with the aim of meeting long-term sustainability goals such as lower levels of waste generation and increased levels of recycling. In this regard, prior studies (e.g., Velte, 2016) have documented that the implementation of ESG performance-based compensation policies for management is positively associated with CSR performance, thus suggesting that ESG performance-based compensation might be a channel that can shape the behavior of management regarding the implementation of effective waste management practices. This may, in turn, also influence financial performance.

To empirically test these arguments, we conducted a sub-sample analysis based on firms with and without ESG performance-based compensation policies. Panel B of Table 6 presents the results of this analysis. For the sub-sample of firms with an ESG performance-based compensation policy, we found no significant association between the level of waste produced (*WASTE*) or recycled (*R\_WASTE*) and financial performance, suggesting that such a policy mitigates the negative impact of higher levels of waste produced on financial performance. However, *WASTE* (*R\_WASTE*) is negatively (positively) and significantly associated with the financial performance of firms with no ESG performance-based compensation policy, thus implying that stakeholders penalize (reward) firms more if firms with no such policy engage in anti- (pro-) environmental behavior, e.g., higher (lower) levels of waste produced and lower (higher) levels of recycling. Although these results are not in complete agreement with prior studies documenting the favorable impact of ESG performance-based compensation policies (e.g., Velte, 2016), they still show that stakeholders reward firms for their pro-environmental initiatives.

The impact of waste management on financial performance can also vary across industries.<sup>11</sup> Extant studies (Boiral and Heras-Saizarbitoria, 2017; Nadeem et al., 2020) have argued that firms operating in environmentally sensitive industries are subject to greater scrutiny from regulators and stakeholders regarding the impact of their operations on the environment than those operating in other industries. Thus, firms belonging to environmentally sensitive industries are likely to be more sensitive to environmental issues, e.g., waste management.

To test these predictions, we performed a sub-sample analysis by dividing our sample into firms belonging to environmentally sensitive and environmentally non-sensitive industries.<sup>12</sup> Panel C of Table 6 presents the results of this analysis. We found that *WASTE* (*R\_WASTE*) was negatively (positively) associated with the financial performance of firms operating in environmentally sensitive industries. Conversely, neither *WASTE* nor *R\_WASTE* had a significant impact on the financial performance of firms belonging to environmentally non-sensitive industries. Overall, these findings are in line with prior studies (Boiral and Heras-Saizarbitoria, 2017; Nadeem et al., 2020) on the impact of anti- or pro-environmental practices on firms belonging to environmentally sensitive industries. In other words, stakeholders react negatively (positively) to the higher levels of waste produced (recycled) by firms operating in environmentally sensitive industries, which can have negative (positive) effects on financial performance.

Global environmental pacts or initiatives, such as the Paris agreement on climate change, can also have a bearing on the association between waste management and the financial performance of firms.<sup>13</sup> The Paris agreement, which aims at achieving a climate-neutral world by the mid-century, was signed by 196 countries on December 12, 2015. Such initiatives can enhance the understanding of stakeholders regarding the grave nature of the climate change issue and the fact that the large-scale operations of corporations also have a detrimental effect on the environment and climate. Consequently, stakeholders are highly likely to reward and penalize firms for their environmentally (ir)responsible actions.

To empirically test these arguments, we divided our sample into pre- and post-Paris agreement periods, and re-estimated Equations (1) and (2). Panel D of Table 6 presents the

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<sup>11</sup> We are grateful to the anonymous reviewer for suggesting this line of reasoning.

<sup>12</sup> Firms operating in the agricultural, chemical, forestry, fishing and mining, metal, petroleum, and construction industries are included in the environmentally sensitive sample, while the rest of the firms are included in the environmentally non-sensitive sample (Cho et al., 2010; Nadeem et al., 2020).

<sup>13</sup> We are grateful to the anonymous reviewer for suggesting this line of reasoning.

results of this analysis. For the post-agreement period, we found that *WASTE* (*R\_WASTE*) was negatively (positively) associated with financial performance. In contrast, neither *WASTE* nor *R\_WASTE* had a significant impact on financial performance for the pre-agreement period. The significant impact of waste management practices on the financial performance of firms for only the post-agreement period validates our argument that global environmental initiatives have a bearing on firms' financial performance.

Finally, we presumed that the global financial crisis would have an impact on the relationship between waste management and firms' financial performance. In this regard, some scholars (e.g., Lins et al., 2017; Saeed et al., 2022) have argued that the primary objective of firms during this crisis was to survive, rather than pursue environmentally friendly initiatives that require financial resources. Thus, we expected a more pronounced effect of waste management on financial performance during the normal period.

In order to validate these arguments, we re-estimated Equations (1) and (2) by using the sub-samples from the global financial crisis period (i.e., 2007–2009) and the normal period (i.e., the rest of the sample years). Panel E of Table 6 presents the results. We found that *WASTE* (*R\_WASTE*) was negatively (positively) associated with the financial performance of firms during the normal period. Conversely, neither *WASTE* nor *R\_WASTE* had a significant impact on the financial performance of firms during the crisis period. Taken together, these results support the arguments of Lins et al. (2017) and Saeed et al. (2022), i.e., firms tend to be more concerned about survival than sustainability practices (i.e., waste management) during times of crisis. Moreover, stakeholders understand this issue and do not penalize them for not actively pursuing sustainability practices during such times.

**[Insert Table 6 here]**

#### **4.5. Identification strategies**

Our main results, which are based on OLS estimations, might be subject to potential endogeneity issues due to self-selection bias or reverse causality. Self-selection bias implies that better financial performance may be due to firm-specific factors such as CG characteristics, ownership structure, research and development intensity, or other factors (i.e., control variables) than waste management practices. Hence, we followed previous studies (Gull et al., 2018; Benjamin et al., 2020; Nekhili et al., 2020; Atif et al., 2021; Usman et al., 2022; Shahab et al., 2021) and mainly relied on three techniques (i.e., PSM, the lagged

independent variable (IV) approach, and 2SLS estimations) to address potential endogeneity concerns.

We also applied PSM to address the potential issue of self-selection bias, which refers to the possibility that better or worse financial performance is the result of firm-level factors, rather than the efficacy of waste management practices (Gull et al., 2018; Nekhili et al., 2020). To perform PSM, we created two treatment dummy variables, i.e., *WASTE\_DUMMY* and *R\_WASTE\_DUMMY*, which are based on the sample average of waste produced and recycled, respectively. In this case, *WASTE\_DUMMY* and *R\_WASTE\_DUMMY* took the value of 1 if the firm produced and recycled waste more than the sample average, or 0 otherwise. Additionally, we formed the treatment and control groups by using these dummy variables. The treatment group included firms that produced and recycled waste more than the sample average, while the control group consisted of firms that produced and recycled waste less than the sample average. We then estimated the predicted value of implementing effective waste management practices by estimating the logit regressions for both dummy variables (*WASTE\_DUMMY* & *R\_WASTE\_DUMMY*) on the same control variables used in Equations (1) and (2).<sup>14</sup> This process yielded the propensity scores for all of the firm-year observations. Next, we composed two identical sub-samples based on different criteria (i.e., the treatment and control group) by using the propensity scores. Moreover, we used a matched sample to investigate the nexus of waste management practices and financial performance.

Additionally, we conducted diagnostic tests to ensure that PSM was applied correctly. First, we performed logit regressions by using *WASTE\_DUMMY* and *R\_WASTE\_DUMMY* as dependent variables on the original and matched sample. The results of the pre- and post-matched logit regressions using *WASTE\_DUMMY* and *R\_WASTE\_DUMMY* as dependent variables are reported in Models 1–2 and Models 5–6 of Table 7 (Panel A), respectively. According to the results, in the pre-matched logit regressions, several firm-level variables were significantly associated with *WASTE\_DUMMY* and *R\_WASTE\_DUMMY*, while none of the firm-level variables were significantly associated with *WASTE\_DUMMY* and *R\_WASTE\_DUMMY* in the post-matched logit regressions. This implies that the PSM procedure was applied correctly. Second, we conducted a post-matched sample univariate analysis to ensure that the treatment and control groups were comparable and there were no significant differences between the two groups. Panel B of Table 7 reports the results of the

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<sup>14</sup> The matching was performed by using the nearest neighbor option and by setting the caliper distance at 1%.

mean differences between the characteristics of the treatment and control groups. Based on the findings, both groups were identical, confirming the accuracy of the PSM procedure.

We also re-estimated Equations (1) and (2) by using a matched sample. According to the results in Table 7 (Models 3–4 and 7–8), they are qualitatively similar to those reported in the main analysis (see Table 4). This confirms that the negative (positive) association between higher levels of waste produced (recycled) and financial performance is not the result of firm-level characteristics.

**[Insert Table 7 here]**

Overall, our results suggest that waste management practices can affect firms' financial performance. However, firms with better (poor) financial performance may have an active (passive) approach toward sustainable business practices, due to the abundance (lack) of financial resources required to implement waste management initiatives. This implies that not only waste management practices can affect financial performance, but that financial performance can also affect such practices. This situation is known as reverse causality.

We also used the lagged independent variables approach to tackle the issue of reverse causality (Atif et al., 2021), since it is highly unlikely that the current year's financial performance will have any impact on the level of waste produced or recycled in the previous year. In order to perform this analysis, we used the one-year lag of total waste produced ( $WASTE_{t-1}$ ) and recycled ( $R\_WASTE_{t-1}$ ) and re-estimated Equations (1) and (2). The results of this analysis, as reported in Table 8, are comparable to our main results reported in Table 4, across all specifications.

**[Insert Table 8 here]**

Furthermore, we used 2SLS estimates to further address the issue of endogeneity, due to reverse causality. Following Benjamin et al. (2020), we used one-year lagged values ( $L\_WASTE$  &  $L\_R\_WASTE$ ) and the industry average of total waste produced and recycled ( $WASTE\_IA$  &  $R\_WASTE\_IA$ ) as instrumental variables to perform the 2SLS estimations. Both instruments were likely to meet the exclusion criterion by (not) being correlated with the (dependent variables, i.e.,  $ROA$  and  $TQ$ ) likelihood of having effective waste management practices in place, i.e., less waste and more recycling.

The results of the first-stage estimates are reported in Models 1, 3, 5, and 7 of Table 9, where the level of waste produced (*WASTE*) and recycled (*R\_WASTE*) are the dependent variables, respectively. In these regressions, we controlled for all of the variables in Equations (1) and (2), including industry, year, and country fixed effects. As shown in the first-stage estimates, the coefficients for all of the instrumental variables (*WASTE\_IA*, *R\_WASTE\_IA*, *L.WASTE*, & *L.R\_WASTE*) were positively and statistically significant at the 1% level. We also reported several diagnostic tests, i.e., the under-identification test (Kleibergen-Paap rk LM statistic), weak identification tests (Cragg-Donald Wald F statistic and Kleibergen-Paap rk Wald F statistic), and Stock-Yogo weak ID test critical values at different IV sizes, in order to validate the choice of instruments. The Kleibergen-Paap rk LM statistic was highly significant, suggesting that our instruments were not under-identified. The Cragg-Donald Wald F statistic and the Kleibergen-Paap rk Wald F statistic were also highly significant in all of the first-stage estimates. Meanwhile, the Stock-Yogo weak ID test's critical values at different IV sizes were lower than the Cragg-Donald Wald F statistic in all of the first-stage estimates, thereby confirming that our instruments were not weak. Additionally, the Hansen *J*-statistic was not significant in all of the specifications, suggesting that our instruments were valid. Models 2, 4, 6, and 8 of Table 9 report the results of the second-stage estimates by using the predicted values of *WASTE* and *R\_WASTE* from the first-stage models to estimate financial performance (*ROA* and *TQ*). According to the findings, there was a negative (positive) and statistically significant (at the 1% level) coefficient on *WASTE* (*R\_WASTE*). Therefore, we can reliably infer that a higher level of waste produced (recycled) is associated with lower (higher) levels of financial performance.

**[Insert Table 9 here]**

## **5. Conclusion**

In recent years, climate change and soaring temperatures have emerged as major threats to the sustainability of our planet (Nyambuu and Semmler, 2020). Meanwhile, the world continues to generate enormous amounts of solid waste per year, which ends up in landfills and ultimately emits greenhouse gases that further impact the climate (Clifford, 2021). Prior studies (e.g., Mishra and Suar, 2010; Boulouta, 2013; McGuinness et al., 2017; Hussain et al., 2018; Atif et al., 2021) regarding the effect of environmentally friendly initiatives on firm performance have largely ignored an important aspect, i.e., waste management. Thus, we extended the existing literature on firm financial performance by

proposing a new perspective on waste management. Using an unbalanced panel of 14,601 firm-year observations, representing 2,284 unique firms from 41 countries over the 2002–2019 period, we provided reliable evidence to suggest that firms’ waste management practices can significantly affect their financial performance.

We also found a negative (positive) impact of the level of waste produced (recycled) on financial performance. A negative association between waste generation and financial performance was also observed for the sub-components of waste, i.e., hazardous and non-hazardous waste. While testing for plausible channels, we found that waste management mainly affects financial performance through firms’ operating costs. Additionally, we documented that the negative impact of waste on financial performance was mitigated by the introduction of ESG performance-based compensation policies. We also showed that the negative (positive) impact of the level of waste produced (recycled) on financial performance can vary across firms operating in environmentally sensitive and environmentally non-sensitive industries, thus suggesting that stakeholders expect environmentally sensitive firms to better manage their waste. Moreover, we observed a pronounced relationship post-Paris agreement on climate change and during the entire sample period, except during the global financial crisis.

Overall, our main findings are robust to the sub-components of waste, alternative measures of waste and financial performance, and the composition of the sub-samples. We also applied several identification strategies, including PSM, the lagged independent variable approach, and 2SLS, the findings of which were upheld. Furthermore, our results not only support the arguments of Gallego-Álvarez et al. (2015) and Awaysheh et al. (2020), i.e., firms’ environmentally friendly initiatives reward them in the long run (as shareholders’ wealth is linked to stakeholders’ welfare), but they are also consistent with stakeholders’ orientation theory.

This study also offers important implications for academic research and policy formulation. For academic research, it adds to the scarce literature on waste management practices at the firm level (Benjamin et al., 2020; Shahab et al., 2022). The main policy implications of our study are that effective waste management practices can yield higher financial performance, while the implementation of ESG performance-based compensation policies for managers can mitigate the negative effects of waste on financial performance. As a result, firms should consider paying closer attention to their waste management practices and linking the compensation of key executives to long-term sustainability goals. In addition, given the global focus on sustainable development agendas, our study provides important

empirical evidence for policymakers, which can be used to inform their decision-making on the development of environmentally friendly initiatives (i.e., waste management and recycling) that can enhance firms' financial performance. Our robust cross-country findings can also be the impetus for formulating sustainable development policies across different countries.

Finally, our study includes several limitations. First, the data related to waste management was sourced from Asset4, which only covers large firms. Thus, our findings may not be applicable to small and medium-sized firms. Second, our study did not differentiate between controllable and non-controllable waste because of the unavailability of such data. Although we provided international evidence, our findings should be interpreted with caution because the results may vary across countries, due to different governance and environmental regulations. Hence, future studies should examine the influence of controllable and non-controllable waste on financial performance. Such research may also be able to distinguish the trade-off between waste generation and firms' production of goods and services. Finally, an interesting avenue for research might be examining the impact of waste management on other firm-level aspects of significant importance to stakeholders, i.e., the costs of debt and mergers and acquisitions.

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**Table 1:** Sample distribution by country and year**Panel A:** Sample distribution by country

<i>Country</i>	<i>Firms</i>	<i>N</i>	<i>ROA</i>	<i>TQ</i>	<i>WASTE</i>	<i>Country</i>	<i>Firms</i>	<i>N</i>	<i>ROA</i>	<i>TQ</i>	<i>WASTE</i>
ARGENTINA	12	33	0.121	2.297	8.902	MALAYSIA	34	142	0.112	2.278	8.822
AUSTRALIA	96	584	0.071	1.548	11.956	MEXICO	24	120	0.108	1.988	11.823
AUSTRIA	14	93	0.056	1.179	10.903	NETHERLANDS	38	295	0.078	1.602	10.833
BELGIUM	19	153	0.071	1.486	10.711	NEW ZEALAND	7	31	0.109	1.835	7.915
BRAZIL	56	340	0.086	1.556	11.787	NORWAY	18	143	0.062	1.387	10.814
CANADA	116	655	0.049	1.413	12.797	PERU	9	23	0.065	1.086	9.978
CHILE	27	128	0.072	1.391	10.434	PHILIPPINES	18	67	0.081	1.541	8.852
CHINA	92	254	0.061	1.353	11.745	POLAND	17	93	0.051	1.006	11.505
COLOMBIA	19	95	0.067	1.237	8.988	PORTUGAL	12	72	0.056	1.311	10.328
DENMARK	21	173	0.132	3.174	9.952	RUSSIA	23	176	0.115	1.307	14.824
FINLAND	27	259	0.092	1.783	10.836	SOUTH AFRICA	38	193	0.089	1.482	10.579
FRANCE	96	845	0.065	1.506	10.863	SOUTH KOREA	72	499	0.066	1.179	10.871
GERMANY	86	627	0.065	1.492	11.792	SPAIN	50	374	0.068	1.409	9.925
GREECE	9	45	0.031	1.014	9.617	SWEDEN	25	173	0.079	1.658	10.965
HONG KONG	139	482	0.057	1.535	10.448	SWITZERLAND	46	428	0.079	2.139	9.936
HUNGARY	3	25	0.052	0.976	10.449	TAIWAN	49	248	0.072	1.469	9.973
INDIA	45	227	0.105	2.252	11.601	THAILAND	14	90	0.079	1.438	9.932
INDONESIA	14	57	0.104	2.401	11.576	TURKEY	12	63	0.074	1.297	10.959
ISRAEL	5	30	0.067	1.509	10.761	UNITED KINGDOM	228	1,560	0.072	1.691	10.906
ITALY	55	344	0.054	1.346	10.821	UNITED STATES	277	1,525	0.085	1.999	10.934
JAPAN	322	2,837	0.059	1.272	10.806	All Countries	2,284	14,601	0.075	1.581	10.693

**Panel B:** Sample distribution by year

<i>Year</i>	<i>N</i>	<i>ROA</i>	<i>TQ</i>	<i>WASTE</i>	<i>Year</i>	<i>N</i>	<i>ROA</i>	<i>TQ</i>	<i>WASTE</i>
2002	43	0.065	1.388	11.018	2011	931	0.072	1.411	10.472
2003	70	0.076	1.633	11.139	2012	1008	0.073	1.439	10.697
2004	123	0.094	1.671	10.925	2013	1079	0.065	1.535	10.273
2005	226	0.101	1.707	11.062	2014	1155	0.061	1.524	10.706
2006	271	0.101	1.878	10.527	2015	1225	0.061	1.577	10.594
2007	429	0.096	1.812	11.006	2016	1357	0.064	1.571	10.595
2008	556	0.085	1.411	11.085	2017	1524	0.069	1.738	10.399
2009	674	0.055	1.415	10.166	2018	1610	0.077	1.584	10.501
2010	849	0.078	1.516	10.805	2019	1471	0.067	1.653	10.516
					All Years	14,601	0.075	1.581	10.693

This table reports the distribution of the sample by country and year. The final sample consisted of 14,601 firm-year observations from 41 countries between 2002 and 2019.

**Table 2:** Descriptive statistics

<b>Variables</b>	<b>Observations</b>	<b>Mean</b>	<b>Standard deviation</b>	<b>Minimum</b>	<b>1st quartile</b>	<b>Median</b>	<b>3<sup>rd</sup> quartile</b>	<b>Maximum</b>
<i>ROA</i>	14,601	0.075	0.078	-0.690	0.034	0.067	0.109	0.406
<i>TQ</i>	14,601	1.581	1.010	0.632	1.018	1.247	1.753	9.215
<i>WASTE</i>	14,601	10.693	2.900	4.082	8.758	10.507	12.383	19.187
<i>R_WASTE</i>	10,304	0.623	0.293	0.000	0.412	0.680	0.879	1.000
<i>B_SIZE</i>	14,601	2.375	0.320	1.386	2.197	2.398	2.565	3.045
<i>B_IND</i>	14,601	0.714	0.254	0.000	0.600	0.786	0.900	1.000
<i>F_PRO</i>	14,601	0.147	0.131	0.000	0.000	0.125	0.250	0.471
<i>SEPARATE</i>	14,601	0.335	0.472	0.000	0.000	0.000	1.000	1.000
<i>RD_INT</i>	14,601	0.021	0.042	0.000	0.000	0.001	0.025	0.511
<i>CAP_INT</i>	14,601	0.107	0.204	0.000	0.027	0.051	0.111	4.260
<i>NCF</i>	14,601	15.258	2.668	7.674	13.236	14.879	17.271	21.073
<i>LEVERAGE</i>	14,601	0.255	0.162	0.000	0.137	0.246	0.357	0.911
<i>CRISIS</i>	14,601	0.113	0.317	0.000	0.000	0.000	0.000	1.000
<i>INST_OWN</i>	14,601	0.361	0.480	0.000	0.000	0.000	1.000	1.000
<i>STATE_OWN</i>	14,601	0.110	0.313	0.000	0.000	0.000	0.000	1.000
<i>SIZE</i>	14,601	17.928	2.712	10.845	15.799	17.441	20.053	23.867

This table presents the descriptive statistics for all of the variables. All of the variables are defined in Appendix 1.

**Table 3:** Correlation matrix

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	VIFs
1. ROA	1.000																
2. TQ	0.616*	1.000															
3. WASTE	-0.025*	-0.144*	1.000														1.07
4. R_WASTE	0.019	0.003	-0.077*	1.000													1.12
5. B_SIZE	-0.080*	-0.122*	0.100*	0.079*	1.000												1.11
6. B_IND	0.080*	0.137*	0.005	-0.262*	-0.018*	1.000											1.46
7. F_PRO	0.042*	0.120*	-0.058*	-0.086*	0.025*	0.448*	1.000										1.40
8. SEPARATE	0.021*	0.031*	0.024*	0.048*	0.096*	-0.113*	-0.058*	1.000									1.05
9. RD_INT	0.087*	0.202*	-0.127*	0.114*	-0.045*	-0.076*	-0.062*	0.108*	1.000								1.11
10. CAP_INT	-0.076*	-0.083*	0.028*	-0.147*	-0.062*	0.048*	-0.005	-0.045*	-0.108*	1.000							1.06
11. NCF	0.010	-0.126*	0.129*	0.160*	0.207*	-0.440*	-0.364*	0.097*	0.058*	-0.121*	1.000						5.44
12. LEVERAGE	-0.156*	-0.123*	0.082*	-0.061*	0.091*	0.059*	0.024*	0.027*	-0.186*	0.147*	-0.015	1.000					1.08
13. CRISIS	0.016*	-0.016	0.040*	-0.001	0.011	-0.033*	-0.168*	0.066*	0.043*	-0.006	-0.024*	-0.010	1.000				1.05
14. INST_OWN	0.026*	0.066*	-0.043*	-0.020*	-0.101*	0.056*	0.104*	-0.011	0.048*	0.030*	-0.237*	0.001	0.042*	1.000			1.08
15. STATE_OWN	-0.037*	-0.076*	0.022*	-0.097*	0.083*	0.157*	0.166*	-0.079*	-0.116*	0.066*	-0.016*	0.069*	-0.035*	-0.071*	1.000		1.08
16. SIZE	-0.151*	-0.262*	0.092*	0.160*	0.233*	-0.442*	-0.357*	0.085*	0.010	-0.108*	0.478*	0.014	-0.035*	-0.246*	0.003	1.000	5.51

This table presents the correlation coefficients for all of the variables.

All of the variables are as defined in Appendix 1.

\* Significance at the 0.05 level.

**Table 4:** Waste management and firm performance

Variables	(1) <i>ROA</i>	(2) <i>TQ</i>	(3) <i>ROA</i>	(4) <i>TQ</i>
<i>WASTE</i>	-0.001*** (-4.31)	-0.028*** (-7.37)		
<i>R_WASTE</i>			0.001*** (6.00)	0.001*** (3.33)
<i>B_SIZE</i>	0.003 (1.25)	0.067** (2.53)	0.004 (0.19)	0.051 (1.56)
<i>B_IND</i>	-0.000 (-0.08)	0.036 (0.69)	0.004 (0.86)	0.043 (0.68)
<i>F_PRO</i>	0.025*** (4.09)	0.388*** (5.19)	0.026*** (3.64)	0.354*** (3.89)
<i>SEPARATE</i>	0.001 (0.69)	0.028* (1.76)	0.001 (0.58)	0.052*** (2.72)
<i>RD_INT</i>	-0.074*** (-4.46)	2.116*** (10.28)	-0.070*** (-3.79)	2.061*** (8.62)
<i>CAP_INT</i>	-0.017*** (-5.42)	-0.106*** (-2.69)	0.002 (0.48)	-0.107** (-2.21)
<i>NCF</i>	0.040*** (54.72)	0.396*** (43.19)	0.039*** (46.43)	0.391*** (35.49)
<i>LEVERAGE</i>	-0.069*** (-17.94)	-0.191*** (-3.99)	-0.070*** (-15.30)	-0.184*** (-3.11)
<i>CRISIS</i>	-0.022** (-2.28)	-0.162 (-1.31)	-0.116*** (-2.71)	-1.382** (-2.50)
<i>INT_OWN</i>	-0.004*** (-3.50)	-0.068*** (-4.51)	-0.003** (-2.20)	-0.053*** (-2.93)
<i>STATE_OWN</i>	-0.003* (-1.74)	-0.115*** (-4.69)	-0.001 (-0.41)	-0.072** (-2.42)
<i>SIZE</i>	-0.039*** (-46.90)	-0.476*** (-45.22)	-0.040*** (-42.75)	-0.490*** (-39.96)
<i>Intercept</i>	0.241*** (14.01)	4.798*** (22.34)	0.350*** (7.63)	6.161*** (10.37)
<i>Observations</i>	14,601	14,601	10,304	10,304
<i>Industry</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.362	0.408	0.377	0.424
<i>F-stat</i>	63.38	76.52	48.51	58.79

This table presents the regression results for the relationship between waste management and financial performance. \*, \*\*, and \*\*\* represent significance at the 0.1, 0.05, and 0.01 levels, respectively.

T-statistics are given in parentheses.

All of the variables are as defined in Appendix 1.

**Table 5:** Robustness analysis**Panel A:** Sub-components of waste and firm performance

Variables	(1) <i>ROA</i>	(2) <i>TQ</i>	(3) <i>ROA</i>	(4) <i>TQ</i>
<i>H_WASTE</i>	-0.001** (-2.20)	-0.023*** (-5.39)		
<i>NH_WASTE</i>			-0.001*** (-2.63)	-0.016*** (-3.26)
<i>Controls</i>	Yes	Yes	Yes	Yes
<i>Observations</i>	7,182	7,182	7,526	7,526
<i>Industry</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.406	0.454	0.400	0.447
<i>F-stat</i>	38.99	47.28	39.66	47.88

**Panel B:** Alternate measures of waste and firm performance

Variables	(1) <i>ROA</i>	(2) <i>TQ</i>	(3) <i>ROA</i>	(4) <i>TQ</i>
<i>WASTE_ASSETS</i>	-0.031*** (-6.07)	-0.567*** (-8.77)		
<i>WASTE_SALES</i>			-0.045*** (-9.21)	-0.654*** (-10.62)
<i>Controls</i>	Yes	Yes	Yes	Yes
<i>Observations</i>	14,601	14,601	14,599	14,599
<i>Industry</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.363	0.408	0.365	0.410
<i>F-stat</i>	63.59	76.81	64.14	77.26

**Panel C:** Waste management and firm performance: Using alternate measures of performance

Variables	(1) <i>ROE</i>	(2) <i>ROS</i>	(3) <i>SP</i>	(4) <i>ROE</i>	(5) <i>ROS</i>	(6) <i>SP</i>
<i>WASTE</i>	-0.003** (-2.21)	-0.009*** (-6.74)	-0.871** (-2.00)			
<i>R_WASTE</i>				0.001*** (4.34)	0.001*** (4.88)	0.088** (2.32)
<i>Controls</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Observations</i>	14,601	14,601	11,386	10,304	10,304	8,144
<i>Industry</i>	Yes	Yes	Yes	Yes	Yes	Yes

<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.132	0.189	0.230	0.152	0.280	0.267
<i>F-stat</i>	17.74	26.55	45.17	15.14	31.53	24.56

**Panel D:** Waste management and firm performance: Excluding firms from Japan, the United Kingdom, and the United States

Variables	(1) <i>ROA</i>	(2) <i>TQ</i>	(3) <i>ROA</i>	(4) <i>TQ</i>
<i>WASTE</i>	-0.001*** (-3.78)	-0.021*** (-4.43)		
<i>R_WASTE</i>			0.001*** (5.51)	0.002*** (5.06)
<i>Controls</i>	Yes	Yes	Yes	Yes
<i>Observations</i>	8,679	8,679	5,845	5,845
<i>Industry</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.388	0.452	0.412	0.485
<i>F-stat</i>	44.31	57.35	33.43	44.76

**Panel E:** Waste management and firm performance: G10 vs. non-G10 countries

	G10 (1) <i>ROA</i>	Non-G10 (2) <i>ROA</i>	G10 (3) <i>TQ</i>	Non-G10 (4) <i>TQ</i>	G10 (5) <i>ROA</i>	Non-G10 (6) <i>ROA</i>	G10 (7) <i>TQ</i>	Non-G10 (8) <i>TQ</i>
<i>WASTE</i>	-0.001*** (-4.94)	-0.001*** (-3.10)	-0.034*** (-8.18)	-0.038** (-6.02) *				
<i>R_WASTE</i>					0.001** (2.21)	0.001*** (4.14)	0.001** (2.01)	0.003*** (4.69)
<i>Controls</i>	Yes	Yes	Yes	Yes	<i>Controls</i>	Yes	Yes	Yes
<i>Observations</i>	9,442	5,159	9,442	5,159	6,879	3,425	6,879	3,425
<i>Industry</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.307	0.299	0.393	0.403	0.344	0.405	0.392	0.449
<i>F-stat</i>	117.3	60.32	70.61	41.09	42.50	29.82	52.07	35.49

**Panel F:** Waste management and firm performance: The role of corporate governance (CG) quality

	High CG (1) <i>ROA</i>	Low CG (2) <i>ROA</i>	High CG (3) <i>TQ</i>	Low CG (4) <i>TQ</i>	High CG (5) <i>ROA</i>	Low CG (6) <i>ROA</i>	High CG (7) <i>TQ</i>	Low CG (8) <i>TQ</i>
Variables								

<i>WASTE</i>	-0.002** *	-0.001** *	-0.044** *	-0.012**				
	(-4.85)	(-3.37)	(-8.63)	(-2.11)				
<i>R_WASTE</i>					0.001*** (5.81)	0.001** (2.31)	0.001*** (3.33)	0.002*** (3.35)
<i>Controls</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Observations</i>	8,133	6,468	8,133	6,468	5,810	4,494	5,810	4,494
<i>Industry</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.362	0.331	0.390	0.441	0.382	0.391	0.527	0.624
<i>F-stat</i>	37.95	42.56	42.52	39.40	29.67	23.15	18.36	19.34

This table presents the regression results of the robustness tests for the relationship between waste management and financial performance. We included all of the control variables in the regressions, as reported in Table 4. However, for brevity, we only present the results for the main independent variables. All of the regressions controlled for industry, year, and country fixed effects. In the regressions in Panel A, we replaced our main proxy of waste (*WASTE*) with the sub-components of waste, i.e., hazardous (*H\_WASTE*) and non-hazardous waste (*NH\_WASTE*). In the regressions in Panel B, we replaced our main proxy of waste (*WASTE*) with alternate measures of waste, i.e., the waste to assets ratio (*WASTE\_ASSETS*) and waste to sales ratio (*WASTE\_SALES*). In the regressions in Panel C, we replaced our main proxies of financial performance (*ROA* and *TQ*) with alternate measures of financial performance, i.e., return on sales (*ROS*) and return on equity (*ROE*). Panel D presents the regression results, excluding the dominating countries from the sample, i.e., Japan, the United States, and the United Kingdom. Panel E presents the regression results by using the sub-samples of firms from G10 and non-G10 countries. Panel F reports the regression results by using the sub-samples of high and low corporate governance quality firms.

\*, \*\*, and \*\*\* represent significance at the 0.1, 0.05, and 0.01 levels, respectively.

T-statistics are given in parentheses.

All of the variables are as defined in Appendix 1.

**Table 6:** Exploring Channels**Panel A:** Waste management and firm performance: The role of operating costs

Variables	(1) <i>ROA</i>	(2) <i>TQ</i>	(3) <i>ROA</i>	(4) <i>TQ</i>
<i>WASTE</i>	-0.616*** (-6.98)	-0.134*** (-10.02)		
<i>R_WASTE</i>			-0.001 (-0.41)	-0.001 (-0.60)
<i>OP_COST</i>	-0.651*** (-6.13)	-0.080*** (-4.98)	-0.001 (-1.27)	0.001 (0.04)
<i>WASTE X OP_COST</i>	-0.041*** (-4.95)	-0.010*** (-8.01)		
<i>R_WASTE X OP_COST</i>			0.001* (1.67)	0.001* (1.87)
Controls	Yes	Yes	Yes	Yes
<i>Observations</i>	10,293	10,315	7,249	7,262
<i>Industry</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.368	0.436	0.384	0.458
<i>F-stat</i>	46.82	61.99	37.21	50.15

**Panel B:** Waste management and firm performance: The role of ESG compensation

	ESG-COMP	No ESG-COMP	ESG-COMP	No ESG-COMP	ESG-COMP	No ESG-COMP	ESG-COMP	No ESG-COMP
Variables	(1) <i>ROA</i>	(2) <i>ROA</i>	(3) <i>TQ</i>	(4) <i>TQ</i>	(5) <i>ROA</i>	(6) <i>ROA</i>	(7) <i>TQ</i>	(8) <i>TQ</i>
<i>WASTE</i>	-0.000 (-0.12)	-0.002*** (-4.91)	-0.010 (-1.25)	-0.034*** (-7.77)				
<i>R_WASTE</i>					0.000 (1.63)	0.001*** (5.71)	-0.001 (-0.95)	0.002*** (4.08)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Observations</i>	3,096	11,505	3,096	11,505	2,348	7,956	2,348	7,956
<i>Industry</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.365	0.372	0.400	0.420	0.380	0.384	0.399	0.438
<i>F-stat</i>	15.24	52.14	17.52	63.67	12.49	39.18	13.49	48.66

**Panel C:** Waste management and firm performance: The role of industry nature

	<b>Sensitive Industries</b>	<b>Non-sensitive industries</b>						
	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>	<b>(4)</b>	<b>(5)</b>	<b>(6)</b>	<b>(7)</b>	<b>(8)</b>
Variables	<b>ROA</b>	<b>ROA</b>	<b>TQ</b>	<b>TQ</b>	<b>ROA</b>	<b>ROA</b>	<b>TQ</b>	<b>TQ</b>
<i>WASTE</i>	-0.002*** (-3.64)	-0.001 (-1.58)	-0.033*** (-6.17)	-0.002 (-0.37)				
<i>R_WASTE</i>					0.001*** (3.70)	0.001 (1.58)	0.002*** (4.60)	-0.000 (-0.59)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Observations</i>	5,945	8,656	5,945	8,656	4,159	6,145	4,159	6,145
<i>Industry</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.366	0.429	0.385	0.565	0.383	0.432	0.410	0.471
<i>F-stat</i>	44.50	53.08	48.15	31.91	33.67	39.26	37.57	45.78

**Panel D:** Waste management and firm performance: The role of global sustainability initiatives (e.g., Paris agreement)

	<b>Post-Paris</b>	<b>Pre-Paris</b>	<b>Post-Paris</b>	<b>Pre-Paris</b>	<b>Post-Paris</b>	<b>Pre-Paris</b>	<b>Post-Paris</b>	<b>Pre-Paris</b>
	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>	<b>(4)</b>	<b>(5)</b>	<b>(6)</b>	<b>(7)</b>	<b>(8)</b>
Variables	<b>ROA</b>	<b>ROA</b>	<b>TQ</b>	<b>TQ</b>	<b>ROA</b>	<b>ROA</b>	<b>TQ</b>	<b>TQ</b>
<i>WASTE</i>	-0.001*** (-3.06)	-0.001 (-1.46)	-0.037*** (-6.72)	-0.004 (-0.78)				
<i>R_WASTE</i>					0.001*** (6.07)	0.001 (1.63)	0.002*** (3.66)	0.001 (0.17)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Observations</i>	7,187	7,414	7,187	7,414	5,264	5,040	5,264	5,040
<i>Industry</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.355	0.441	0.422	0.511	0.375	0.414	0.440	0.482
<i>F-stat</i>	34.29	23.15	45.12	30.33	27.79	18.46	36.05	40.13

**Panel E:** Waste management and firm performance: The role of the global financial crisis

	<b>Crisis period</b>	<b>Normal period</b>						
	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>	<b>(4)</b>	<b>(5)</b>	<b>(6)</b>	<b>(7)</b>	<b>(8)</b>
Variables	<b>ROA</b>	<b>ROA</b>	<b>TQ</b>	<b>TQ</b>	<b>ROA</b>	<b>ROA</b>	<b>TQ</b>	<b>TQ</b>
<i>WASTE</i>	-0.001 (-0.91)	-0.001*** (-4.23)	-0.010 (-0.80)	-0.028*** (-7.01)				
<i>R_WASTE</i>					0.000 (0.07)	0.001*** (6.62)	0.000 (0.11)	0.001*** (3.43)

Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Observations</i>	1,659	12,942	1,659	12,942	1,145	9,159	1,145	9,159
<i>Industry</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.405	0.369	0.522	0.417	0.423	0.388	0.495	0.433
<i>F-stat</i>	11.54	59.27	9.835	72.29	9.146	46.44	11.89	55.64

This table presents the regression results of the channel analysis for the relationship between waste management and financial performance. We included all of the control variables in the regressions, as reported in Table 4. However, for brevity, we only present the results for the main independent variables. All of the regressions controlled for industry, year, and country fixed effects. Panel A presents the regression results by using operating costs as a mechanism to explain the relationship between waste management and financial performance. Panel B presents the regression results using sub-samples of firms with and without an ESG compensation policy for the management. Panel C presents the regression results by using sub-samples of firms belonging to the environmentally sensitive and non-sensitive industries. Panel D presents the regression results by using sub-samples from the pre-and post-Paris agreement period. Panel E presents the regression results by using sub-samples from the global financial crisis period and the normal period.

\*, \*\*, and \*\*\* represent significance at the 0.1, 0.05, and 0.01 levels, respectively.

T-statistics are given in parentheses.

All of the variables are as defined in Appendix 1.

**Table 7:** Propensity score matching**Panel A:** Waste management and firm performance: Using a propensity score-matched sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	Pre-match logit	Post-match logit	PSM Pooled	PSM Pooled	Pre-match logit	Post-match logit	PSM Pooled	PSM Pooled
	<i>WASTE_DUMMY</i>		<i>ROA</i>	<i>TQ</i>	<i>R_WASTE_DUMMY</i>		<i>ROA</i>	<i>TQ</i>
<i>WASTE</i>			-0.002*** (-4.16)	-0.027*** (-5.71)				
<i>R_WASTE</i>							0.001*** (4.77)	0.001*** (3.29)
<i>B_SIZE</i>	-0.044 (-0.55)	-0.044 (-0.47)	0.004 (1.35)	0.074** (2.20)	0.013 (0.14)	-0.054 (-0.51)	0.001 (0.34)	0.075* (1.93)
<i>B_IND</i>	-0.394** (-2.57)	0.164 (0.91)	-0.009* (-1.75)	-0.046 (-0.73)	-0.892*** (-5.07)	0.008 (0.04)	0.007 (1.18)	-0.039 (-0.54)
<i>F_PRO</i>	-0.369 (-1.61)	-0.175 (-0.65)	0.018** (2.35)	0.220** (2.32)	0.176 (0.66)	0.194 (0.64)	0.028*** (3.05)	0.375*** (3.32)
<i>SEPARATE</i>	0.042 (0.90)	0.002 (0.04)	0.001 (0.66)	0.047** (2.41)	-0.006 (-0.12)	-0.031 (-0.50)	0.002 (1.25)	0.066*** (2.89)
<i>RD_INT</i>	-10.214*** (-14.84)	0.648 (0.78)	-0.007 (-0.30)	2.571*** (8.67)	0.905 (1.41)	-0.369 (-0.53)	-0.097*** (-4.71)	2.093*** (8.09)
<i>CAP_INT</i>	-0.012 (-0.10)	0.134 (0.90)	-0.014*** (-3.36)	-0.150*** (-2.89)	-0.115 (-0.85)	-0.002 (-0.01)	0.008* (1.73)	-0.105* (-1.88)
<i>NCF</i>	0.168*** (5.78)	0.007 (0.21)	0.038*** (38.91)	0.380*** (31.74)	0.034 (1.05)	0.041 (1.15)	0.038*** (35.96)	0.366*** (27.43)
<i>LEVERAGE</i>	0.389*** (2.67)	0.028 (0.17)	-0.071*** (-14.61)	-0.145** (-2.43)	0.074 (0.43)	-0.159 (-0.82)	-0.076*** (-13.09)	-0.123* (-1.70)
<i>CRISIS</i>	1.702*** (3.37)	-0.001 (-0.00)	-0.023 (-1.21)	-0.286 (-1.25)	-0.271** (-2.08)	0.013 (0.09)	-0.036 (-0.85)	-0.411 (-0.77)
<i>INT_OWN</i>	0.126*** (2.80)	0.015 (0.29)	-0.006*** (-3.92)	-0.077*** (-4.16)	-0.091* (-1.76)	-0.018 (-0.30)	-0.002 (-1.13)	-0.053** (-2.42)
<i>STATE_OWN</i>	-0.041 (-0.55)	0.062 (0.71)	-0.006** (-2.36)	-0.124*** (-4.05)	-0.042 (-0.48)	0.052 (0.50)	-0.006** (-1.97)	-0.094** (-2.41)
<i>SIZE</i>	0.507*** (15.38)	-0.026 (-0.67)	-0.037*** (-32.44)	-0.437*** (-31.22)	-0.017 (-0.48)	-0.021 (-0.52)	-0.038*** (-31.90)	-0.446*** (-30.02)
<i>Intercept</i>	-13.983*** (-17.97)	0.713 (0.72)	0.203*** (7.16)	3.977*** (11.46)	-1.351* (-1.84)	0.874 (0.71)	0.263*** (4.89)	5.556*** (8.26)
<i>Observations</i>	14,601	8,008	8,008	8,008	10,304	6,554	6,558	6,558
<i>Industry</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>			0.368	0.408			0.357	0.424
<i>Pseudo R<sup>2</sup></i>	0.147	0.004			0.068	0.003		
<i>F-stat</i>			39.53	46.59			32.72	42.90

**Panel B:** Post-matched sample univariate analysis

Variables	WASTE (N = 8,008)				R_WASTE (N = 6,554)			
	Treated	Control	Mean Differences	t-statistics	Treated	Control	Mean Differences	t-statistics
<i>B_SIZE</i>	2.395	2.396	-0.002	-0.22	2.382	2.384	-0.002	-0.19
<i>B_IND</i>	0.691	0.687	0.004	0.66	0.667	0.671	-0.004	-0.61
<i>F_PRO</i>	0.142	0.142	-0.001	-0.18	0.146	0.145	0.001	0.24
<i>SEPARATE</i>	0.356	0.354	0.002	0.19	0.353	0.355	-0.002	-0.15
<i>RD_INT</i>	0.020	0.020	0.000	-0.04	0.028	0.028	0.000	0.15
<i>CAP_INT</i>	0.112	0.107	0.005	1.26	0.109	0.112	-0.003	-0.49
<i>NCF</i>	15.628	15.721	-0.093	-1.63	15.554	15.518	0.036	0.53
<i>LEVERAGE</i>	0.263	0.262	0.001	0.39	0.251	0.254	-0.003	-0.66
<i>CRISIS</i>	0.110	0.105	0.005	0.79	0.104	0.101	0.003	0.28
<i>INST_OWN</i>	0.364	0.357	0.007	0.65	0.374	0.378	-0.004	-0.33
<i>STATE_OWN</i>	0.110	0.107	0.003	0.40	0.088	0.086	0.002	0.31
<i>SIZE</i>	18.312	18.402	-0.090	-1.53	18.239	18.231	0.008	0.12

This table presents the regression results for the relationship between waste management and financial performance by using Propensity Score Matching (PSM). Panel A presents the results of the PSM regressions on the matched sample. Panel B presents the univariate mean comparisons between the treatment and control firms' characteristics and their corresponding t-statistics.

\*, \*\*, and \*\*\* represent significance at the 0.1, 0.05, and 0.01 levels, respectively.

T-statistics are given in parentheses.

All of the variables are as defined in Appendix 1.

**Table 8:** Waste management and firm performance: Using the lagged independent variables approach

Variables	(1) <i>ROA</i>	(2) <i>TQ</i>	(3) <i>ROA</i>	(4) <i>TQ</i>
<i>WASTE</i> <sub>(t-1)</sub>	-0.002*** (-4.86)	-0.033*** (-7.63)		
<i>R_WASTE</i> <sub>(t-1)</sub>			0.001*** (5.57)	0.001*** (3.68)
<i>B_SIZE</i>	0.004* (1.66)	0.071** (2.40)	0.002 (0.73)	0.064* (1.75)
<i>B_IND</i>	0.001 (0.13)	0.036 (0.63)	0.005 (0.94)	0.014 (0.21)
<i>F_PRO</i>	0.025*** (3.71)	0.309*** (3.74)	0.020*** (2.58)	0.311*** (3.09)
<i>SEPARATE</i>	-0.000 (-0.02)	0.033* (1.90)	-0.001 (-0.47)	0.060*** (2.86)
<i>RD_INT</i>	-0.069*** (-3.87)	2.058*** (9.28)	-0.068*** (-3.35)	2.149*** (8.35)
<i>CAP_INT</i>	-0.010** (-2.51)	-0.150*** (-3.16)	0.001 (0.25)	-0.131** (-2.41)
<i>NCF</i>	0.044*** (52.12)	0.453*** (42.57)	0.044*** (43.48)	0.443*** (34.64)
<i>LEVERAGE</i>	-0.065*** (-15.28)	-0.156*** (-2.94)	-0.070*** (-13.67)	-0.169*** (-2.58)
<i>CRISIS</i>	-0.021* (-1.84)	0.034 (0.25)	-0.133*** (-3.13)	-1.302** (-2.42)
<i>INT_OWN</i>	-0.005*** (-3.50)	-0.063*** (-3.89)	-0.003** (-2.09)	-0.051*** (-2.58)
<i>STATE_OWN</i>	-0.003 (-1.22)	-0.119*** (-4.42)	-0.001 (-0.48)	-0.088*** (-2.69)
<i>SIZE</i>	-0.043*** (-44.83)	-0.517*** (-43.02)	-0.044*** (-40.16)	-0.535*** (-38.50)
<i>Intercept</i>	0.227*** (11.28)	4.272*** (17.00)	0.358*** (7.64)	5.848*** (9.82)
<i>Observations</i>	11,557	11,557	8,224	8,224
<i>Industry</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>Country</i>	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.378	0.439	0.386	0.455
<i>F-stat</i>	54.72	70.13	40.69	53.73

This table presents the regression results for the relationship between waste management and financial performance by using the lagged independent variables approach.

\*, \*\*, and \*\*\* represent significance at the 0.1, 0.05, and 0.01 levels, respectively.

T-statistics are given in parentheses.

All of the variables are as defined in Appendix 1.

**Table 9:** Waste management and firm performance: Using two-stage least squares (2SLS) regression

	1 <sup>st</sup> Stage	2 <sup>nd</sup> Stage	1 <sup>st</sup> Stage	2 <sup>nd</sup> Stage	1 <sup>st</sup> Stage	2 <sup>nd</sup> Stage	1 <sup>st</sup> Stage	2 <sup>nd</sup> Stage
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>WASTE</i>	<i>ROA</i>	<i>WASTE</i>	<i>TQ</i>	<i>R_WASTE</i>	<i>ROA</i>	<i>R_WASTE</i>	<i>TQ</i>
<i>WASTE_IA (R_WASTE_IA)</i>	0.122*** (9.59)		0.122*** (9.59)		0.395*** (43.63)		0.395*** (43.63)	
<i>L_WASTE (L.R_WASTE)</i>	0.885*** (80.16)		0.885*** (80.16)		0.697*** (109.35)		0.697*** (109.35)	
<i>WASTE</i>		-0.002*** (-3.05)		-0.035** * (-4.02)				
<i>R_WASTE</i>						0.001*** (5.73)		0.001*** (2.97)
<i>B_SIZE</i>	-0.023 (-0.98)	0.004 (1.07)	-0.023 (-0.98)	0.070 (1.36)	-0.442 (-0.86)	0.002 (0.54)	-0.442 (-0.86)	0.044 (1.06)
<i>B_IND</i>	0.027 (0.64)	0.001 (0.10)	0.027 (0.64)	0.037 (0.35)	-0.780 (-0.79)	0.005 (0.88)	-0.780 (-0.79)	-0.016 (-0.20)
<i>F_PRO</i>	-0.036 (-0.57)	0.024** (2.36)	-0.036 (-0.57)	0.307** (2.28)	1.072 (0.75)	0.023*** (2.93)	1.072 (0.75)	0.285** (2.46)
<i>SEPARATE</i>	0.006 (0.42)	-0.000 (-0.01)	0.006 (0.42)	0.033 (1.04)	-0.374 (-1.26)	-0.001 (-0.32)	-0.374 (-1.26)	0.063*** (2.60)
<i>RD_INT</i>	-1.251** * (-6.15)	-0.071* (-1.90)	-1.251** * (-6.15)	2.017*** (3.17)	3.033 (0.83)	-0.067*** (-3.31)	3.033 (0.83)	1.973*** (6.66)
<i>CAP_INT</i>	-0.020 (-0.50)	-0.010 (-1.41)	-0.020 (-0.50)	-0.151** * (-2.87)	-0.497 (-0.62)	0.002 (0.45)	-0.497 (-0.62)	-0.136** (-2.09)
<i>NCF</i>	0.025*** (2.92)	0.044*** (22.16)	0.025*** (2.92)	0.453*** (16.82)	0.313* (1.73)	0.044*** (43.34)	0.313* (1.73)	0.463*** (31.49)
<i>LEVERAGE</i>	0.083* (1.95)	-0.065*** (-7.86)	0.083* (1.95)	-0.153 (-1.31)	0.327 (0.35)	-0.068*** (-13.15)	0.327 (0.35)	-0.155** (-2.06)
<i>CRISIS</i>	0.162 (0.84)	-0.020** (-2.29)	0.162 (0.84)	0.039 (0.34)	8.381 (1.11)	-0.133*** (-3.19)	8.381 (1.11)	-1.316** (-2.16)
<i>INT_OWN</i>	-0.011 (-0.91)	-0.005*** (-2.66)	-0.011 (-0.91)	-0.064** (-2.39)	-0.758*** (-2.72)	-0.003** (-2.26)	-0.758*** (-2.72)	-0.047** (-2.07)
<i>STATE_OWN</i>	-0.017 (-0.75)	-0.003 (-0.80)	-0.017 (-0.75)	-0.119** * (-2.75)	0.327 (0.70)	-0.001 (-0.39)	0.327 (0.70)	-0.103*** (-2.74)
<i>SIZE</i>	0.038*** (3.14)	-0.043*** (-18.66)	0.038*** (3.14)	-0.515** * (-16.44)	-0.307 (-1.56)	-0.044*** (-40.16)	-0.307 (-1.56)	-0.558*** (-34.92)
<i>Intercept</i>	-1.430** * (-5.36)	2.365*** (7.48)	-1.430** * (-5.36)	3.472*** (6.75)	-1.366 (-0.16)	2.356*** (4.66)	-1.366 (-0.16)	2.531*** (5.47)
<i>Observations</i>		11,557		11,557		8,037		8,037
<i>Industry</i>		Yes		Yes		Yes		Yes
<i>Year</i>		Yes		Yes		Yes		Yes

<i>Country</i>	Yes	Yes	Yes	Yes
<i>R<sup>2</sup></i>	0.374	0.438	0.389	0.424
<i>F-stat</i>	849.2	208.3	44.19	50.96
<b>Under-identification test:</b>				
<i>Kleibergen-Paap rk LM statistic</i>	445.4	445.4	6,374	6,374
<b>Weak identification tests:</b>				
<i>Cragg-Donald Wald F statistic</i>	42,794	42,794	15,155	15,155
<i>Kleibergen-Paap rk Wald F statistic</i>	11,479	11,479	7,485	7,485
<b>Stock-Yogo weak ID test critical values:</b>				
<i>10% maximal IV size</i>	19.93	19.93	19.93	19.93
<i>15% maximal IV size</i>	11.59	11.59	11.59	11.59
<i>20% maximal IV size</i>	8.75	8.75	8.75	8.75
<i>25% maximal IV size</i>	7.25	7.25	7.25	7.25
<b>Hansen J (P-value)</b>	0.288	0.891	0.174	0.141

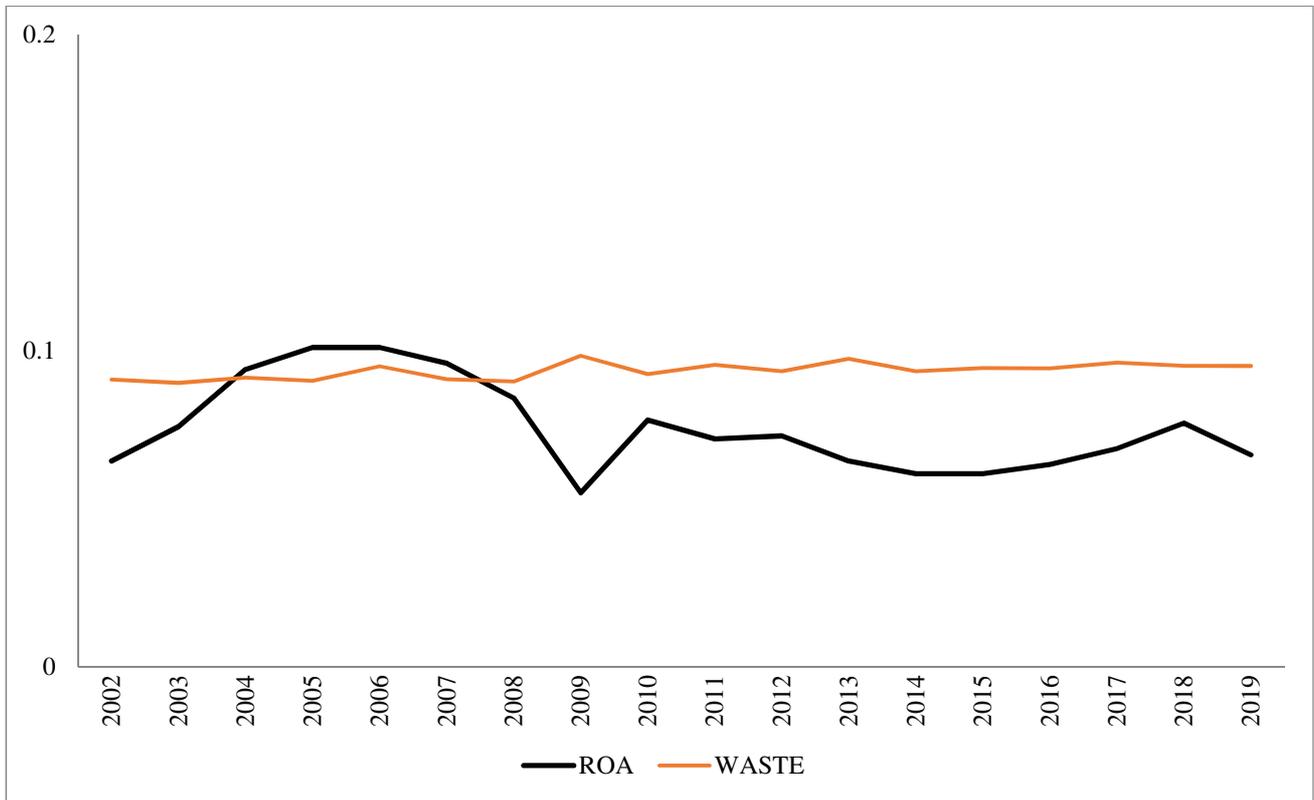
This table presents the regression results for the relationship between waste management and financial performance by using two-stage least squares (2SLS) regression. In the first-stage estimates of 2SLS, *WASTE\_IA* and *R\_WASTE\_IA* (*L.WASTE* & *L.R\_WASTE*) are instruments with an industry average (one-year lag) of total waste produced and recycled, respectively.

\*, \*\*, and \*\*\* represent significance at the 0.1, 0.05, and 0.01 levels, respectively.

T-statistics are given in parentheses.

All of the variables are as defined in Appendix 1.

**Figure 1:** Waste generation and firm performance over time



This figure shows the relationship between firm performance (ROA) and waste generation (waste generation yearly averages has been divided by 1 for graph presentation) over the sample period.

**Appendix 1: Definitions of variables**

<b>Variable name</b>	<b>Symbol</b>	<b>Definition</b>	<b>Source</b>
Return on assets	<i>ROA</i>	Net profit/loss divided by total assets.	WorldScope
Tobin's Q	<i>TQ</i>	The ratio of the sum of market capitalization and total assets minus the book value of shareholders' equity divided by total assets.	WorldScope
Waste	<i>WASTE</i>	Natural log of the total waste produced in tons.	Asset4
Hazardous waste	<i>H_WASTE</i>	Natural log of the total hazardous waste produced in tons.	Asset4
Non-hazardous waste	<i>NH_WASTE</i>	Natural log of the total non-hazardous waste produced in tons.	Asset4
Recycled waste	<i>R_WASTE</i>	The ratio of the recycled waste to total waste produced.	Asset4
Board size	<i>B_SIZE</i>	Natural log of the number of directors on the board.	BoardEx
Board independence	<i>B_IND</i>	The proportion of independent directors on the board.	BoardEx
Board gender diversity	<i>F_PRO</i>	The proportion of female directors on the board.	BoardEx
CEO-chair separation	<i>SEPARATE</i>	Dummy variable coded as 1 if the CEO and chairman positions are separate, or 0 otherwise.	BoardEx
Research and development intensity	<i>RD_INT</i>	The ratio of research and development expenditures to sales.	WorldScope
Capital intensity	<i>CAP_INT</i>	The ratio of capital expenditures to sales.	WorldScope
Net cash flow	<i>NCF</i>	Natural log of the cash flow from operations.	WorldScope
Financial leverage	<i>LEVERAGE</i>	The ratio of a firm's total debt to total assets.	WorldScope
Financial crisis	<i>CRISIS</i>	Dummy variable coded as 1 for the financial crisis years (i.e., 2007–2009), or 0 otherwise.	WorldScope
Institutional ownership	<i>INST_OWN</i>	Dummy variable coded as 1 if the institutional ownership is more than five percent, or 0 otherwise.	WorldScope
State ownership	<i>STATE_OWN</i>	Dummy variable coded as 1 if the state ownership is more than five percent, or 0 otherwise.	WorldScope
Firm size	<i>SIZE</i>	Natural log of total assets.	WorldScope
Risk	<i>RISK</i>	The standard deviation of earnings before interest, taxes, depreciation, and amortization (EBITDA).	WorldScope
Operating cost	<i>OP_COST</i>	Total operating expenses.	WorldScope

All of the continuous variables are winsorized at the bottom 1% and top 99% levels.

**Appendix 2: Waste management and risk**

Variables	(1) <i>RISK</i>	(2) <i>RISK</i>
<i>WASTE</i>	0.002*** (2.87)	
<i>R_WASTE</i>		-0.001*** (-3.93)
<i>B_SIZE</i>	0.001 (1.13)	0.001 (1.02)
<i>B_IND</i>	-0.003 (-1.35)	0.001 (0.55)
<i>F_PRO</i>	0.000 (0.07)	0.003 (0.61)
<i>SEPARATE</i>	-0.002** (-2.35)	-0.002** (-2.08)
<i>RD_INT</i>	0.027*** (3.39)	0.084*** (9.33)
<i>CAP_INT</i>	0.001 (0.39)	-0.001 (-0.66)
<i>NCF</i>	0.002*** (6.26)	0.005*** (10.02)
<i>LEVERAGE</i>	-0.002 (-1.16)	-0.003 (-1.17)
<i>CRISIS</i>	-0.017* (-1.92)	-0.021 (-0.70)
<i>INT_OWN</i>	0.001 (0.99)	0.000 (0.43)
<i>STATE_OWN</i>	0.006*** (5.76)	0.007*** (4.99)
<i>SIZE</i>	-0.005*** (-12.14)	-0.007*** (-14.05)
<i>Intercept</i>	0.210*** (16.94)	0.197*** (6.07)
<i>Observations</i>	10,790	7,780
<i>Industry</i>	Yes	Yes
<i>Year</i>	Yes	Yes
<i>Country</i>	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.391	0.253
<i>F-stat</i>	58.29	36.09

This table presents the regression results for the relationship between waste management and risk. *RISK* is measured as the standard deviation of earnings before interest, taxes, depreciation, and amortization (*EBITDA*).

\*, \*\*, and \*\*\* represent significance at the 0.1, 0.05, and 0.01 levels, respectively.

T-statistics are given in parentheses.

All of the variables are as defined in Appendix 1.