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Sentiment analysis in sustainability accounting reporting: does the tone reveal future environmental performance?

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Abstract: This paper investigates whether positive or negative tones in US public firms' sustainability reports are associated with their future environmental performance. Using three-stage least squares simultaneous equations (3SLS) model and a sample of resource extractive firms (mining, quarrying, oil and gas extraction) listed on the US stock exchanges that issue stand-alone sustainability reports between 2010 and 2018, we find a negative correlation between the tones in sustainability reports and future environmental performance. Our result suggests that firms with low environmental performance use more optimistic tones to impress stakeholders. In contrast, firms with good performance tend to be more risk-averse and pessimistic in sustainability reporting to mitigate litigation risks. Our study contributes to understanding what motivates firms to disclose sustainability activities.

Keywords: sustainability accounting reporting; tone analysis; environmental performance; legitimacy theory; resource extractive firms; USA; Loughran and McDonald sentiment dictionary; 3SLS.

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1 Introduction

Sustainability has been an indispensable part of the strategic plan (Brusca et al., 2018). Firms engage in sustainability activities to gain competitive advantages (York, 2009) and fulfil the need for sustainable development (Rodriguez et al., 2002). Firms use sustainability reporting to communicate non-financial performance to stakeholders. Sustainability reports usually include information on economic, social, and environmental aspects of the performance, called the 'triple bottom line' (Hussain et al., 2018). Environmental performance refers to the management activities related to the natural environment, which usually covers energy, greenhouse gas emissions, waste, and water (Trumpp et al., 2015). Unlike mandatory financial reporting, disclosing sustainability performance and issuing stand-alone sustainability reports are voluntary.

Sustainability reporting is an important communication tool. Previous studies find that firms use sustainability reports to inform stakeholders (Farneti and Guthrie, 2009), to meet stakeholders' demands (Amran and Keat Ooi, 2014), and to engage stakeholders in the journey of achieving sustainability (Brusca et al., 2018). Firms with more level of disclosure have better financial performance (Jones et al., 2007), lower greenhouse gas emissions (GHG) (Mahmoudian et al., 2021), and higher values (Kuzey and Uyar, 2017). Investors respond positively to the disclosure of sustainability information. Issuing sustainability reports is associated with positive market reactions and abnormal stock returns (Du et al., 2017).

Tone analysis uses various methods such as content analysis or bag of words to classify the disclosure into positive (optimistic) and negative (pessimistic) tones. Accounting researchers first use tone analysis to analyse financial disclosure. Recently, more and more studies use tone analysis in sustainability reports. García-Sánchez et al. (2019) find that female boards of directors are associated with more pessimistic tones in sustainability reporting. Better environmental, social, and governance (ESG) scores are associated with more positive tones (Beretta et al., 2019, 2021). Tones in sustainability reports are also linked with more accurate analyst forecasts (Muslu et al., 2019) and future CSR performance (Du and Yu, 2020). Previous studies have found that sustainability reports' content is informative of future sustainability performance (Rezaee and Tuo, 2017) and demonstrated that tones in sustainability reports are relevant to stakeholders' decision-making. However, the link between the tones in sustainability reports and future environmental performance is underexplored.

Legitimacy theory and impression management literature (Cho et al., 2012; Michelon et al., 2015) suggest that managers are motivated to manipulate sustainability reporting to provide biased information to impress the stakeholders and disguise actual sustainability performance (Hummel and Schlick, 2016), especially when there is negative news coverage (Brown and Deegan, 1998; Neu et al., 1998). However, previous research investigating sustainability disclosure and environmental performance is limited to how much sustainability information firms disclose (Lu and Wang, 2021; Qian and Schaltegger, 2017; Tadros and Magnan, 2019), whether firms issue stand-alone sustainability reports (Uyar et al., 2020), and the quality and quantity of disclosure (Hummel and Schlick, 2016). Few studies have examined the link between the tones in sustainability reports and environmental performance because tone analysis is an emerging accounting research tool.

Does the tone in sustainability reports reveal actual future environmental performance? Or do managers use tones in sustainability reports to impress stakeholders? Our study answers these research questions by investigating a sample of US resource extractive firms (mining, quarrying, oil and gas extraction) between 2010 and 2018 using three-stage least squares (3SLS). We find a negative association between the tones in sustainability reports and future environmental performance (i.e., firms with more optimistic tones have poor future environmental performance), supporting the impression management literature. Furthermore, we find that firms with low environmental performance are more likely to use positive tones in next year's sustainability reports to impress investors. Consistent with legitimacy theory, our results suggest that sustainability reporting is a vital impression management tool to maintain US resource extractive firms' legitimacy. Firms with good environmental performance use more pessimistic tones to minimise litigation risks, while poorly performing firms try to disguise actual environmental performance with more positive tones.

This study is original in the following aspects. Firstly, we empirically test the association between tones and environmental performance simultaneously. Previous studies on tones of sustainability reports often focus on one direction. For example, Du and Yu (2020) test how the change of tones in CSR reports affects future CSR performance. Beretta et al. (2021) test how ESG performance affects non-financial disclosure tones. We expand previous studies' ordinary least squares (OLS) models to simultaneous equations modelling using 3SLS. Our 3SLS models provide a better solution to capture the simultaneous relationship between tones and environmental performance and address reverse causality issues (i.e., tones in sustainability reports affect future environmental performance, and environmental performance affects future tones).

Secondly, we focus our sample on resource extractive industries (mining, quarrying, oil and gas extraction). Although sustainability reports cover common topics such as labour safety across industries, most topics are industry-specific (Christensen et al., 2021). The association between tones and environmental performance might differ in more environmentally impacting (e.g., mining, oil, and gas) and less environmentally impacting industries (e.g., banks). Firms in resource extractive industries have more institutional pressure (Jain et al., 2020; Negash and Lemma, 2020) from stakeholders such as investors, government, and NGOs. Industry context is a crucial factor in sustainability research. Previous studies (e.g., Lu and Herremans, 2019; Qureshi et al., 2020) have found consistent evidence of industry differences.

Thirdly, we expand the horizontal analysis (trend analysis) in Du and Yu (2020) to vertical analysis (compare a firm's tone with its industry peers' tones). Like earning announcement conference calls, sustainability reporting might be firm or manager-specific (Allee and Deangelis, 2015), which means the tones in sustainability reports might have huge differences across firms but few variations across time.

This study contributes to the literature on the informativeness of tones in sustainability reports. The main contribution of our paper is threefold. First, we demonstrate that sustainability reports' tones provide additional information on future environmental performance beyond the reports' contents. Second, we provide empirical evidence that the relationship between tones in sustainability reports and environmental performance is a two-way dynamic relationship (i.e., tones affect future environmental performance, and environmental performance affects future tones). Third, we expand the impressing management literature by providing empirical evidence of a negative

relationship between tones in sustainability reports and environmental performance, which was never documented in the literature before, to the best of our knowledge. Regarding social and practical implications, our study helps regulators understand the motivation for sustainability disclosure and decide whether sustainability reporting should be mandatory.

The remainder of the paper is organised as follows. Section 2 provides a review of the literature and develops our hypothesis. We discuss our data and methodology in Section 3. In Section 4, we present our results. We discuss the implications and conclude the paper in Section 5.

2 Literature review and hypotheses development

2.1 Tone analysis

Accounting researchers first use tone analysis to analyse financial disclosure. Tone analysis of financial disclosures provides relevant information to stakeholders. Previous studies have found that firms with more lawsuits or scoring low on corporate governance use more ethics terms in their financial reports (Loughran et al., 2009). Optimistic tones increase litigation risks (Rogers et al., 2011). Tones in IPO filing are related to first-day stock returns (Loughran and McDonald, 2013). Tone dispersion (use insensitively or evenly spread out) is a good indicator of financial performance (Allee and Deangelis, 2015). Tones of earning's conference calls reduce information asymmetry (Boudt et al., 2018) and inform future risks in the equity options market (Borochin et al., 2018).

The widely used tone dictionary to analyse financial disclosures is the Loughran and McDonald sentiment dictionary, which captures word frequency in US 10-Ks (annual reports in SEC format) and develops a bag of words to capture the tones in financial reporting (Loughran and McDonald, 2011, 2015, 2016). Researchers find that word frequency tone measure using a bag of words is as powerful as other alternative methods, such as using the Naive Bayesian machine-learning algorithm to analyse the tones in financial disclosures (Henry and Leone, 2015).

Recent studies on tone analysis often focus on financial disclosures. For example, Lee and Park (2019) analyse the audit committee's financial expertise on the tone of management discussion and analysis (MD&A). They find that accounting-related expertise is linked with positive tones. Gandhi et al. (2019) find that negative tones in banks' annual reports are associated with higher future risks such as the higher possibility of delisting from the stock exchange, lower chance of paying dividends, higher loss provisions, and lower future returns. Managers who use more negative tones in conference calls will likely have lower future earnings (Druz et al., 2020).

The scope of tone analysis has recently expanded from analysing financial disclosures to sustainability reporting. However, the number of studies using tone analysis in sustainability reporting is still limited. Muslu et al. (2019) find that CSR disclosure scores and tones are associated with more accurate analyst forecasts. García-Sánchez et al. (2019) find that female directors' existence reduces impression management and is negatively associated with optimistic tones in sustainability reports. Beretta et al. (2019) find that firms with higher ESG scores use more positive tones in the intellectual capital disclosure (ICD) section of the integrated reports (a combination of financial and

sustainability reports). Du and Yu (2020) find a positive link between tone change in sustainability reports and future CSR performance.

2.2 Industry and environmental performance

The industry is important in studying environmental performance (Lu and Herremans, 2019; Qureshi et al., 2020). Resource extractive industries are under more institutional pressure (Jain et al., 2020; Negash and Lemma, 2020) to improve environmental performance than firms in less environmentally impacting industries such as banks. Mining, quarrying, and oil and gas extraction firms have large carbon footprints. Oil spills and leaks resulting in catastrophic environmental disasters (e.g., BP oil spills in 2010) will take the ecosystem dozens of years to recover. Resource extractive firms are frequently going under the radar regarding their environmental performance. For example, the US Environmental Protection Agency (EPA) has special requirements for oil and gas firms to report greenhouse gas emissions. US Small Business Administration (SBA) demands a special environment assessment report if a resource extractive firm wants to apply for a loan.

2.3 Legitimacy theory, impression management, and environmental performance

Impression management suggests that narrative disclosures are powerful tools to manipulate readers' impressions (Goffman, 1959). Managers can disclose information selectively or present information in certain ways to change stakeholders' perceptions of actual achievements (Godfrey et al., 2003).

Legitimacy theory argues that firms must align their activities with social expectations to be legitimate (Deegan, 2002). Disclosure is important for maintaining legitimation (Gray et al., 1995; Guthrie and Parker, 1989; Neu et al., 1998; Tinker, 1991). Sustainability reporting allows stakeholders to check whether firms are fulfilling the social contracts (García-Sánchez et al., 2019). When firms' legitimacy is threatened (e.g., more media exposure of bad news), firms will respond with more level of disclosure (Brown and Deegan, 1998; Neu et al., 1998). They want to use disclosure to improve environmental performance perceptions (Deegan, 2002) and hide the actual performance (Hummel and Schlick, 2016). Managers attempt to influence stakeholders' perception by creating an image of commitment through reporting practices such as issuing stand-alone reports, following sustainability reporting guidelines, or providing additional assurance (Michelon et al., 2015). Legitimacy theory argues that sustainability disclosure is symbolic and does not improve firms' sustainability activities (Cho et al., 2012; Gray, 2006; Hopwood, 2009; Patten, 2002). Previous studies find supporting evidence. For example, Firms using minimal narrative disclosure (a selective disclosure strategy to omit or include certain information) in annual financial reports have worse future financial performance (Leung et al., 2015). Malaysian firms use rhetorical words to disclose climate change information in annual reports to manage stakeholders' impressions and be legitimate (Nik Ahmad Nik and Hossain Dewan, 2019).

Couched within this framework, we empirically investigate whether the tones in sustainability reports are associated with better environmental performance. Previous studies find that media coverage (Brown and Deegan, 1998) and public pressure (Cerin, 2002) lead to more sustainability disclosures. Firms in resource extractive industries

experience tremendous pressure from various stakeholders (e.g., regulators, investors, creditors, and NGOs) and increased media scrutiny to improve their environmental performance. Low environmentally performing firms in resource extractive industries are motivated to hide actual environmental performance through impression management. We argue that using more positive words to glorify sustainability disclosure is managers' coping strategy to legitimatise their operations.

Based on legitimacy theory, impression management, and previous empirical evidence, we anticipate:

H1 There is a negative association between the tone of sustainability reports and environmental performance.

3 Methodology

3.1 Sample

This study uses mining, quarrying, and oil and gas extraction firms (NAICS two digits 21) in the USA between 2010 and 2018 as our sample. Initially, we find 100 firm-year observations that issue stand-alone sustainability reports. We lose 24 observations because we lag one period in the regressions. Thus, our final sample includes 76 observations.

3.2 Variables

We collect environmental performance from Sustainalytics, which is a widely used database for ESG performance (e.g., Thorne et al., 2017; Jacoby et al., 2019; Lu and Herremans, 2019; Naciti, 2019). Environmental performance ranges from 0 (worst) to 100 (best).

We count the frequency of positive and negative words in our sustainability reports using the Loughran and McDonald (2011, 2015, 2016) sentiment dictionary to capture the tones. The 2018 version identifies 354 positive and 2,355 negative words. Loughran and McDonald's sentiment dictionary is initially designed to analyse the tone of financial disclosures. Recently, researchers start to use it to analyse sustainability reports (e.g., García-Sánchez et al., 2019; Muslu et al., 2019; Du and Yu, 2020).

We use two methods to measure tones in sustainability reports. Method 1 is derived from the work of Du and Yu (2020). To control the length of sustainability reports, we scale the net tone (number of positive words minus negative words) by the total number of words in the sustainability report. A positive number indicates optimistic tones, and a negative number indicates pessimistic tones.

$$Tone1 = \frac{Number\ of\ \ positive\ words - Number\ of\ \ negative\ words}{Total\ number\ of\ \ words\ in\ a\ sustainability\ report} \tag{1}$$

Method 2 is established by García-Sánchez et al. (2019). It ranges from –1 (all negative tones) to 1 (all positive tones).

$$Tone2 = \frac{Number\ of\ \ positive\ words - Number\ of\ \ negative\ words}{Number\ of\ \ positive\ words + Number\ of\ \ negative\ words} \tag{2}$$

We include the following control variables in our tests, which are widely used in sustainability research: corporate governance performance, sales growth, size, return on assets (ROA), free cash flow, leverage, the newness of equipment, and capital expenditure. We collect corporate governance performance from Sustainalytics and the remaining financial controls from the Eikon database. Corporate governance is a composite score indicating corporate governance performance, such as board gender diversity, CEO duality, and board independence. Good corporate governance affects environmental performance (Hussain et al., 2018). Corporate governance performance ranges from 0 (worst) to 100 (best). Sales growth is the change of this year's sales from last year's sales divided by last year's sales. We use the natural logarithm of total assets to measure firm size. ROA is net income divided by total assets. Free cash flow is measured as operating cash flow divided by total assets. Leverage is calculated as long-term debt divided by total assets. Newness is net property plant and equipment (PP&E) divided by gross PP&E. Capital expenditure is capital expenditure divided by total sales. All control variables are winsorised at 1% and 99% by year to remove outliers' impact on the tests.

Wintoki et al. (2012) suggest that two possible endogeneity issues in firm performance research are unobserved factors and simultaneity. Lu and Wang (2021) confirm that environmental performance and sustainability disclosure are a function of each other (simultaneity), implying that traditional methods such as OLS might fail to address the dynamic relationship between performance and disclosure. Besides, unobserved factors might affect sustainability disclosure and environmental performance, such as CEO narcissism (Tang et al., 2018) and management's strategy (Al-Tuwaijri et al., 2004). To address these endogeneity concerns, we use the three-stage least squares simultaneous equations (3SLS) following Al-Tuwaijri et al. (2004), Abdallah and Ismail (2017) and Mahmoudian et al. (2021). We regress the following two equations simultaneously:

$$Environmental\ performance_{it} = \beta_0 + \beta_1 Tone_{it-1} + \beta_2 Control\ variables_{it} + Year\ dummy \tag{3}$$

$$Tone_{it} = \beta_0 + \beta_1 Environmental\ performance_{it-1} + \beta_2 Control\ variables_{it} + Year\ dummy \tag{4}$$

4 Results and discussion

Table 1 shows the sample size by year. We observe an increased number of sustainability reports issued over the years. In 2010, only three firms issue stand-alone sustainability reports in our sample. The number of sustainability reports grows up to twelve in 2018. Table 2 displays descriptive statistics. Environmental performance ranges from 15.68 to 71, with an average of 52.78. Tone 1 measures the percentage of net tone words scaled by the total number of words in sustainability reports [equation (1)]. The lowest is -0.29%, which means after offsetting the number of positive/negative words, the sustainability report's net tone contains a 0.29% negative tone. The highest is 1.82%, which indicates a positive tone. Tone 2 measures the net tone scaled by the total number of tone words [equation (2)]. The lowest number is –14.46%, which indicates after offsetting, the most

pessimistic report contains 14.46% of negative words out of all tone words. Likewise, the most optimistic report has 67.57% of positive words out of all tone words.

Table 1 Number of stand-alone sustainability reports in US oil and gas industry

Year	*Obs.*
2010	3
2011	3
2012	5
2013	11
2014	9
2015	11
2016	11
2017	11
2018	12
Total	76

Table 3 reports the Pearson correlation table. The highest correlation is between the two tone measures (97%), suggesting the tone measure's reliability. Since we do not put both tone measures in the same regression, no multi-collinearity concern exists.

We report our main 3SLS results in Table 4. We simultaneously regress last year's tone on environmental performance and last year's environmental performance on tone. Models 1.1 and 1.2 use the first tone measure following Du and Yu (2020). In model 1.1, we find that last year's tone is negatively associated with the following year's environmental performance ($\beta = -732.89$, $p < 0.01$). It implies that firms that use more positive tones in their sustainability reports will have poor environmental performance next year. In model 1.2, there is a significant negative relationship between last year's environmental performance and the following year's tone ($\beta = -0.0002$, $p < 0.01$), which suggests that firms with better environmental performance will use more negative tones in the next year's sustainability reports.

In models 2.1 and 2.2, we use the second tone measure following García-Sánchez et al. (2019). Consistent with tests in the models 1 and 2, we find a negative link between last year's tone and environmental performance ($\beta = -23.72$, $p < 0.01$) and a negative association between last year's environmental performance and tone ($\beta = -0.01$, $p < 0.01$). Our results support H1 under the legitimacy theory that firms using more negative tones will have better future environmental performance.

We conduct two additional tests using the OLS and random effects (RE) model as robustness checks. OLS is used to test the link between tones and sustainability performance (e.g., Du and Yu, 2020). Random or fixed-effects models are popular methods for panel data related to environmental performance. To decide between the fixed effects and random effects, we run a Hausman test following Lu and Herremans (2019) and find an insignificant result that supports using random-effects model. In all four tests reported in Table 5 [models 3 to 6], we find constant results that there is a negative relationship between the tones in sustainability reports and environmental performance ($\beta = -614.00$, $p < 0.05$ in model 3 using OLS and tone method 1, $\beta = -19.05$, $p < 0.05$ in model 4 using OLS and tone method 2, $\beta = -617.02$, $p < 0.05$ in model 5 using RE and tone method 1, $\beta = -23.72$, $p < 0.05$ in model 6 using RE and tone method 2).

Table 2 Descriptive statistics

Variable	*Details*	*Source*	*Obs.*	*Mean*	*Std. dev.*	*Min*	*Max*
Environmental performance	Environmental Performance (0 worst, 100 best)	Sustainalytics	76	53.14	9.58	15.68	71.00
Tone 1	Positive tone minus negative tone divided by total number of words in the sustainability reports		76	0.60%	0.43%	–0.29%	1.82%
Tone 2	Positive tone minus negative tone divided by positive tone plus negative tone		76	20.56%	16.94%	–14.46%	67.57%
Governance Performance	Governance performance (0 worst, 100 best)	Sustainalytics	76	66.98	9.53	53.00	92.00
Sales growth	Change of sales divided by last year's sales	Eikon	76	0.05	0.27	–0.49	0.77
Size	Natural log of total assets	Eikon	76	23.82	0.91	21.21	25.49
ROA	Net income divided by total assets (in percentage)	Eikon	76	0.26	11.59	–47.12	19.97
Free cashflow	Operating cashflow divided by total assets	Eikon	76	–0.01	0.05	–0.12	0.13
Leverage	Long term debt dividend by total assets (in percentage)	Eikon	76	26.78	11.23	9.78	68.07
Newness	Net property plants and equipment (PP&E) divided by gross PP&E	Eikon	76	0.56	0.13	0.26	0.99
Capital expenditure	Capital expenditure divided by total assets	Eikon	76	0.12	0.06	0.01	0.27

Since sustainability reporting is voluntary, not all resource extractive firms issue stand-alone sustainability reports. To control for the self-selection problem, we use a popular method called the Heckman two-stage model (e.g., Du and Yu, 2020; Lu et al., 2021) to test the impact of selection bias as a robustness check. In the first stage, we use a probit model to estimate the likelihood of issuing stand-alone sustainability reports. Our dependent variable *sustainability reporting*, which equals one if a firm has issued a stand-alone sustainability report in a specific year and zero otherwise. We find 247 observations in the US mining, quarrying, and oil and gas industry with no missing data between 2010 and 2018. Among them, 76 observations (our sample) have issued sustainability reports. We include all control variables in the first stage of the Heckman test. We also add one additional variable *sustainability committee* from the Eikon

database as our exclusion restriction following Lu et al. (2021). The sustainability committee indicates whether a firm has a board-level committee to supervise sustainability issues. Having a sustainability committee increases the likelihood of issuing sustainability reports (Pucheta-Martínez et al., 2019). The *sustainability committee* is a dummy variable, which equals one if a firm has a sustainability committee and zero otherwise. Table 6 model 7 shows the results of the first stage of the Heckman test. The sustainability committee is significantly related to the likelihood of issuing stand-alone sustainability reports ($\beta = 3.47$, $p < 0.01$), which makes it a valid exclusion restriction suggested by Certo et al. (2016). Table 6 model 8 reports the second stage of the Heckman test using the first tone measure. The association between tone and environmental performance is negative and marginally significant ($\beta = –529.13$, $p < 0.1$). When using the second tone measure (Table 6 model 9), we find consistent results that there is a negative link between tone and environmental performance ($\beta = –16.25$, $p < 0.05$). Heckman's two-stage test results are consistent with our main results: there is a negative link between the tone of the sustainability reports and future environmental performance.

Table 3 Pearson correlations

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	Environmental performance	1									
2	Tone 1	–0.42	1								
		(0.00)									
3	Tone 2	–0.41	0.97	1							
		(0.00)	(0.00)								
4	Governance performance	0.37	–0.44	–0.46	1						
		(0.00)	(0.00)	(0.00)							
5	Sales growth	–0.17	0.08	0.06	–0.20	1					
		(0.15)	(0.50)	(0.58)	(0.08)						
6	Size	0.31	–0.28	–0.29	0.24	–0.17	1				
		(0.01)	(0.01)	(0.01)	(0.03)	(0.15)					
7	ROA	–0.10	0.12	0.09	–0.15	0.53	0.13	1			
		(0.40)	(0.30)	(0.45)	(0.21)	(0.00)	(0.27)				
8	Free cashflow	0.14	–0.07	–0.06	0.18	0.25	0.16	0.29	1		
		(0.22)	(0.55)	(0.63)	(0.12)	(0.03)	(0.16)	(0.01)			
9	Leverage	–0.11	–0.01	0.00	–0.05	–0.29	–0.44	–0.62	–0.21	1	
		(0.36)	(0.94)	(0.97)	(0.65)	(0.01)	(0.00)	(0.00)	(0.07)		
10	Newness	–0.08	–0.17	–0.19	–0.08	0.30	–0.03	0.44	–0.24	–0.43	1
		(0.47)	(0.13)	(0.11)	(0.51)	(0.01)	(0.78)	(0.00)	(0.03)	(0.00)	
11	Capital expenditure	–0.41	0.22	0.21	–0.38	0.16	–0.24	0.06	–0.48	–0.09	0.30
		(0.00)	(0.06)	(0.06)	(0.00)	(0.16)	(0.03)	(0.58)	(0.00)	(0.42)	(0.01)

Note: Numbers in parentheses are *p* values.

Table 4 Environmental performance and tone (3SLS)

Dependent variable	*Environmental performance*		*Tone 1*	
	1.1		*1.2*	
	Coef.	*z*	*Coef.*	*z*
Lag tone 1	–732.89***	(–3.09)		
Lag tone 2				
Lag environmental performance			–0.0002***	(–3.73)
Governance performance	0.00	(0.03)	0.00***	(–3.20)
Sales growth	–13.45**	(–2.22)	–0.01*	(–1.87)
Size	0.00	(0.00)	0.00**	(–1.96)
ROA	–0.09	(–0.80)	0.00	(–0.42)
Free cashflow	–11.50	(–0.48)	–0.01	(–0.86)
Leverage	–0.34***	(–2.83)	0.00**	(–2.13)
Newness	0.77	(0.14)	0.00	(–1.44)
Capital expenditure	–49.78**	(–2.02)	–0.02	(–1.46)
Constant	73.46**	(1.98)	0.06***	(3.89)
Year dummy	Yes		Yes	
No. of obs.	76		76	
Pseudo R-squared	45.27%		43.60%	
Chi-squared	65.47		61.61	
Dependent variable	*Environmental performance*		*Tone 2*	
	2.1		*2.2*	
	Coef.	*z*	*Coef.*	*z*
Lag tone 1				
Lag tone 2	–23.72***	(–3.75)		
Lag environmental performance			–0.01***	(–3.85)
Governance performance	–0.07	(–0.59)	–0.01***	(–3.79)
Sales growth	–15.09**	(–2.50)	–0.25**	(–2.36)
Size	–0.43	(–0.34)	–0.05**	(–2.28)
ROA	–0.13	(–1.16)	0.00	(–0.99)
Free cashflow	–8.26	(–0.35)	–0.21	(–0.50)
Leverage	–0.37***	(–3.16)	–0.01**	(–2.56)
Newness	–0.02	(0.00)	–0.11	(–1.14)
Capital expenditure	–52.91**	(–2.17)	–0.65	(–1.46)
Constant	91.74**	(2.44)	2.47***	(4.20)
Year dummy	Yes		Yes	
No. of obs.	76		76	
Pseudo R-squared	46.54%		46.37%	
Chi-squared	71.57		70.22	

Notes: *, **, and *** denote significance of coefficients at the 10%, 5%, and 1% levels (two-tailed), numbers in parentheses are *z* values.

Table 5 Robustness check: OLS and RE

Dependent variable: environmental performance	*OLS*		*OLS*	
	3		*4*	
	Coef.	*z*	*Coef.*	*z*
Lag tone 1	–614.00**	(–2.25)		
Lag tone 2			–19.05**	(–2.62)
Governance performance	0.02	(0.18)	–0.03	(–0.22)
Sales growth	–12.63*	(–1.82)	–13.83**	(–2.00)
Size	0.07	(0.05)	–0.23	(–0.16)
ROA	–0.10	(–0.72)	–0.13	(–0.98)
Free cashflow	–12.03	(–0.44)	–9.60	(–0.36)
Leverage	–0.33**	(–2.42)	–0.36**	(–2.63)
Newness	1.28	(0.20)	0.68	(0.11)
Capital expenditure	–49.93*	(–1.78)	–52.05*	(–1.88)
Constant	69.02	(1.64)	81.96*	(1.92)
Year dummy	Yes		Yes	
No. of obs.	76		76	
F	2.79***		2.96***	
R-squared	44.99%		46.49%	
Chi-squared				
Dependent variable: environmental performance	*RE*		*RE*	
	5		*6*	
	Coef.	*z*	*Coef.*	*z*
Lag tone 1	–617.02**	(–2.15)		
Lag tone 2			–19.05***	(–2.62)
Governance performance	0.02	(0.17)	–0.03	(–0.22)
Sales growth	–12.79*	(–1.88)	–13.83**	(–2.00)
Size	0.24	(0.16)	–0.23	(–0.16)
ROA	–0.05	(–0.4)	–0.13	(–0.98)
Free cashflow	3.47	(0.13)	–9.60	(–0.36)
Leverage	–0.27**	(–2.00)	–0.36***	(–2.63)
Newness	1.24	(0.20)	0.68	(0.11)
Capital expenditure	–40.36	(–1.43)	–52.05*	(–1.88)
Constant	62.16	(1.47)	81.96*	(1.92)
Year dummy	Yes		Yes	
No. of obs.	76		76	
F				
R-squared	56.35%		62.53%	
Chi-squared	40.47***		50.40***	

Notes: *, **, and *** denote significance of coefficients at the 10%, 5%, and 1% levels (two-tailed), numbers in parentheses are *z* values.

Table 6 Robustness check for selection bias: Heckman two stages

	First stage (probit) dependent variable: sustainability reporting		*Second stage dependent variable: environmental performance*		*Second stage dependent variable: environmental performance*	
	7		*8*		*9*	
	Coef.	*z*	*Coef.*	*z*	*Coef.*	*z*
Lag tone 1			–529.13*	(–1.93)		
Lag tone 2					–16.25**	(–2.26)
Governance performance	0.02	(1.43)	–0.02	(–0.10)	–0.06	(–0.38)
Sales growth	0.36	(0.56)	–14.66*	(–1.91)	–15.55**	(–2.09)
Size	0.87***	(4.31)	–2.77	(–1.37)	–2.90	(–1.49)
ROA	0.01	(0.45)	–0.10	(–0.62)	–0.13	(–0.83)
Free cashflow	8.25**	(2.29)	–58.14	(–1.57)	–54.20	(–1.52)
Leverage	0.07***	(3.44)	–0.43***	(–2.68)	–0.45***	(–2.90)
Newness	6.14***	(4.40)	–9.33	(–1.09)	–9.38	(–1.14)
Capital expenditure	5.36*	(1.71)	–65.44**	(–2.04)	–66.48**	(–2.17)
Sustainability committee	3.47***	(4.71)				
Constant	–30.38***	(–5.05)	165.75***	(2.66)	172.16***	(2.87)
Inverse mills ratio			–10.64***	(–2.62)	–10.20***	(–2.62)
Year dummy	Yes		Yes		Yes	
No. of obs.	247		247		247	
No. of obs. selected	76		76		76	
Chi-squared	180.86***		33.17**		36.97**	
Pseudo R-squared	59.31%					

Notes: *, **, and *** denote significance of coefficients at the 10%, 5%, and 1% levels (two-tailed), numbers in parentheses are *z* values.

5 Conclusions and limitations

Using US resource extractive firms between 2010 and 2018, we find a negative association between the tones in sustainability reports and future environmental performance. Our result suggests that firms using more pessimistic tones in their sustainability reports will have better environmental performance next year, while firms using more optimistic tones will have poor future environmental performance. Our result is consistent with the legitimacy theory and impression management literature (H1). Our results could be explained by two reasons: risk mitigation and corporate governance. Firms that use more optimistic tones are more likely to be sued later, which increases

litigation risks (Rogers et al., 2011). Corporate governance might be another reason. Previous studies have found consistent evidence that supports a positive link between corporate governance and environmental performance (e.g., Lu and Herremans, 2019; Walls et al., 2012). Firms that issue high-quality environmental disclosure have better corporate governance (Iatridis, 2013). Moreover, board gender diversity (part of corporate governance) is associated with negative tones in sustainability reports (García-Sánchez et al., 2019). Thus, our result is consistent with the literature that firms with better corporate governance are less likely to engage in sustainability impression management.

Our study makes the following two theoretical contributions. First, we find that tones in sustainability reports are informative of future environmental performance. Second, our simultaneous equation (3SLS) shows that the relationship between tones and environmental performance is two-way. More negative tones in sustainability reports are linked with higher future environmental performance, and firms with better environmental performance will use more negative tones in the future.

Our results call for more attention to sustainability reports' tones since we find a negative relationship between tone and future environmental performance. Our study suggests that managers in poor-performing firms tend to glorify their sustainability reports with optimistic tones to hide actual environmental performance.

Like Du and Yu (2020), our research relies on the Loughran and McDonald sentiment dictionary, which was initially designed for financial disclosure. A sentiment dictionary designed for sustainability reporting would be desirable for future studies. Besides, our sample is mining, quarrying, and oil and gas extraction industries. Future research might want to expand to other more environmentally impacting industries to generalise the findings.

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