

ORIGINAL RESEARCH

Does Uncertainty in Annual Reports Affect ESG Score?

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Abstract

This study examines whether uncertainty in the wording of annual reports (10-K) is associated with Environmental, Social, and Governance (ESG) performance for 64 US public firms. Findings show a negative relation between uncertain words and ESG performance, indicating that greater use of ambiguous words in firms' financial statements is negatively related to firms' ESG scores. This finding shows that market participants may notice that firms could use vagueness or ambiguity in their 10-K reports to delay market response to poor performance or negative impact on the environment (i.e., Greenwashing). Findings from this study could provide some insights to investors, managers, and regulators in the capital market by suggesting that public firms use more transparent and clear language in their 10-K reports.

Keywords: ESG (Environmental, Social, and Governance); ESG scores; annual reports; 10-K; uncertain words in 10-K

1. Introduction

It is becoming more important for firms to consider environmental, social, and governance (ESG) factors for their success (Kell, 2014; Beard, 2019). These factors can significantly impact a company's financial results and value generation despite not being strictly financial in nature (Hales, 2018). Recent surveys indicate that investors acknowledge the financial implications of ESG risks for their investment portfolios (Krueger et al., 2020). These arguments are supported by Laurence Fink (BlackRock's chairman and CEO), who stresses the importance of integrating ESG-related reputation risks into core strategies for long-term financial performance.¹ ESG-related reputation risk is a potential firm value loss from ESG factor management (Asante-Appiah and Lambert, 2023). Increased focus on ESG has led to demand for ESG data and services (AICPA 2021a). Organizations must consider identifying potential ESG-related corporate risks, assess detected risk factors, and propose remedial measures.

¹Please refer to letters dated February 2016 and January 2018 at <https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter>.

Business writing is a key part of how firms showcase their ESG endeavors and initiatives in their financial disclosures. Recent studies find that ambiguous words used in corporate disclosures increase valuation uncertainty. Ambiguity is found in financial statements that can be interpreted in several ways. Companies may use both vagueness and ambiguity to make it harder to understand their claims, which reduces criticism and creates positive images of their environmental initiatives (Bloomfield, 2002; Poole, 2026). Loughran and McDonald (2011) create word lists that reflect important ambiguous words widely used in the financial context. They argue that uncertain words such as *approximate*, *assume*, *contingent*, *depend*, and *indefinite* express imprecision. According to Bloomfield (2002), managers may use ambiguous language to obscure information about firms' uncertain or poor future performance to postpone market reaction to bad news. Rooted in the management obfuscation hypothesis and the incomplete revelation hypothesis (Bloomfield, 2002), managers use vague terminology to raise information processing fees for analysts and the public. Similarly, in an analysis of John Browne (the CEO of BP, formerly British Petroleum)'s speech at Stanford University in 1997, Poole (2026) argues that his speech is an instance of greenwashing through vague language and presenting possibilities rather than certain promises. Firms can use vague lexical choices to reduce immediate scrutiny while preserving future operational benefits.

This study examines how uncertainty in firms' annual reports may affect ESG performance. Specifically, I investigate the relation between uncertain words in annual reports and ESG scores of 64 US firms in 2012 and 2021. Enhanced ESG performance can lower agency costs and information asymmetry by enhancing stakeholder engagement, increasing ESG disclosure, and improving earnings quality (Cheng et al., 2014; Cho et al., 2013; Kim et al., 2012). For instance, firms with more robust ESG performance can attract more institutional ownership and greater analyst following (Benlemlih & Bitar, 2018; Bofinger et al., 2022; Gillan et al., 2021). Furthermore, firms with better ESG performance are more likely to behave ethically across various dimensions, leading to lower levels of corporate misconduct, reduced discretionary accruals, and a lower chance of regulatory investigations (Christensen, 2016; He et al., 2022; Kim et al., 2012).

To test the above hypothesis, I obtain 491 firm-year observations of 64 publicly traded US industrial companies with ESG scores and financial information for 2012–2021. ESG score is the dependent variable for the analyses in this study, and these data were obtained from an open-source database. The dataset includes financial and non-financial indicators of companies as well (Bogomolova, 2024). This observation was matched with uncertain words from Professor McDonald's 10-K word analysis database.²

Focusing on the findings of this study, the main variables from descriptive statistics show that the mean (median) of the natural logarithm of ESG scores (*ESG_Score*) is 3.966 (4.086). The mean (median) of uncertain words (*Uncertain_Words*) is 0.013 (0.013), meaning about 1.3% of the total word count in the 10-K report consists of uncertain words. Pearson correlations are conducted for the variables used in the multivariate regression analyses. The results show a negative relation between *Uncertain_Words*, *ROA*, *Quick_Ratio*, *Asset_Growth*, *PE_Ratio*, and *ESG_Score*, indicating that uncertain words in 10-K filings are negatively associated with ESG Score. However, I find a positive relation between *Firm_Size*, *Leverage*, and *ESG_Score*. Focusing on regression analysis, I find a significant negative relation between *Uncertain_Words* and *ESG_Rank* (coefficient = -13.853 , t-stat. = -1.960), which supports the argument of this study. This result indicates that more ambiguous words in 10-K reports are associated with lower ESG scores. In addition, I find a significantly positive coefficient on *Firm_Size* (coefficient = 0.164 , t-stat.

²Professor McDonald's (University of Notre Dame) personal website provides free academic data source for sentiment words counts and other textual analysis information via his personal website. <https://sraf.nd.edu/sec-edgar-data/>

= 7.28), indicating that larger firms may promote their ESG-related activities and would show their efforts more effectively in the report. This result is consistent with the univariate analysis result. In addition, a Variance Inflation Factor (VIF) test is conducted to detect possible multicollinearity in the variables used in the regression analysis, and the variables are moderately correlated.

This study makes two contributions. First, the findings contribute to the literature on the economic consequences of ESG initiatives by exploring how uncertainty in 10-K is associated with ESG performance. Second, the findings can be beneficial for various stakeholders, corporate managers, and investors seeking to understand the short- or long-term impacts of ambiguity in financial disclosures on ESG reputation and ratings.

2. Literature Review and Hypothesis Development

2.1 Strategic Benefits of Better ESG Performance

The strategic perspective on ESG suggests that ESG activities can bring strategic benefits that may offset the costs associated with ESG implementation (Porter & Kramer, 2006; Siegel & Vitaliano, 2007). Better ESG performance is connected to higher legitimacy recognized by stakeholders (Eliwa et al., 2021; Zerbini, 2017), with legitimacy being an essential intangible resource for ensuring firms' survival (Suchman, 1995). For instance, companies with better ESG performance may gain favor with customers in terms of increased product demand and reduced price elasticity (Kassinis & Soteriou, 2003), while those with poorer ESG performance may experience reductions in corporate customers and supply-chain contracts (Darendeli et al., 2022). ESG endeavors contribute to enhancing employee loyalty and motivation (Greening & Turban, 2000; Porter & Kramer, 2006) and cultivating goodwill with governments and other regulators (Cao & Rees, 2020). Hence, companies with better ESG performance may achieve improved financial performance and market values (Chen & Xie, 2022; Ho, Chen, & Wu, 2021; Qiu et al., 2016).

2.2 Ambiguity in 10-K, Greenwashing, and ESG Ratings

Vague business writing may occur when a word has no clear boundary. Loughran and McDonald (2011) create word lists to reflect important ambiguous words that have been widely used in the financial context. They document that uncertain words such as *approximate*, *assume*, *contingent*, *depend*, and *indefinite* express imprecision.

Recent studies find that ambiguous words used in corporate disclosures increase valuation uncertainty. Ambiguity is found in financial statements that can be interpreted in several ways. Companies may use both vagueness and ambiguity to make it harder to evaluate their claims, and it reduces criticism and creates positive images in their environmental reputation (Bloomfield, 2002; Poole, 2026).

Prior literature documents that the management obfuscation hypothesis expects that managers have incentives to obscure information when their companies expect poor performance or underachievement. According to Bloomfield (2002), managers may use ambiguous linguistic choices to obfuscate information about firms' uncertain or poor future performance to postpone market reaction to bad news. Rooted in the management obfuscation hypothesis and the incomplete revelation hypothesis (Bloomfield, 2002), managers use vague terminology to increase information processing costs for analysts and the public. In a similar vein, in an analysis of John Browne (the CEO of BP, formerly British Petroleum)'s speech at Stanford University in 1997, Poole (2026) states that his speech is an instance of greenwashing through vague language and presenting possibilities rather than certain promises. Firms could engage in

vague lexical choices to reduce immediate scrutiny while preserving future operational benefits in their environmental sustainability areas.

Findings of previous studies are consistent with their prediction that 10-K filings with more ambiguous words are related to a higher cost of capital. Overall, their results provide evidence that ambiguous words in 10-K filings are associated with a firm's information-concealing behavior, which undermines the credibility of companies' environmental and sustainability efforts.

Based on the discussions above, I formulate an alternative hypothesis below.

H1: *There is a negative relation between uncertain words in 10-K reports and ESG scores.*

3. Research Method

3.1 Data and Sample

Initially, ESG scores (the dependent variable) dataset is from an open-source database covering 72 publicly traded US industrial firms from 2012–2021, creating 720 firm-year observations (Bogomolova 2024). The sample includes firms from industrial sectors such as transportation, machinery, aerospace, and manufacturing. According to Bogomolova (2024), ESG score dataset was downloaded from the Bloomberg and Refinitiv Eikon databases, and it can range from 0 to 100. My sample has a score range of 5.718 to 91.715. Table 1 details both original ESG scores and the natural logarithm of ESG scores. I use the natural logarithm of ESG scores to normalize the distribution. This open-source database also provides financial data and ratios, including market capitalization, return on assets (*ROA*), quick ratio (*Quick_Ratio*), asset growth (*Asset_Growth*), financial leverage (*Leverage*), and price-to-equity ratio (*PE_Ratio*). I match this dataset with uncertain word-count data from Professor McDonald's webpage.³ These words express imprecision, and examples include *approximate*, *assume*, *contingent*, *depend*, and *indefinite*, etc.

Table 1 below shows the sample selection. I start with 72 firms with 720 observations. I delete missing ESG scores from the original dataset, which yields 666 observations. Matching on uncertain words in the 10-K dataset makes me deduct 175 observations, so my final sample size is 64 firms with 491 observations. The same firms can appear in multiple years (panel data), and among 491 observations, about 29.33% of the sample is in the machinery industry, and 12.63% of the sample is in Aerospace & Defense. The rest of the sample firms' industries are shown in Table 2.

Table 1. Sample Selection

	N
Original data source	720
Less: missing ESG score	–54
Data before matching with uncertain words dataset	666
Less: missing data from matching with uncertain words data	–175
Final Sample Size	491

³Professor McDonald's (University of Notre Dame) personal website provides a free academic data source for sentiment word counts and other textual analysis information via his personal website. <https://sraf.nd.edu/sec-edgar-data/>

Table 2. Sample by Industry

Industry	Number	Percent
Aerospace & Defense	62	12.63%
Air Freight & Logistics	30	6.11%
Airlines	28	5.70%
Building Products	36	7.33%
Commercial Services & Supplies	46	9.37%
Construction & Engineering	2	0.41%
Electrical Equipment	23	4.68%
Industrial Conglomerates	36	7.33%
Machinery	144	29.33%
Professional Services	38	7.74%
Road & Rail	32	6.52%
Trading Companies & Distributors	14	2.85%
Total	491	100.00%

3.2 Research Design

I use the following OLS regression model for *HI*, which predicts the relation between uncertain words in 10-K and ESG scores of US public sample firms.

$$\begin{aligned}
 ESG_Score_{i,t} = & \beta_0 + \beta_1 Uncertain_Words_{i,t} + \beta_2 Firm_Size_{i,t} + \beta_3 ROA_{i,t} \\
 & + \beta_4 Quick_Ratio_{i,t} + \beta_5 Asset_Growth_{i,t} + \beta_6 Leverage_{i,t} \\
 & + \beta_7 PE_Ratio_{i,t} + \varepsilon_{i,t-1}
 \end{aligned} \quad (1)$$

In Equation (1), to test *HI*, the dependent variable, *ESG_Score*, is defined as the natural logarithm of the original ESG scores. The main variable of interest, *Uncertain_Words*, is measured by the proportion of uncertain words in the total number of words in 10-K reports. Control variables are as follows. *Firm_Size* is the natural logarithm of market capitalization and measures firm size. *ROA* measures the firm's operational performance. *Quick_Ratio* measures a company's capacity to pay short-term debts. It is measured by the sum of cash, cash equivalents, marketable securities, and accounts receivable, divided by current liabilities. *Asset_Growth* measures how quickly a company has been growing its assets. It is calculated by the difference between ending total assets and beginning total assets, divided by beginning total assets, and multiplied by 100 to present as a % change. *Leverage* is measured by long-term debt plus current debt over the average of total assets of the current and previous years. *PE_Ratio* compares a company's share price with its earnings per share (EPS). It is measured by current stock price divided by earnings per share. Appendix A provides all variable definitions.

4. Results

4.1 Descriptive Statistics and Correlation Analysis

Table 3 presents descriptive statistics, and Table 4 shows Pearson correlations for the variables used in the multivariate regression analyses. As shown in Table 3, the total sample size is 491 firm observations.

The mean (median) of the original ESG score (*ESG_Score_Raw*) is 56.287 (59.525). The mean (median) of the natural logarithm of the original ESG score (*ESG_Score*) is 3.966 (4.086), indicating the natural logarithm of the original ESG scores. The mean (median) of uncertain words (*Uncertain_Words*) is 0.013 (0.013), meaning about 1.3% of the total word count in the 10-K report consists of uncertain words. *Firm_Size* indicates the natural logarithm of market capitalization, and the mean (median) is 24.208 (24.112). The mean (median) of *ROA* is 8.175 (7.861). The mean (median) of *Quick_Ratio* is 1.070 (0.922). *Asset_Growth* has a mean of 6.986 and a median of 4.447. *Leverage* has a mean of 8.289 and a median of 2.761. Lastly, *PE_Ratio* has a mean of 22.815 and a median of 20.217. In Table 4, I conduct a univariate analysis with Pearson pairwise correlation analysis. The results show a negative relation between *Uncertain_Words*, *ROA*, *Quick_Ratio*, *Asset_Growth*, *PE_Ratio*, and *ESG_Score*, indicating that uncertain words in 10-K filings negatively affect ESG Score. However, I find a positive relation between *Firm_Size*, *Leverage* and *ESG_Score*.

Table 3. Descriptive Statistics

Variable Name	Obs.	Mean	Std. Dev.	0.25	Median	0.75
<i>ESG_Score_Raw</i>	491	56.287	17.678	42.083	59.525	69.491
<i>ESG_Score</i>	491	3.966	0.393	3.740	4.086	4.241
<i>Uncertain_Words</i>	491	0.013	0.002	0.011	0.013	0.014
<i>Firm_Size</i>	491	24.208	0.851	23.489	24.112	24.855
<i>ROA</i>	491	8.175	5.686	4.833	7.861	11.177
<i>Quick_Ratio</i>	491	1.070	0.587	0.647	0.922	1.402
<i>Asset_Growth</i>	491	6.986	16.096	-0.071	4.447	10.551
<i>Leverage</i>	491	8.289	36.515	2.196	2.761	4.047
<i>PE_Ratio</i>	491	22.815	13.649	15.989	20.217	25.737

Table 4. Pearson Correlations Analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) <i>ESG_Score</i>	1							
(2) <i>Uncertain_Words</i>	-0.195*	1						
(3) <i>Firm_Size</i>	0.371*	-0.220*	1					
(4) <i>ROA</i>	-0.254*	0.120*	-0.014	1				
(5) <i>Quick_Ratio</i>	-0.336*	0.060	-0.158*	0.315*	1			
(6) <i>Asset_Growth</i>	-0.177*	0.076	-0.093*	0.098*	-0.010	1		
(7) <i>Leverage</i>	0.068	0.041	0.032	-0.076	-0.080	-0.034	1	
(8) <i>PE_Ratio</i>	-0.147*	0.111*	-0.034	0.049	0.141*	0.029	-0.024	1

* Significant at the 5% level.

4.2 Multivariate Regression Analysis

This section shows the primary result of this study. Table 5 shows the OLS regression results for *H1*. The central finding is a significant negative coefficient on *Uncertain_Words* (coefficient = -13.853, t-stat. = -1.960), providing support for *H1*. This result indicates that more ambiguous words in 10-K reports are associated with lower ESG scores. In addition, I find a significantly positive coefficient on *Firm_Size* (coefficient = 0.139, t-stat. = 7.430), indicating that larger firms may promote their companies'

ESG-related activities and show their efforts in the report more effectively. This result is consistent with the univariate analysis result.

Table 5. Multivariate Regression Analysis

Variable Name	Coefficient	Std. Error	t	P> t	95% Conf. Interval	
<i>Uncertain_Words</i>	-13.853	7.055	-1.960	0.050	-27.716	0.010
<i>Firm_Size</i>	0.139	0.019	7.430	0.000	0.102	0.175
<i>ROA</i>	-0.010	0.003	-3.650	0.000	-0.016	-0.005
<i>Quick_Ratio</i>	-0.149	0.028	-5.340	0.000	-0.204	-0.094
<i>Asset_Growth</i>	-0.003	0.001	-3.240	0.001	-0.005	-0.001
<i>Leverage</i>	0.000	0.000	0.670	0.501	-0.001	0.001
<i>PE_Ratio</i>	-0.002	0.001	-2.140	0.033	-0.005	0.000
<i>_cons</i>	1.105	0.483	2.290	0.022	0.157	2.054

Following prior literature, I conduct a Variance Inflation Factor (VIF) test to detect multicollinearity. Table 6, as follows, indicates the results of the test, and each VIF and the mean VIF are less than 2–2.5, which means there is no noticeable inflation of the standard errors and the variables are moderately correlated.

Table 6. Variable Inflation Factor to Detect Multicollinearity

Variable Name	VIF	1/VIF
<i>Quick_Ratio</i>	1.17	0.856
<i>ROA</i>	1.14	0.875
<i>Firm_Size</i>	1.09	0.918
<i>Uncertain_Words</i>	1.08	0.922
<i>PE_Ratio</i>	1.03	0.969
<i>Asset_Growth</i>	1.03	0.975
<i>Leverage</i>	1.01	0.986
Mean VIF	1.08	

5. Conclusions

This study provides some evidence that uncertain words that show imprecision in firms' disclosure are significantly associated with ESG performance scores for 64 US public firms from 2012 to 2021. The main results of the multivariable regression analysis show a statistically significant negative relation between uncertain words and ESG performance, indicating that greater use of ambiguous words in firms' financial statements is negatively associated with firms' ESG scores. VIF test is conducted to detect multicollinearity in variables used in regression analysis, and the variables are moderately correlated. This study provides some insights to major capital market players such as investors, corporate managers, public accountants, and regulators in that firms may use vague and ambiguous financial disclosure to delay the market response to their weak performance or lack of environmental effort. It supports the notion that integrating ESG principles is not merely a regulatory or ethical obligation but that it could be improved through strategic lexical choice in firms' financial disclosures.

Conflicts of Interest

The author declares that there are no conflicts of interest related to this work.

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Appendix A

Variable Definitions

<i>ESG_Score_Raw</i>	= Original ESG rating score from open-source dataset (Bogomolova, 2024);
<i>ESG_Score</i>	= Natural logarithm of the original ESG rating score from the open-source dataset (Bogomolova, 2024);
<i>Uncertain_Words</i>	= The proportion of uncertain words to the total words in 10-K filings as defined in Loughran and McDonald (2011);
<i>Firm_Size</i>	= The natural logarithm of market capitalization, which measures firm size;
<i>ROA</i>	= Measures the firm's operational performance. It is measured by net income divided by average total assets;
<i>Quick_Ratio</i>	= Assesses a company's capacity to pay short-term debts. It is measured by the sum of cash, cash equivalents, marketable securities, and accounts receivable, and divided by current liabilities;
<i>Asset_Growth</i>	= Assesses how quickly a company has been growing its assets. It is measured by the difference between ending total assets and beginning total assets, divided by beginning total assets, and multiplied by 100 to get the % change;
<i>Leverage</i>	= Long-term debt plus current debt over the average of total assets of the current and previous years;
<i>PE_Ratio</i>	= PE (Price-to-earnings) ratio compares a company's share price with its earnings per share (EPS). It is measured by current stock price divided by earnings per share.