1 **Is sustainability advertising just a public relations stunt?**

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5 **Abstract**

6 Companies and related consumer behaviours contribute significantly to global carbon emissions.
7 However, consumer behaviour has shifted, with the public now recognising the real and immediate
8 impact of climate change. Companies are aware and seemingly eager to align to consumers
9 increasing sustainability consciousness, yet there is a risk that companies present themselves as
10 sustainable without implementing sustainable processes (i.e. using sustainability advertising as a
11 public relations stunt). Here, using longitudinal climate leadership, sustainable messaging (Twitter)
12 and stock price data, we explore how climate leadership (a relative climate change mitigation
13 metric) and sustainable messaging have changed for hundreds of UK companies. We also assess if
14 companies are simply using sustainable messaging as a public relations stunt and failing to improve
15 their climate leadership. Finally, we explore how climate leadership and sustainable messaging
16 influence companies' stock prices. We found that companies have increased their climate
17 leadership and sustainable messaging between 2010 and 2019, but both at a lower rate than
18 expected. We also found that companies with more sustainable messaging had a higher climate
19 leadership, suggesting there is little to no evidence of broadscale false sustainability advertising in
20 UK companies. In fact, companies may be under-advertising their sustainability. Finally, we found
21 that companies with a greater increase in sustainable messaging also had a slower stock price
22 growth, suggesting sustainable messaging might not be appreciated by investors, or sustainable
23 messaging increases with poorer stock performance.

24 **Keywords**

25 Advertising, Business, Climate change, Corporate social responsibility, Finance, Sustainability,
26 Twitter

27 **Introduction**

28 Climate change has been an area of concern within academic and policy circles for decades
29 (Houghton, Jenkins, & Ephraums, 1990) but has only gained widespread public attention in recent
30 years (Leiserowitz et al., 2018). This societal desire to increase sustainability has changed people's
31 priorities and behaviours. For example, environmental protection rivals the economy as one of
32 American citizens top concerns (Pew Research Center, 2020), and companies are having to adapt
33 to increasing numbers of individuals avoiding single-use plastic (Ertz, Huang, Jo, Karakas, &
34 Sarigöllü, 2017), switching to renewable energy (Ren21, 2019) and embracing electric vehicles
35 (International Energy Agency, 2019). A huge proportion of global carbon emissions are produced by
36 private sector companies (Ekwurzel et al., 2017), and many companies have acknowledged
37 changes in consumer behaviour and peoples' desire for a reduction in carbon emissions (Bonini,
38 Hintz, & Mendonca, 2008; Allen & Craig, 2016).

39 Companies may not only align with more sustainable practices due to ethical decision making –
40 becoming more sustainable can also be a good business decision (Fadul & Maurer, 2004; Wagner
41 & Schaltegger, 2004), as consumers have been shown to engage more with companies that exhibit
42 good social, environmental and ethical behaviour (El Zein, Consolacion-Segura, & Huertas-Garcia,
43 2020). However, this information is at least partially opaque for consumers at the point of purchase,
44 and so consumers are reliant on making the purchasing decisions based on the item's branding
45 (amongst other things). For this decision to be effective from the consumers perspective, the
46 branding needs to accurately represent the company's social and environmental performance.

47 Many countries have marketing law to ensure products are described fairly. For example, in the
48 United Kingdom it is illegal to falsely advertise products and deceive consumers (Gov, 2008). These
49 laws should protect consumers as companies are required to represent their products accurately,
50 allowing a reasoned decision by the consumer about whether to buy or not. However, there are
51 numerous high-profile incidences where these laws are stretched, or even ignored e.g. the health
52 impacts of smoking (Gilmore, Fooks, Drope, Bialous, & Jackson, 2015). Misrepresentations of this
53 severity are likely rare, but misdirection may still pervade the issue of climate change and
54 sustainability. For example, oil companies in the United States were more likely to advertise the

55 benefits of their products when the companies received media and governmental scrutiny (Brulle,
56 Aronczyk, & Carmichael, 2020). This suggests that advertising was a mechanism used to sway
57 public opinion and legitimise their products, despite these products having extreme carbon outputs
58 i.e. using advertising as a public relations stunt to present the company as more sustainable than
59 their sustainability actions deserve.

60 Here, we explore how climate leadership (embracing strategies to mitigate climate change) and
61 sustainability messaging have changed over the past 10 years (2010-2019) for hundreds of UK
62 companies, and we assess if sustainable messaging accurately represents companies' climate
63 leadership. Assuming companies have implemented some climate change mitigation in response to
64 the increasing recognition of climate impacts, we expect climate leadership and sustainable
65 messaging to have increased over time. However, we predict that some companies may not fully
66 embrace sustainable processes, but will still try to obtain benefit from sustainable messaging (a
67 stunt). If this is the case, we would expect a weak relationship between sustainable messaging and
68 climate leadership, or perhaps a clustered relationship, where some companies with high
69 sustainable messaging have high climate leadership, and a splinter group have high sustainable
70 messaging and low climate leadership. If companies are, on the whole, embracing sustainability,
71 and accurately representing this in their brand, we would expect a clear positive relationship, where
72 companies with high sustainable messaging also have high climate leadership. Finally, we explore
73 how climate leadership and sustainable messaging influence a selection of companies' stock prices,
74 to evaluate the relationship between sustainability and company performance.

75 **Methods**

76 Data

77 *CDP data*

78 We obtained climate sustainability performance data from the publicly available CDP (formerly
79 known as the Carbon Disclosure Project) companies dataset (CDP, 2020). Globally in 2019, over
80 8,400 companies disclosed their sustainability information, which falls into three themes with
81 descending degrees of available data (N represents number of disclosing companies in each

category): climate change (N = 8361), water security (N = 2435), and forests (N = 543). Here we focus solely on climate change, as it is the most populated theme and has been collected for a selection of companies as far back as 2003 (CDP, 2020). The publicly available CDP dataset provides an ordinal sustainability summary score for each company in each year, ranging from A to D: A represents 'leadership', B is 'management', C is 'awareness', and D represents 'disclosure'. Such that, an A company would be one of the 'world's most pioneering companies leading on environmental transparency and performance', whilst a D company is participating in the disclosure but is not a leader in addressing environmental risks. Earlier in the scheme, there was also a category E which has now been removed by the CDP from the scoring. To simplify this ordinal scale and allow averaging over years, we converted this into a numeric integer scale ranging from 9 to 1, where A = 9, A- = 8, B = 7, and so forth up to E = 1. In cases where a company had provided insufficient information to be assessed, or had been asked to participate in the disclosure by an investor or customer, but failed to complete the disclosure, the company is granted an F. We classed these F scores, as well as a series of additional categories with similar sentiment, as missing values.

Each of the 510 UK companies listed in the CDP fell into one of 13 sectors. Some sectors only contained one company, so these smaller sectors were consolidated into other relevant groups. Specifically, 'Transport OEMS' was merged with 'Transport services', the 'Steel' and 'Cement' sectors were placed in 'Construction', and any companies with missing sector information were placed in the 'General' category. The number of companies falling in each sector was highly variable (Figure 1a), and more than 80% of companies were in the 'General' category, which could occur when companies don't align to any specific sector. The proportion of companies disclosing in each sector varied considerably, with 86% of agricultural commodity companies missing climate scores in at least 8 of the last 10 years, whilst in food beverage and tobacco, only 15% of companies were missing values (Figure 1a). The proportion of missing values also varied over time, by extracting all publicly available climate change scores dating back to 2010, there was a general trend towards fewer missing values in recent years (Figure 1b). One concern with these missing values is that companies failing to disclose could have lower climate scores (Dawkins & Fraas, 2011). If the values were missing with a bias towards only good companies disclosing, we may

111 expect to see higher climate scores in sectors with more missing values. However, when we tested
 112 mean sector climate score against proportion of missing scores within the sector, we found no
 113 relationship between missingness and score (Figure 1c).

114 **Figure 1.** a) Percentage of companies in each sector with less than two climate leadership scores, labelled
 115 with accompanying total (with and without missing data) number of companies (N) in the sector. b) Change in
 116 missing climate scores (%) per sector between 2010 and 2019. The black dashed line represents the average
 117 across all sectors. c) Mean (± 1 standard deviation) climate score per sector against missing climate scores.
 118 Black line and the accompanying grey ribbon (95% confidence intervals)) represent a linear model between
 119 the mean climate score and missing climate scores. d) Each horizontal line represents a company with an
 120 account on Twitter, and the left-point on each line indicates the account opening date. Tweets that fell within
 121 the last 3200 of each account were downloaded and are indicated in blue, whilst grey indicates the period
 122 where tweets were unavailable (missing values).
 123

125 *Twitter data*

126 For each of the 510 UK companies listed in the CDP, we manually searched for their Twitter handle
127 (profile). Some companies had multiple handles for different aspects of their company, and in these
128 cases we always selected the account that most closely represented the UK arm of the business
129 e.g. 'Coca Cola' have one global account with 3.3 million followers, but it was the smaller account
130 'Coca Cola European Partners' which more closely represented the UK operations. There were also
131 some accounts where we were uncertain if we had identified the correct Twitter handle, and so we
132 removed these accounts from the dataset. After this step, we were left with 287 companies, and we
133 downloaded each companies last 3,200 (the limit set by Twitter) tweets using the 'rtweet' R package
134 (Kearney, 2017). These tweets were all in the public domain. For some companies, the 3200 tweets
135 stretched beyond 2010 (over 10 years) and covered companies' entire history on Twitter. Whilst for
136 over companies, tweets only stretched back a matter of months and missed much of the companies'
137 historic tweets (Figure 1d).

138 With this Twitter timeseries dataset, we identified all tweets which contained any of the following
139 terms: climate, temperature, global warming, sustainable, sustainability, nature, renewable, carbon
140 neutral, flood, drought, desertification, ocean acidification, coral bleaching, and wildfire. It is worth
141 noting that some of these terms are only tangential to the topic of climate change, unlike the CDP
142 climate score, but were specifically selected so we could capture companies talking about the
143 potential impacts (e.g. wildfire) or mitigation strategies (e.g. renewable) of climate change.

144 *Stock prices*

145 We searched for stock prices from the London Stock Exchange for all companies with at least two
146 years of climate and Twitter data ($N = 128$) using the 'BatchGetSymbols' R package (Perlin, 2020).
147 Thirty-four companies were not listed on the London Stock Exchange, and so we removed these
148 from the dataset. Two further companies (Kingfisher and Taylor Wimpey plc) had incomplete stock
149 histories so were also removed. For each company, we extracted the mean adjusted closing stock
150 price for each year to produce an annual time series of stock prices. The adjusted closing stock
151 price was used, as stock value can be influenced by dividends, stock splits, and new stock releases
152 (e.g. changes in stock volume), which would be accounted for in the adjusted stock closing price.

153 Models

154 *Change in climate leadership and sustainable messaging*

155 To assess how climate leadership and sustainable messaging have changed over time, we
156 developed two mixed effect models. We used a linear model for climate leadership, with climate
157 score as the response ranging from 1 to 9. Conventionally, this ordinal data should be handled with
158 an ordinal model, but in later models (see '*Link between climate leadership, sustainable advertising,*
159 *and stock prices*') this rank is summarised into a temporal trend and an average rank, which are
160 both more easily interpreted when the score is treated as a continuous number. As a result, for
161 consistency, we treated this response as continuous throughout, however, to ensure inference is
162 valid, we also repeated this change in climate leadership test with an ordinal model in the
163 supplementary material. For sustainable messaging we used a logistic model, with a binary value
164 indicating whether each tweet contained any of the specified sustainable terms. We used the same
165 predictor, years since 2010, in both the climate leadership and sustainable messaging models and
166 included company name as a random intercept, nested within company sector (as specified by the
167 CDP). Notably, the distribution of companies was uneven across sectors (Figure 1a). This change in
168 climate leadership (N = 510) and sustainable messaging (N = 287) was assessed across all
169 companies with available data. As an accompaniment to the sustainable messaging model, we also
170 characterised the overall word use, identifying the 50 most used words across UK companies. As
171 part of this, we removed all punctuation and numbers, and then stemmed words (e.g. 'consulting'
172 and 'consultation' would both become 'consult'). Finally, we removed all stop words (e.g. common
173 words like 'the' and 'a') specified by the 'tm' R package (Feinerer & Hornik, 2019).

174 *Link between climate leadership, sustainable advertising, and stock prices*

175 For each company, in each of the last 10 years (2010-2019) we derived the mean climate
176 leadership score, percentage of sustainable tweets, and the mean adjusted closing stock price. We
177 then removed all years with any missing values, and all companies which had less than two years of
178 complete data. In the remaining companies (N = 92), we derived five variables: climate score –
179 mean climate score across all available years; annual change in climate score – slope coefficient
180 from a log-linear regression of climate score against year; sustainable messaging – mean

181 sustainable messaging (%) across all available years; annual change in sustainable messaging -
182 slope coefficient from a log-linear regression of sustainable messaging (%) against year; and annual
183 change in stock prices - slope coefficient from a log-linear regression of adjusted closing stock
184 prices against year. We also extracted the number of Twitter followers for each company, to act as a
185 proxy for how public-facing a company is i.e. is this company reliant on a good relationship with the
186 public for sales.

187 We developed five linear mixed-effect models within a piecewise structural equation framework to
188 explore climate leadership, sustainable advertising, and stock prices. In step 1, we assess if climate
189 leadership (response) is greater in companies with more followers. In step 2, we explore how the
190 number of followers and climate leadership influence sustainable messaging (response). In step 3,
191 we assess if the change in climate leadership (response) is influenced by the number of followers,
192 whilst controlling for the mean climate leadership which could confound this result. In step 4, we
193 explore how the number of followers, climate leadership, the change in climate leadership, and
194 sustainability messaging all influence the change in sustainable messaging (response). Finally, in
195 step 5, we assess how climate leadership, the change in climate leadership, sustainability
196 messaging, and the change in sustainability messaging all influence the change in companies stock
197 prices (response). In all five models, we included the company's sector as a random intercept to
198 account for sector specific variation. To meet model assumptions, we added 0.1 to sustainable
199 messaging to deal with companies that never produced a sustainable tweet and then log
200 transformed (base 10) the variable; we present the back-transformed values in marginal effects
201 plots within the results. The only model assumption we failed to meet was within the step 3 model,
202 where the variance of the residuals was heterogenous as companies with high climate leadership
203 scores had a lower change in their scores. This heterogeneous error is captured in the marginal
204 effect plots.

205 **Results**

206 *Change in climate leadership and sustainable messaging*

207 Climate leadership has increased since 2010 (coef: 0.20, CI: 0.17 – 0.22, R^2_{marginal} : 0.06, $R^2_{\text{conditional}}$:
208 0.58, Figure 2a), with companies gaining a grade (e.g. B to A-) every 5 years. However, tot all

224 $R^{2\text{marginal}}: 0.03$, $R^{2\text{conditional}}: 0.46$), where on average across all companies, the probability of tweets
225 containing a sustainable message was less than 0.001 in 2010, and increased to 0.03 in 2019. This
226 change in sustainable messaging was highly variable, where some companies exhibited a decline,
227 whilst others exhibited growth. For example, one company increased their sustainable messaging
228 rate, and from 2010 to 2019, the probability of a tweet containing a sustainable message grew from
229 0.02 to 0.17.

230 *Link between climate leadership, sustainable advertising, and stock prices*

231 In the piecewise structural equation model (see Table 1 and Figure 3), the number of followers had
232 a positive effect on climate leadership, but no effect on sustainable messaging. However,
233 sustainable messaging was greater in companies with a higher climate leadership. The number of
234 followers also had no effect on change in climate leadership or the change in the sustainable
235 messaging. We did, however, observe greater growth in climate leadership from companies with low
236 climate scores, but conversely, growth in sustainable messaging was greater in companies with a
237 higher mean sustainable messaging. These effects are not surprising given some companies
238 reached their maximum climate score, whilst no companies were dedicating all their tweets to
239 sustainable messaging, so there was still room for growth in this messaging. Finally, stock price
240 decreased in companies that had an increasing sustainable messaging, but with a poor fit. Mean
241 sustainable messaging, mean climate leadership, and change in climate leadership all had no effect
242 on the change in stock price.

243

244 **Table 1.** Structures and outputs from the piecewise structural equation models. The predictors of the five
245 models are indented, and we do not show the intercept (b_0), random intercept ($Sector_i$), or gaussian error
246 terms ($error_{ij}$) in the models. For each predictor, we show the slope coefficient (coef) and 95% confidence
247 intervals (95% CI), which were derived from 1000 bootstrap simulations. Predictors with an effect at the 95%
248 confidence interval are depicted in bold. For each model, we report the marginal (R^{2m}) and conditional (R^{2c}) r-
249 squared.

Models	coef	95% CI	R^{2m}	R^{2c}
<i>Climate leadership score_{ij} ~</i>			0.33	0.48
<i>b₁Followers_{ij}</i>	1.20	0.89, 1.53		
<i>Sustainable messaging_{ij} ~</i>			0.11	0.13
<i>b₁Followers_{ij}</i>	-0.05	-0.24, 0.14		
<i>b₂Climate leadership score_{ij}</i>	0.14	0.05, 0.24		
<i>Annual change in climate leadership score_{ij} ~</i>			0.08	0.08
<i>b₁Followers_{ij}</i>	0.28	-3.64, 4.39		
<i>b₂Climate leadership score_{ij}</i>	-2.53	-4.66, -0.50		
<i>Annual change in sustainable messaging_{ij} ~</i>			0.05	0.63
<i>b₁Followers_{ij} +</i>	-3.51	-16.0, 8.67		
<i>b₂Climate leadership score_{ij} +</i>	3.22	-3.90, 9.65		
<i>b₃Sustainable messaging_{ij} +</i>	19.26	5.27, 33.7		
<i>b₄Annual change in climate leadership score_{ij}</i>	0.12	-0.40, 0.70		
<i>Annual change in stock price_{ij} ~</i>			0.05	0.20
<i>b₁Climate leadership score_{ij}</i>	1.02	-1.42, 3.71		
<i>b₂Sustainable messaging_{ij}</i>	3.84	-2.85, 10.45		
<i>b₃Annual change in climate leadership score_{ij}</i>	0.06	-0.25, 0.34		
<i>b₄Annual change in sustainable messaging_{ij}</i>	-0.10	-0.19, -0.01		

250

Figure 3. Piecewise structural equation model describing effect of predictors (base of arrows) on responses (tips of arrows). Black arrows indicate a significant effect, whilst grey arrows indicate no effect, both at the 95% confidence interval-level. Text adjacent to arrows describes the slope coefficient of the corresponding response-predictor relationship. For significant effects: * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$. Panels a - c describe the marginal effects and 95% confidence intervals of a selection of significant effects in the structural equation model, with all other variables held at their mean. The points in panels a – c are the raw values.

Discussion

We explored how climate leadership and sustainable messaging have changed across UK companies, and assessed if sustainability messaging is simply being used as a public relations stunt to attract consumers under the guise of sustainable practices. We found evidence that climate leadership and sustainable messaging have increased in the last 10 years, and found that companies with a larger number of followers had higher climate leadership, but followers had no

265 effect on sustainable messaging. This is partly encouraging, as more public-facing companies (more
266 followers) appear to be truly embracing climate leadership instead of simply increasing sustainable
267 messaging to appease their consumers. The downside to this is that generally, less public-facing
268 companies have a lower climate leadership, yet growth in climate leadership was greatest in these
269 low climate leadership companies. In contrast, growth in sustainable messaging was greater in
270 companies with a high mean sustainable messaging. There was no relationship between the
271 change in sustainable messaging and change in climate leadership. However, we did find a positive
272 relationship between mean climate leadership and sustainable messaging, suggesting that overall
273 companies are fairly advertising their climate performance. Although, there are some exceptions
274 here, with some companies still regularly releasing sustainable messages despite having low
275 climate leadership.

276 Sustainability messaging was greater in companies with higher climate leadership scores,
277 suggesting, generally, companies are not using sustainability messaging as a public relations stunt.
278 Furthermore, as the number of followers had no effect on sustainable messaging, but did positively
279 impact climate leadership, it appears that large public-facing companies are truly embracing
280 sustainability, instead of just pandering to their many followers. However, the fixed effects only
281 contributed a relatively small amount to the model fit (low marginal R^2) and some companies far
282 exceeded their expected sustainable messaging i.e. low climate leadership but high sustainable
283 messaging. In these cases, it may be reasonable to suggest these companies are exhibiting false
284 advertising. However, deviating from the sustainable messaging-climate leadership trend does not
285 automatically imply the company is trying to deceive. In fact, the low overall probability of companies
286 releasing a sustainable message possibly suggests that most companies are under-advertising their
287 work. As a result, this sustainable messaging-climate leadership trend is valuable for assessing
288 whether companies are generally advertising their sustainability proportionately to their climate
289 leadership. However, its unfit for determining what degree of advertising is generally proportionate,
290 which is why we have made no effort to highlight companies which may be under- or over-reporting
291 sustainable messages. It is also worth noting, this model exhibited substantial sector specific
292 variation (high conditional R^2), and what may be perfectly adequate sustainable messaging in one
293 sector, could be over- or under-advertising in another.

Climate leadership has increased across UK companies, which is encouraging, but not surprising given companies have already stressed willingness to adopt sustainable practices (Allen & Craig, 2016),. However, with the immediate threat of climate change (IPCC, 2014), it is unclear whether the rate of growth in climate leadership is sufficient. For example, on average, companies only increased their climate score by one point every 5 years, suggesting at the current rate, it would take 35 years to move from the lowest score (climate disclosure) to the highest score (climate leadership). There is already extensive guidance to support companies trying to embrace sustainability (Hoffman, 2007; Sussman & Freed, 2008; Ihlen, 2009; Aggarwal & Dow, 2012; Begg, van der Woerd, & Levy, 2018), but if this guidance has only supported the slow observed increase in climate leadership, the guidance may not be ambitious enough (Ekwurzel et al., 2017). Future work could explore what mechanisms limit this growth in sustainability.

With increasing public interest in sustainability issues (Leiserowitz et al., 2018; Pew Research Center, 2020), it's not surprising to see companies have increased their sustainability messaging between 2010 and 2019. However, despite the increase, these sustainability messages were still infrequent, where the average probability of a tweet containing a sustainability term in 2019 at 0.03, and only two terms broadly related to sustainability ('forest' and 'planet') occur in the 50 most used words. This low frequency of sustainability messages was unexpected given sustainability issues rank amongst the most important of consumer concerns (Pew Research Center, 2020). Whether this low frequency of sustainable messaging is proportionate to public sustainable messaging remains unclear, but regardless, the scarcity of sustainable messages suggests companies are prioritising other themes and more foundational work could characterise the language use and topics discussed by these companies. Furthermore, given the low frequency of sustainable messages, it's plausible that there is room for companies to further promote their sustainability.

We expected high and increasing climate leadership would lead to stock price growth, as investors would see potential long-term gains in value, as in El Zein et al (2020). However, climate leadership, and change in climate leadership, had no effect on stock growth. Instead, stock growth was lower in companies with increasing sustainable messaging. We are unsure what has driven this effect, it is possible promoting sustainability implies organisational change and discourages investors, but this

322 seems unlikely. More work is needed here to assess if this is a genuine effect, or simply a
323 consequence of making inference on a small sample of data (which may be biased – see below).

324 A potential limitation with this work is that our main variables (climate leadership and sustainable
325 messaging) may not be adequate proxies to address our hypotheses. We used climate leadership
326 as a proxy to describe companies climate performance i.e. emissions and attempts to reduce
327 carbon pollution. Whilst these emissions features are captured within the CDP climate leadership
328 score, it is unclear whether the score is completely fair, and what a fair score would look like. For
329 example, one very large energy company was granted a high score in 2019 (B: Climate
330 management) despite being one of the ten largest carbon emitting companies and releasing nearly
331 2% of the world's greenhouse gases (Ekwurzel et al., 2017). Should these extreme-emitters be
332 granted high-scores? Should companies be rewarded with a high score for simply making efforts to
333 mitigate carbon emissions, even if their mitigation had a negligible impact when considering their
334 overall emissions? These are important dilemmas to address when designing climate change
335 metrics if consumers are to make informed decisions. Whilst for sustainability messaging, we would
336 expect a brands image to be mainly derived from traditional paid adverts and not corporate twitter
337 accounts. This presents an issue, where there could be discrepancy between the companies
338 climate leadership, the brand image consumers rely on, and companies Twitter posts (our
339 sustainable messaging variable). A qualitative analysis to understand similarities and differences
340 between these three components would be valuable. However, for our analysis, we would expect
341 tweets from corporate accounts to fairly represent the climate leadership of a company, even more
342 so than paid adverts, so using Twitter posts should be an acceptable proxy of sustainable
343 messaging.

344 A further limitation in this work is the high abundance of missing values in the climate leadership
345 and sustainable messaging data, and the real risk that these values are missing with a bias. For
346 sustainable messaging, a potential bias could be that companies with more tweets (and in turn more
347 incomplete data), are more active on social platforms, have more engaged followers, so will be
348 more in touch with consumer concerns (e.g. sustainability). As a result, with more complete data, we
349 may expect a positive relationship between followers and sustainable messaging, as well as
350 followers and change in sustainable messaging. However, the climate leadership missing data bias

351 may be even more critical, where companies failing to disclose their climate performance may have
352 a lower climate leadership and less growth in their climate leadership. There is already evidence of
353 this bias in corporate climate change disclosure data (Dawkins & Fraas, 2011). Further
354 encouragement of companies to embrace climate change disclosure would be beneficial for
355 understanding how climate performance is changing on a larger scale, but even more importantly,
356 as companies social responsibility improves with reporting, wholesale uptake of reporting, and a
357 more a general shift towards increased transparency could have substantial benefits for mitigating
358 carbon emissions.

359 The growth in climate leadership is encouraging and suggests that UK companies are eager to
360 mitigate their carbon outputs. However, the current rate of growth could be insufficient, and calls
361 from companies for policymakers to provide clear guidance on mitigation steps remain essential
362 (Allen & Craig, 2016). Similarly, the growth in sustainable messaging shows that companies are
363 aware of the public's desire for more sustainable products, and encouragingly, we found evidence
364 that sustainable messaging is generally aligned with climate leadership i.e. there is no evidence of
365 sustainability messaging generally being used for a public relations stunt.

366 **Acknowledgments**

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369 **Data availability**

370 The CDP and Twitter data are protected and so cannot be shared, but both can be sourced
371 independently (CDP: <https://www.cdp.net/en/companies/companies-scores>; Twitter:
372 <https://github.com/ropensci/rtweet>). Code are available at (zenodo link TBC after peer review)

373 **Author contributions**

374 TFJ developed the ideas, TFJ and MPG collected the data, TFJ analysed the data, and wrote the
375 manuscript. MPG critiqued the ideas and contributed critically to a draft of the work.

376

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