Investing Green to Become More Green: An Analysis of Whether S&P 100 Companies are Decreasing their Carbon Footprint Proportional to their Liquidity

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Investing Green to Become More Green: An Analysis of Whether S&P 100 Companies are Decreasing their Carbon Footprint Proportional to their Liquidity

Ashley Hendler and Ethan Hunter, Washington University in St. Louis

William Bottom, Ph.D., Advisor

Abstract: Global warming may have ignited the flame in corporations to invest in the changing business and environmental climate. The importance of a broader stakeholder value perspective has grown as firms have impacted the global environment. The S&P 100 firms are at the forefront of the public’s attention in maximizing shareholder and stakeholder value. With the worldwide expectation for corporate social responsibility, these top firms are not in question of whether they are investing in sustainability initiatives but to what extent. We seek to decipher if these top corporations are reducing their carbon footprint proportional to their excess available funds. Since 2016, total GHG emissions induced by S&P 100 firms have steadily decreased; however, a potential collective attitude of “doing enough” to appease investors and the public eye could generate a plateau in GHG emission reduction amongst these top firms. Our research study leverages a fixed effect regression analysis to determine the relationship between business liquidity and GHG emission reduction to ultimately unveil whether social impact is proportional to financial means. In our regression analysis, liquidity measures and ratios yield statistically significant results, demonstrating the alignment between the bottom line and triple bottom line (environmental, social and governance, ESG, investments). The presence of a public ESG auditor and early adopters of sustainability reporting also are statistically significant, with a surprising finding that early adopters of sustainability reports have higher annual GHG emissions. The assurance from public auditors is associated with lower GHG emissions; with only 11 S&P 100 companies having a public auditor and the SEC instituting new regulations, there is optimism in the continued reduction of corporate-induced emissions. Our exploratory analysis delves deeper into the unquantifiable contributors of emission outputs, investigating industry-specific trends, marketing materials, and sustainability reports.
Introduction
Some may assume that businesses have always had one overriding objective — maximizing the bottom line. However, the environmental, social, and governance (ESG) demands of stakeholders and financial demands of shareholders have recently begun to converge on the concept of the “triple bottom line” — a multidimensional accounting framework that includes social and environmental dimensions of business (Elkington, 1997). While the consensus on firm motivation and purpose of a corporation has evolved significantly since the post-war era, we hope to investigate the correlation between corporations’ accessible monetary resources and investment in mitigating their environmental impact.

ESG has gained more traction recently as more firms realize that their environmental efforts and corporate governance are of increasing concern to various stakeholders, in turn affecting businesses’ success. Today, many look to corporations and governments' most prominent institutions to enact positive environmental change proportional to their reach and wealth. Thus, major corporations are investing in their employees and communities to generate long-term value and success for stakeholders.

To effectively explore the relationship between financial health and investment in environmentalism, we are honed in on the top 100 U.S. corporations comprising the 2020 S&P 100 stock market index.1 Given their size and economic prominence, S&P 100 firms tend to be at the forefront of the media’s attention. That may explain why 92% of them are currently addressing their sustainability goals; However, having a “green mission” may not be the same as taking tangible action. Indeed shareholders and stakeholders have begun probing corporations to enact measurable change proportional to their environmental impact (Governance & Accountability Institute, 2021).

Firms' ability to engage in tangible actions reflects resource ability to do so. Executives of firms with greater liquidity should enjoy more discretion to invest in sustainable practices. Those lacking resources may be consumed in fighting to ensure survival in “the market for corporate control.” We will be focusing on the liquidity of corporations in the S&P 100 between January 1, 2016, through December 31, 2020. This time period includes significant political and social changes that affected corporations' ability and willingness to invest in environmental causes — most notably including the Trump administration’s signature legislation reducing corporate taxes and their effort to delegitimize interest in climate change (Wagner et al., 2018). At the same time, the COVID-19 pandemic induced significant market volatility, record-high earnings and may have increased expectations for decreasing business carbon footprints. We will supplement our

1 The S&P 100 is a stock market index that comprises the 100 leading U.S. firms with exchange-listed options. The exchange is a subset of the S&P 500 and is designed to measure the performance of large-cap companies across multiple industry groups in the United States. A company’s inclusion in the S&P 100 is dependent on market capital, financial viability and adequate liquidity, leading the index to be widely regarded as a benchmark for overall market performance.
quantitative analysis by including an exploratory analysis of patterns observed in S&P 100 firms’ actualized GHG emission reduction and their messaging to the public eye.

The two-pronged approach to measuring the impact of financial and communication measures to evaluate their impact on sustainability is an effort to assess whether or not top corporations’ actions or words speak louder. By analyzing our independent variable, liquidity, alongside our dependent variable, carbon emissions reduction, we will examine the relationship, or gap, between the bottom line and the triple bottom line. Our regression model seeks to test the effect of liquidity on a company’s actualized decrease in carbon emissions.

**Background**

The corporate governance landscape in the United States has undergone distinct waves of dominant logic. In C. Wright Mills’ 1956 book, *The Power Elite*, he called attention to the synergy of interests between corporations, the military, and the political elite, suggesting that the ordinary citizen is a relatively powerless subject of manipulation by those entities (Mills, 1956). He argued that the American business community in the post-war period was composed of “practical” and “sophisticated” members, which the latter represent “the outlook and the interest of the whole” (Mills, 1956). Corporations were placed under more stringent reigns in the 1980s when American banks lost their centrality in the networks of the “practical” and “sophisticated” members of the business community. A new conception of stakeholder value maximization, articulated most clearly by Friedman (1962), gradually gained traction among the corporate elite and wider public. The logic Friedman and colleagues articulated eventually led to a mass wave of hostile corporate takeovers, promoted as advancing shareholder value maximization, followed by the shift to a precarious corporate environment in which executives were under scrutiny to maximize shareholder value with little ramifications (Walsh, 1993). Corporate executives have learned to focus narrowly on share price without attending to long-term consequences such as profound inequality, market crashes, and environmental concerns (Mizruchi, 2017). In recent years, these potential consequences have brought to light yet another shift in firm motivation; a shift in implementing ESG initiatives to serve the greater society — stakeholder value creation (Dimon, 2020).

Scholars increasingly stress the distinction between firms’ views of corporate social responsiveness versus corporate social responsibility (Allen, 2016). Responsiveness requires communication, emphasizing how organizational processes and structures need to react to the social needs and values of many individuals and groups interested in the organization (Allen 2016). Corporate social responsibility (CSR) began to receive systematic attention when the concept of a ‘social contract’ between firms and society was declared by the Committee for Economic Development in 1971 (Association of Corporate Citizenship Professionals, 2022). It was then that the notion that CSR initiatives spanned beyond the board room, and when firms' consumers and communities thrive, the company would as well. The key interlink between accounting and sustainability measures is how corporations communicate with potential and
existing shareholders and stakeholders. Systematic CSR reporting by specific firms now comes in many forms from a few paragraphs in a company’s annual financial reports to stand-alone comprehensive reports that are over 100 pages in length. Some reports may represent mere exercises in public relations, whereas others at least appear to candidly confront head-on the key CSR challenges the firm faces in an effort to extend a corporation’s intent beyond the generation of profits for shareholders (Appendix 1).

Today, carbon data is reported annually by individual corporations’ ESG or CSR reports, often with figures constructed according to ISO 14000 (The Center for Audit Quality, 2021). ISO 14000 is a widely utilized framework and set of standards created in 1996 and revised in 2015 by the International Organization for Standardization (ISO) to help firms worldwide reverse their adverse impact on the environment. ISO 14000 includes the environmental standards that cover aspects of management practices inside facilities, in the immediate environment around the facilities, and the impact of the raw materials used to create a product and the impact of its eventual deposit. While adopting the standards is optional, nearly 300,000 organizations have obtained certification. That investment is widely seen as a sign of commitment to the environment which can be a marketing tool for firms (ISO 2022). All S&P 100 companies have some ESG data available in their firm’s shareholders statement, with 90% having an additional standalone ESG report (The Center for Audit Quality, 2021).

In utilizing this background on the evolution of CSR and sustainability reporting, we are able to best understand previous literature and formulate the basis for our study.

Previous Literature
An analysis of the existing literature on the relationship between carbon emissions and corporate performance shows that early studies assumed that investments to protect the environment provided few economic and financial benefits to companies. For example, Walley and Whitehead, among others, suggested a negative link between environmental management and financial performance. They argued that firms trying to enhance their environmental performance draw their resources and management effort away from the core areas of the business, resulting in lower profits (Walley et al., 1994). Managers cannot make both environmental and competitive improvements (Hull et al. 2008). By contrast, Porter and Van der Linde suggested that companies can be both environmentally conscious and decrease their emissions while remaining competitive (Porter et al., 1995).

Looking back at the first empirical Corporate Social Performance (CSP) and Corporate Financial Performance (CFP) study, Bragdon and Marlin (1972) examined whether the virtue of engaging in CSP was virtuous enough to be its reward:

Proponents [of what they called the orthodox economic logic] argue that corporate managers can either control pollution or maximize profits but that the former can be accomplished only at the expense of the latter. From the investor’s perspective, this, in
turn, implies that he can either invest in a profitable company or a “good” company (which protects its environment) but that no company is likely to be both.

A positive link between social and financial performance would legitimize corporate social performance on economic grounds, which are increasingly crucial to stakeholders (Useem, 1996). It would license companies to pursue the good, even incurring additional costs, to enhance their bottom line while also contributing more broadly to the well-being of society. While investor pressure regarding ESG initiatives has historically concentrated on non-financial corporations, specifically the energy sector, major financial institutions have begun to acknowledge the associated long-term threat to financial stability in recent years. With high stakes, investors will demand more from firms than simply setting long-term commitments and will have to provide “credible, achievable near-term signposts on their path to decarbonization” (Bastit et al., 2022).

In 2014, Gallego-Alvarez, Segura, and Martinez-Ferraro examined the impact of carbon emission reduction on the operational performance of international firms. Their findings show that reducing GHG emissions positively impacts financial performance through the analysis of 89 Fortune 500 multinational firms from 2006 to 2009. They used two proxies to demonstrate the possible differences in performance measures: ROA, a measure of financial performance, and ROE, a measure of operational performance (Gallego-Alvarez et al., 2014). Their control variables, including company size, sector, growth, sustainability index, and legal system, were analyzed using panel data. The financial performance measure of ROE showed the most significant effect on emission reductions, “supporting the assertion that those companies that are more proactive in environmental issues, such as GHG emission reductions, can achieve competitive advantage and thus better financial performance” (Gallego-Alvarez et al., 2014).

Evidently, the varied research focal points and results do not offer one single narrative or prediction on how corporations’ financial health associates with their environmental changes. Thus, our study will leverage previous findings in conjunction with nuanced concepts to contribute to this sphere of research.

**Research Focus**

Our research seeks to examine the relationship between the liquidity of S&P 100 firms, their communication efforts measured by frequency related to sustainability, and their impact on GHG emissions. Specifically, we seek to understand the core financial measures along with communicative factors that may drive a firm to have decreased carbon emissions.

**Financial Analysis**

In conducting our financial analysis, we will hone in on examining 12 primary measures of liquidity — all critical indicators of firm performance and revenue that positively impacts the bottom line. These variables include free cash flow, net income, dividend payout ratio, market
Exploratory Analysis
We examine shareholder statement data of the two firms in our sample size, with the most significant increase and decrease of carbon emissions, to investigate the presence of greenwashing of sustainability-oriented communications. The gained traction in ESG investment coincides with greenwashing — the process of providing misleading information about how environmentally conscious a firm or product is to capitalize on the growing demand for environmentally and socially sustainable products (Vieria de Freitas Netto, et al., 2020). The analysis of Twitter posts and sustainability statements of the two firms with the most significant increase and decrease of GHG emissions year over year allows us to identify greenwashing patterns versus actualized commitment toward reducing carbon emissions compared to GHG emissions data.

We also explore relationships between the presence of a public ESG auditor through a qualitative analysis to better understand any descriptive or predictive relationships between formal ESG assurance and emission reduction success. With only 11% of S&P 100 companies having a public ESG auditor, and this variable consistently having statistical significance in reducing GHG emissions, the investigation on exactly which of these firms are electing for this assurance is particularly interesting (The Center for Audit Quality, 2021). Furthermore, this variable provides insights into the growing inclusion of public auditors of sustainability, with only 4.5% of the S&P 500 companies outside of the S&P 100 having a public ESG auditor (Tysiac, 2021). This discrepancy lends itself to understanding the saturation of ESG assurance at the very top, but even only 11 of the top firms have a public auditor. Interestingly enough, despite only 6% of all S&P 500 companies (including the S&P 100) having public ESG auditors, 53% of them had some form of verification or assurance over their ESG reporting. For example they may employ an engineering or consulting firm (Goelzer, 2021). Thus, the distinction between auditor and non-auditor means more than just the presence of assurance and includes the level of assurance. As SEC regulations surrounding ESG reporting tighten, as discussed later, this variable brings high value in anticipating what kind of top firms are going to emerge as environmental leaders.

Hypotheses
We believe our research will help businesses, environmental leaders, and regulatory advisors understand the financial factors influencing corporations’ changes in GHG emissions. All our hypotheses will entail least square (OLS) regression, with a given proxy for liquidity as the predictor variable controlling for total assets and capital expenditures to mitigate a scale bias. Based on our preliminary research, we hypothesize that:
**Hypothesis I: Free Cash Flow**

**H0**: Firms with increases in free cash flow will report the same or increased GHG emissions.

**HA**: Firms with increases in free cash flow will report decreased GHG emissions.

**Hypothesis II: Net Income**

**H0**: Firms with increases in net income will report the same or increased GHG emissions.

**HA**: Firms with increases in net income will report decreased GHG emissions.

**Hypothesis III: Market Capitalization**

**H0**: Firms with increases in Market Capitalization will report the same or increased GHG emissions.

**HA**: Firms with increases in Market Capitalization will report decreased GHG emissions.

**Hypothesis IV: Operating Net Cash Flow**

**H0**: Firms with increases in operating net cash flow will report the same or increased GHG emissions.

**HA**: Firms with increases in operating cash flow will report decreased GHG emissions.

**Hypothesis V: Retention Ratio**

**H0**: Firms with increases in retention ratio will report the same or increased GHG emissions.

**HA**: Firms with increases in retention ratio will report decreased GHG emissions.

**Hypothesis VI: Return on Assets (ROA)**

**H0**: Firms with increases in ROA will report the same or increased GHG emissions.

**HA**: Firms with increases in ROA will report decreased GHG emissions.

**Hypothesis VII: Return on Assets (ROE)**

**H0**: Firms with increases in ROE will report the same or increased GHG emissions.

**HA**: Firms with increases in ROE will report decreased GHG emissions.

**Hypothesis VIII: Current Ratio**

**H0**: Firms with increases in current ratio will report the same or increased GHG emissions.

**HA**: Firms with increases in current ratio will report decreased GHG emissions.

**Hypothesis IX: Degree of Financial Leverage (DFL)**

**H0**: Firms with increases in DFL will report the same or increased GHG emissions.

**HA**: Firms with increases in DFL will report decreased GHG emissions.

**Hypothesis X: Dividend Payout Ratio**

**H0**: Firms with increases in Dividend Payout Ratio will report the same or increased GHG emissions.

**HA**: Firms with increases in Dividend Payout Ratio will report decreased GHG emissions.
**Sample**

In evaluating our research question we will be examining historical panel data (2016-2020) from the 2020 list of S&P 100 corporations. All independent liquidity variables and our dependent variable, GHG emissions, were sourced from the Bloomberg Terminal (BBG) and Compustat, a product of S&P Global Market Intelligence. Our indicator variables — fiscal year, the year of sustainability efforts initiated, the presence of a public ESG auditor, and industry — were all manually aggregated via sifting through the financial statements, ESG reports, and websites of each respective S&P 100 firm.

**Sample Background & Sector Analysis**

The S&P 100 index is a subset of the S&P 500 index and includes leading United States stocks with exchange-listed options. Constituents of the S&P 100 index are selected for sector balance and market capitalization. In 2020, firms listed on the S&P 100 represented 67% of the market capitalization of the S&P 500 and nearly 54% of the entire United States equity market. S&P classifies members of publicly traded companies into 11 sectors and 24 industry groups based on their primary business activity. The index is heavily weighted toward tech, healthcare, and consumer discretionary stocks (as evidenced by figure 1 below). There are not as many utilities, real estate, or firms involved in the production or sale of raw materials. This weighting has changed vastly over the past two decades as tech firms have taken the rise over consumer discretionary and communication services companies. It is imperative to note that the weighting of the S&P 100 does not always represent firms with the strongest financial performance in a given year, but rather the largest in each respective industry by market capitalization. This sample size provides vast industry diversification to investors and researchers alike.

![Figure 1: S&P 100 Sector Composition (2020)](image)

**Data Cleansing Methods**

In our data cleaning phase, we omitted 11 of the S&P 100 firms from 2020 due to significant missing data for nine firms or extraordinary financing activities that caused duplicate or missing tickers for Alphabet and DOW.²

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² Alphabet (GOOG), American Tower Corp (AMT), Charter (CHTR), Dow Inc (DOW), Salesforce (CRM), Tesla (TSLA), Texas Instruments (TXN), Thermo Fisher Scientific (TMO), Union Pacific Corp (UNP), United Parcel Service Inc (UPS) and Verizon (VZ).
Specifically, Alphabet was listed twice on the S&P 100 following the establishment of a new class of capital stock, Class C capital stock, which retains no voting rights. For index purposes, S&P Indices anticipate that over time Class C shares of Alphabet will become the primary equity trading line for Google, leading them to add the Class C share line to the S&P 100 and S&P 500, given that both classes have a substantial market cap. The Class C share line and the Class A share line both represent Google in the S&P 100 and have the same underlying financial information. To mitigate data duplication for our research study, we omitted one listing of Alphabet.

Additionally, we omitted Dow Inc (DOW) from our list of S&P 100 firms due to incomplete financial information available as a result of a merger between Dow Inc (DOW) and DuPont de Nemours Inc (DD) in 2017 to form DowDuPont. Then, in 2019 Dow separated entirely from DuPont de Nemours, leading to a lack of financial information available for FY 2016 and 2017.

**Data Aggregation Methods**

The raw data was aggregated in an Excel file with tabs for each of the years from 2016 to 2020 for all S&P 100 corporations. We repeated this process three times to ensure symmetric information. Our dependent variable, greenhouse gas emissions (GHG), was sourced from the Bloomberg Terminal and compiled in an Excel file with tabs for each of the years from 2016 to 2020. R was utilized to merge the datasets from BBG and Compustat based on ticker symbol and year. Once data was finalized in a merged document, the final transformation was the coding of indicator variables to be read by R as non-continuous and to be used as fixed effects in the regression. The fiscal year, sustainability reporting initiated year range, presence of a public ESG auditor, and classification as in the IT or energy industry are all indicator variables that were transformed to individual coded columns. This transformation allowed the system to recognize these variables as nominal, fixed effect variables rather than numerical, continuous variables. Finally, the BBG-Compustat merged data was bound with these new indicator variable columns to curate the final data for the regression.
# Variables

## Independent Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
<th>Equation</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquidity IVs</td>
<td>Liquidity is an accounting measure of entities' ability to convert assets into cash efficiently; indicative of cash at the bottom line to be reinvested or paid out.</td>
<td>Measures below:</td>
<td>Bloomberg Terminal and Compustat</td>
</tr>
<tr>
<td>Free Cash Flow (FCF)</td>
<td>The amount by which a firm's operating cash flow exceeds its working capital needs and expenditures.</td>
<td>BBG: Cash from Operations - Capital Expenditures</td>
<td>Bloomberg Terminal</td>
</tr>
<tr>
<td>Net Income (NI)</td>
<td>Assesses how much of a firm's revenue exceeds their expenses.</td>
<td>BBG: Total Revenue - Total Expenses</td>
<td>Bloomberg Terminal</td>
</tr>
<tr>
<td>Dividend Payout Ratio</td>
<td>The fraction of net income a firm pays to its shareholders in dividends.</td>
<td>BBG: Total Common Dividends * 100 / Income Before Extraordinary Items Less Minority and Preferred Div</td>
<td>Bloomberg Terminal</td>
</tr>
<tr>
<td>Market Capitalization</td>
<td>The total dollar market value of a firm's outstanding shares of stock.</td>
<td>Total Number of Outstanding Shares * Current Market Price of 1 Share</td>
<td>Compustat</td>
</tr>
<tr>
<td>Capital Expenditures (CapEx)</td>
<td>Funds used by a firm to acquire, upgrade and maintain physical assets.</td>
<td>Net Increase in PP&amp;E + Depreciation Expense</td>
<td>Compustat</td>
</tr>
<tr>
<td>Operating Net Cash Flow (ONCF)</td>
<td>Measures the amount of cash generated by a firm's normal business operations.</td>
<td>Operating Income + Depreciation - Taxes + Changes in Working Capital</td>
<td>Compustat</td>
</tr>
<tr>
<td>Return on Assets (ROA)</td>
<td>Indicator of how profitable a company is relative to its total assets.</td>
<td>BBG: (T12 Net Income / Average Total Assets) * 100</td>
<td>Bloomberg Terminal</td>
</tr>
<tr>
<td>Return on Equity (ROE)</td>
<td>Measure of a firm's profitability and efficiency in relation to equity.</td>
<td>BBG: (T12 Net Income Available for Common Shareholders / Average Total Common Equity) * 100</td>
<td>Bloomberg Terminal</td>
</tr>
<tr>
<td>Retention Ratio (RR)</td>
<td>Measures the percentage of entity profits being reinvested into the business; signals the extent to which profits are going back into the entity rather than being paid out as dividends.</td>
<td>BBG: 100 - Dividend Payout Ratio</td>
<td>Bloomberg Terminal</td>
</tr>
<tr>
<td>Degree of Financial Leverage</td>
<td>Measures the sensitivity of a firm's earnings per share to fluctuations in operating income as a result of changes in its capital structure.</td>
<td>BBG: EBIT / (EBIT - Interest Expense or Interest Expense per BOE)</td>
<td>Bloomberg Terminal</td>
</tr>
<tr>
<td>Current Ratio</td>
<td>Indicator of a company's ability to pay back its short-term liabilities with its short-term assets.</td>
<td>Current Assets / Current Liabilities</td>
<td>Bloomberg Terminal</td>
</tr>
<tr>
<td>Total Assets</td>
<td>Total of all short and long-term assets as reported on the balance sheet</td>
<td></td>
<td>Bloomberg Terminal</td>
</tr>
</tbody>
</table>

## Dependent Variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
<th>Equation</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse Gas (GHG) Emissions</td>
<td>The measurement of GHG emissions is the top indicator used to describe carbon footprint reduction efforts in corporations; GHG emissions are the most universally understood, measured, and reported metric used in sustainability initiatives today.</td>
<td>Total Greenhouse Gas (GHG) Emissions of the company, in thousands of metric tonnes of carbon dioxide equivalent (CO2e), using the location-based method. Greenhouse Gases are defined as those gases which contribute to the trapping of heat in the Earth's atmosphere, including Carbon Dioxide (CO2), methane, Nitrous Oxide, and others. Total GHG Emissions as defined in this field, equals the total of company Scope 1 and Scope 2 emissions. It does not include Scope 3 emissions. Definition of Scope 3 emissions remains subject to much interpretation and therefore there is significant variability in the company reported data- this could cause undue variation in the company's Total GHG emissions figure.</td>
<td>Bloomberg Terminal</td>
</tr>
</tbody>
</table>

Figure 2: Independent & Dependent Variables


**Additional Variables**

In addition to the independent and dependent variables, we will integrate nominal variables in the form of fixed effect and indicator variables to control for confounding factors that may influence corporations’ annual reduction in GHG emissions.

*Fixed effect variables:*

- **Fiscal year:** all variables will be measured over the course of the past five fiscal years to account for any major economic events that were year-specific.

*Indicator variables:*

- **Sustainability efforts initiated:** Three categories of year ranges (2005-2010, 2011-2015, 2016-2020) are indicators of when corporations began reporting their sustainability efforts. This variable will offer insights into how the longevity of sustainability initiatives impacts corporations’ recent reduction in GHG emissions. This data was aggregated from the respective sustainability reports published by each S&P 100 firm in our sample size.

- **Public auditors:** Only 11% of S&P 100 companies received some level of assurance on their ESG information from a public auditor which may drive differences in GHG emissions reported (The Center for Audit Quality, 2021). This data was collected from the respective sustainability reports and financial statements published by each S&P 100 firm in our sample size.

- **Energy industry:** The energy sector comprises 3.7% of the S&P 100 firms in our sample size. As investors are pushing companies to disclose consistent and reliable GHG data, this variable will offer insights into whether an environmentally ‘dirty’ industry has taken strides to reduce its GHG emissions. In 2020, the energy industry’s operations accounted for 9% of all human-made GHG emissions, while the fuels it produces created another 33% of GHG emissions (Beck et al., 2020).

- **IT industry:** The information technology sector is the largest component (28.1%) of the S&P 100 firms in our sample size. The industry is rapidly growing as the world becomes more digitized. This variable will offer insights as to whether the largest composition of our sample size has taken strides to reduce their GHG emissions even without majorly-emitting operations.

*Interpreting Variables*

With our final year of data collection being 2020, our analysis includes the financial and environmental data during the height of the COVID-19 pandemic. The major changes to business demand, regulations, and operations generated shifts in both liquidity and carbon emission reduction out of the normal course of business cycles. This exogenous shock infiltrated every business, but potentially the most negatively affected industry is the energy and oil industry with S&P Global Platts Analytics estimating that “global oil demand declining by 8.7 million b/d (down 8.4%) from the pre-COVID forecast, wiping out six years of growth” (S&P Global,
2022). As evidenced below in figure 3, airlines and oil & gas drilling were the top two industries most impacted by the pandemic in 2020 (S&P Global, 2022).

With the oil and gas drilling industry comprising about 10% of our sample and also serving as the greatest contributors to GHG emissions output, there are potential concerns about the distortions this may introduce into the estimation of our model. Our measure of annual percent change in GHG emissions may be skewed due to reduced operations, which would likely cut into our liquidity measures as well. While the pandemic exacerbated operational changes, the broad range of investment and divestments across the entire time window and within each firm is a major source of variance and is not the primary focus of this study. Nonetheless, our sample selection was based on the 2020 list of S&P 100 companies to capture the impact of this shock on the qualification of the top-ranked companies.

Thus, in trying to understand the relationships between the independent variables and the GHG dependent variable, we will observe patterns in their descriptive statistics, data visualizations, and regression outputs to make speculations within the scope of our research. To best interpret our coefficients, we will outline each of our indicator variables followed by the key variables. The p-values from the below regression results are compared against an alpha level of 0.05 to determine statistical significance.
Descriptive Statistics and Trend Analysis

GHG Emissions (Dependent Variable)

<table>
<thead>
<tr>
<th>Summary Statistics</th>
<th>Summary Statistics</th>
<th>Summary Statistics</th>
<th>Summary Statistics</th>
<th>Summary Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Observations</td>
<td>86.0 Number of Observations</td>
<td>87.0 Number of Observations</td>
<td>87.0 Number of Observations</td>
<td>87.0 Number of Observations</td>
</tr>
<tr>
<td>Mean</td>
<td>7317.4 Mean</td>
<td>6897.8 Mean</td>
<td>6997.4 Mean</td>
<td>7021.1 Mean</td>
</tr>
<tr>
<td>Median</td>
<td>10185.5 Median</td>
<td>8794.0 Median</td>
<td>11050.0 Median</td>
<td>10510.0 Median</td>
</tr>
<tr>
<td>Min</td>
<td>127 Min</td>
<td>10.0 Min</td>
<td>26.0 Min</td>
<td>22.6 Min</td>
</tr>
</tbody>
</table>

Year over year, the mean GHG emissions steadily decrease, with a slight increase between 2018 and 2019 while the median remains fairly constant throughout the time period. This discrepancy between the mean and median trendlines is indicative of the significant outliers skewing the mean values year over year. These outliers may be derived from the diversity in industry in our sample, with energy companies naturally emitting more than service firms. Or perhaps, the lack of standardization in measurement of GHG emissions could be influencing the emissions reported, which is later explained in the regression discussion.
On average, between 2016-2020, firms with ESG auditors had lower annual GHG emissions than their non-publicly ESG audited counterparts. This trend is likely in part to the aversion to additional regulations or attention from high-emitting firms. The indicator variable of whether the firms had a public ESG auditor was measured only by whether they had one in 2020 due to lack of access to comprehensive data prior. Even so, with only 11 S&P 100 companies having a public auditor in 2020, there is indication of a relationship between formal ESG reporting assurance and emissions levels, likely associated via the latter impacting the former. Statistical analyses in the following section will further explore this relationship based on regression coefficients and p-values.

In evaluating the trends of the only 11 S&P 100 companies with a public ESG auditor, it is crucial to also analyze industry-specific patterns. The 11 companies include:

- Amazon
- Apple
- Bank of America
- Capital One
- CocaCola
- Johnson & Johnson
- KinderMorgan
- Microsoft
- Netflix
- Nike
- PayPal

Amazon, Microsoft, and Netflix are in the technology and software industry; Apple, CocaCola, J&J, and Nike primarily in the consumer product goods industry; and Bank of America, Capital One, and Paypal in the financial services industry. However, KinderMorgan stands out as the only energy company, and with their very consistent GHG emissions year over year, their presence of a public ESG auditor is fairly surprising. Without peer pressure, KinderMorgan is
likely leveraging the opinion of an auditor to stay ahead of industry and regulatory trends while appeasing investors.

Even without statistical analysis, there are evident trends in three broad industries who have an even distribution of S&P 100 companies with public ESG auditors. Although the technology and software industry requires large data centers, or data farms, that use incredible amounts of energy, their negative environmental effect is not captured in the measurement of Scope 1 and Scope 2 emissions. Therefore, their ESG auditor is likely more focused on the attestation of waste production and electricity usage. Within the consumer product goods industry, environmental impact likely spans wide, with a large portion of ESG auditing focused on GHG emissions. Finally, the financial services industry, similar to technology and software, likely uses big data centers but are not generating high GHG emissions due to operations. As the SEC moves forward with legislation regarding public ESG auditing, the firms that are ahead of the game are those with the least net impact on emissions in comparison to the greater possible sample. Thus, as these regulations are implemented, we can expect to see major movements in GHG emissions and assurances of sustainability reporting as the big emitters are finally going to be under the auditor’s eye.

![Energy Sector (Indicator Variable)](image.png)

Unsurprisingly, companies in the energy sector continuously surpass non-energy companies in their GHG emissions. However, companies in the energy sector have reduced their average annual GHG emissions more so than their non-energy counterparts. This trend is likely attributable to increased pressure on the very obvious corporate contributors to climate change, as well as the greater ability to decrease given such high numbers to begin with.

The six companies from the S&P 100 2020 list deemed to be in the energy sector include,

- Chevron Corp
- ConocoPhillips
Again, unsurprisingly, IT companies have substantially lower average annual GHG emissions than non-IT companies. However, upon closer investigation, IT companies’ GHG emissions have been slowly rising since 2017 while non-IT companies have been fairly steady, with a drop in 2020. This trend may be attributable to the fact that IT companies are likely more overlooked with regard to sustainability activism due to their majority-intangible operations. Thus, there may be an opportunity in future research to determine the relationship between public perception of which corporations should be more socially responsible and the effect on actualized CSR impact.

The thirteen companies from the S&P 100 2020 list deemed to be in the energy sector include,

- Exxon Mobil Corp
- Kinder Morgan Inc
- Occidental Petroleum Corp
- Schlumberger NV

**IT Sector (Indicator Variable)**

![Graph: Average GHG Emissions YoY in IT vs. Non-IT Companies](image)

*Figure 7: Average GHG Emissions YoY in IT vs. Non-IT Companies*
Our indicator variable of ranges of years for which sustainability reporting was initiated demonstrated a downward trend between 2005 and 2020. Our ranges do not allow for a year over year analysis, however, this decrease is indicative of the right-skewed distribution of adopters of sustainability reporting. With the majority of S&P 100 companies initiating their sustainability reports before 2015, statistical analysis in the following section will describe the significance of adoption on GHG emission reduction.
Year over year, the mean and median of free cash flow steadily increase with a slight decrease observed from 2016 to 2017. From 2018 to 2019, the median of free cash flow grows significantly and stays constant in 2020. The continued increase year over year is indicative that the firms in our panel data are continuing to increase their operating cash flow in contrast to their capital expenditures. The small decline in the mean observed from 2019 to 2020 may be attributed to the onset of the COVID-19 pandemic which forced firms to spend more.

**Net Income (Independent Variable)**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Number of Observations</td>
<td>66</td>
<td>66</td>
<td>66</td>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td>Mean</td>
<td>572,200,000.0</td>
<td>789,300,000.0</td>
<td>846,500,000.0</td>
<td>879,000,000.0</td>
<td>860,900,000.0</td>
</tr>
<tr>
<td>Median</td>
<td>587,200,000.0</td>
<td>612,300,000.0</td>
<td>643,300,000.0</td>
<td>579,900,000.0</td>
<td>590,600,000.0</td>
</tr>
<tr>
<td>Min</td>
<td>-497,700,000.0</td>
<td>-550,000,000.0</td>
<td>-725,000,000.0</td>
<td>-474,000,000.0</td>
<td>-171,100,000.0</td>
</tr>
<tr>
<td>Max</td>
<td>579,100,000.0</td>
<td>642,000,000.0</td>
<td>654,900,000.0</td>
<td>656,700,000.0</td>
<td>1,179,000,000.0</td>
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</tbody>
</table>

The median of net income year over year remains fairly constant while the mean steadily increases in 2017-2019 and then contracts in 2020. The mean being greater than the median is indicative of a right-skewed distribution. These observations provide insight into the general consistency of S&P 100 firms’ net income which can be presumably equated with their growth of economies of scale.
Every year, the mean and median of market capitalization consistently increase. All firms in our sample are large-cap firms in the United States which have varying market capitalization. The sharp increase in mean from 2019 to 2020 may be attributed to the 31.98% annual returns of the S&P 100 index in 2019 (S&P Global, 2022).

**Market Capitalization (Independent Variable)**

<table>
<thead>
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</tr>
</thead>
<tbody>
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<td>87.0</td>
<td>87.0</td>
<td>87.0</td>
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<tr>
<td>Mean</td>
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<td>15440000000.0 Mean</td>
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<td>Median</td>
<td>8636000000.0 Median</td>
<td>9475000000.0 Median</td>
<td>8995000000.0 Median</td>
<td>11950000000.0 Median</td>
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<tr>
<td>Min</td>
<td>2713000000.0 Min</td>
<td>3734000000.0 Min</td>
<td>27430000000.0 Min</td>
<td>14220000000.0 Min</td>
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<tr>
<td>Max</td>
<td>61800000000.0 Max</td>
<td>86750000000.0 Max</td>
<td>75010000000.0 Max</td>
<td>13595000000.0 Max</td>
</tr>
</tbody>
</table>

**Capital Expenditures (Independent Variable)**

<table>
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<td>86.0</td>
<td>87.0</td>
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<td>Mean</td>
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<td>29400000000.0 Mean</td>
<td>39250000000.0 Mean</td>
<td>40640000000.0 Mean</td>
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<tr>
<td>Median</td>
<td>1390000000.0 Median</td>
<td>15480000000.0 Median</td>
<td>13400000000.0 Median</td>
<td>18070000000.0 Median</td>
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<tr>
<td>Min</td>
<td>0.0 Min</td>
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<td>0.0 Min</td>
<td>0.0 Min</td>
</tr>
<tr>
<td>Max</td>
<td>29710000000.0 Max</td>
<td>27340000000.0 Max</td>
<td>25500000000.0 Max</td>
<td>2,446-10 Max</td>
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</tbody>
</table>

**Figure 11: Mean and Median Market Capitalization YoY**

**Figure 12: Mean and Median Capital Expenditures YoY**
The annual mean of capital expenditures steadily increases while the median steadily decreases throughout the time period. The increasing discrepancy between the mean and median trendlines is indicative of outliers skewing the mean values year over year. These outliers may be derived from the differentiation of industries in our sample, some being more capital intensive than others. IT firms possess the largest component of S&P 100 firms and IT firms are highly capital intensive with the shift to cloud computing and semiconductors. In 2018, IT firms pushed Tech capital expenditures to 5-year highs, where a divergence of the trendlines is observed. (CNBC, 2018). Additionally, in 2018 the corporate tax rate was cut under the Trump administration which may have increased S&P 100 firms’ capital investments.

**Operating Net Cash Flow (Independent Variable)**

![Mean and Median Operating Net Cash Flow YoY](image)

The median and mean year over year of operating net cash flow steadily increased with a large increase observed in 2018 and 2019. A potential explanation for the sharp drop in mean between 2019 and 2020 is the onset of the COVID-19 pandemic which halted business operations in multiple sectors, causing a drop in cash generated by a firm’s normal business operations.

**Retention Ratio (Independent Variable)**

<table>
<thead>
<tr>
<th>Summary Statistics</th>
<th>Summary Statistics</th>
<th>Summary Statistics</th>
<th>Summary Statistics</th>
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<tbody>
<tr>
<td>Number of Observations</td>
<td>Number of Observations</td>
<td>Number of Observations</td>
<td>Number of Observations</td>
<td>Number of Observations</td>
</tr>
<tr>
<td>Mean</td>
<td>57.99 Mean</td>
<td>56.2 Mean</td>
<td>56.2 Mean</td>
<td>55.2 Mean</td>
</tr>
<tr>
<td>Median</td>
<td>61.0 Median</td>
<td>57.6 Median</td>
<td>66.8 Median</td>
<td>56.9 Median</td>
</tr>
<tr>
<td>Min</td>
<td>1.0 Min</td>
<td>0.8 Min</td>
<td>4.4 Min</td>
<td>6.8 Min</td>
</tr>
<tr>
<td>Max</td>
<td>100.0 Max</td>
<td>100.0 Max</td>
<td>100.0 Max</td>
<td>100.0 Max</td>
</tr>
</tbody>
</table>
Year over year, the mean and median steadily decrease. The median is greater than the mean which is indicative of a left-skewed distribution. The discrepancy between the mean and median trendlines converges in 2019 which is indicative of a dwindling number of outliers. The sharp decline of the linear median trendline observed year over year represents a larger portion of their profits paid out as dividends instead of reinvested in the business.

**Return on Equity (Independent Variable)**

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Observations</td>
<td>86.0</td>
<td>87.0</td>
<td>87.0</td>
<td>87.0</td>
<td>86.0</td>
</tr>
<tr>
<td>Mean</td>
<td>25.9</td>
<td>28.5</td>
<td>19.7</td>
<td>19.0</td>
<td>16.6</td>
</tr>
<tr>
<td>Median</td>
<td>14.9</td>
<td>16.1</td>
<td>14.0</td>
<td>20.4</td>
<td>20.7</td>
</tr>
<tr>
<td>Min</td>
<td>-57.6</td>
<td>-57.7</td>
<td>-56.7</td>
<td>-52.4</td>
<td>-56.6</td>
</tr>
<tr>
<td>Max</td>
<td>151.188</td>
<td>250.1</td>
<td>1398.0</td>
<td>1088.6</td>
<td>685.3</td>
</tr>
</tbody>
</table>

The mean return on equity steadily increased from 2016 to 2018, followed by a slight decrease in 2019. The median remains fairly constant throughout the time period. The increase observed in the linear mean trendline indicates that S&P 100 firms are working towards more effectively deploying shareholder capital.
Year over year, the mean and median of financial leverage remain constant in 2016 and from 2018 to 2020. There is a large uptick in both the mean and median in 2017. An explanation for this increase is the Trump administration’s significant impact on corporate capital structure, changing how firms raise and deploy capital and how they drive corporate strategy and shareholder value. Interest rates were hiked concurrently with the implementation of new tax policies, forcing many large corporations to revisit their capital structure, strategy, and policies to adapt to the shifting political and economic landscape.

### Dividend Payout Ratio (Independent Variable)

<table>
<thead>
<tr>
<th>Summary Statistics</th>
<th>Summary Statistics</th>
<th>Summary Statistics</th>
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<th>Summary Statistics</th>
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</thead>
<tbody>
<tr>
<td>Number of Observations</td>
<td>86.0 Number of Observations</td>
<td>87.0 Number of Observations</td>
<td>87.0 Number of Observations</td>
<td>87.0 Number of Observations</td>
</tr>
<tr>
<td>Mean</td>
<td>13.7 Mean</td>
<td>14.9 Mean</td>
<td>19.0 Mean</td>
<td>32.8 Mean</td>
</tr>
<tr>
<td>Median</td>
<td>9.5 Median</td>
<td>3.2 Median</td>
<td>4.2 Median</td>
<td>4.7 Median</td>
</tr>
<tr>
<td>Min</td>
<td>0.0 Min</td>
<td>0.0 Min</td>
<td>0.0 Min</td>
<td>0.0 Min</td>
</tr>
<tr>
<td>Max</td>
<td>354.3 Max</td>
<td>529.9 Max</td>
<td>542.5 Max</td>
<td>3161.1 Max</td>
</tr>
</tbody>
</table>

Figure 16: Mean and Median Degree of Financial Leverage YoY

Figure 17: Mean and Median Dividend Payout Ratio YoY
Year over year, the mean dividend payout ratio remains constant in 2016, 2019 and 2020 with a sharp decrease in 2017 followed by a stark increase in 2018. The median remains constant year over year with a decline in 2017. Seven firms in our sample did not pay dividends, and there were no instances in which the amount in dividends equaling zero was due to a lack of change in annual growth of dividends paid.³ Paying dividends sends a powerful message about a firm's performance and future prospects, and the ability to pay a steady dividend over time provides a solid demonstration of financial strength.

³ Firms that do not pay dividends between 2016-2020: Adobe (ADBE), Amazon (AMZN), Biogen (BIIB), Booking Holdings (BKNG), Meta (FB), Netflix (NFLX), and PayPal (PYPL).
Correlation Matrix

The correlation matrix for our regression model is highlighted to draw attention to potential multicollinearity issues, with red highlights indicating the high (>0.7) r² values. There are a few possible instances of multicollinearity, none with high enough values to be of concern regarding the strength of our regression models.

Regression Model

To test our hypotheses of the relationships between measures of liquidity and GHG emissions, we estimated a series of least squares regression models on each variable. To mitigate the impact of scalability effects due to varying sizes and capital structure, Total Assets, and Capital Expenditures are held as constants. Indicator variables in each model include the year in which sustainability reporting was initiated, the presence of a public ESG auditor, the fiscal year, and whether the company is in the IT or Energy industry. Since our independent and dependent variables are continuous, we used Ordinary Least Squares (OLS) regression to test our hypotheses.
### Free Cash Flow

**Regression Results (Free Cash Flow)**

| Variable                              | Estimate  | Standard Error | t      | P>|t| |
|---------------------------------------|-----------|----------------|--------|--------|
| Free Cash Flow                        | -3.57E-07 | 9.15E-08       | -3.898 | 0.000113 |
| Total Assets                          | 2.24E-09  | 1.90E-09       | 1.179  | 0.239032 |
| Capital Expenditures                  | 1.65E-06  | 1.60E-07       | 10.327 | 2.00E-16 |
| Sustainability Reporting Initiated Between 2005-2010 | 7.78E+03  | 2.01E+03       | 3.864  | 0.000129 |
| Sustainability Reporting Initiated Between 2011-2016 | 3.78E+03  | 2.10E+03       | 1.79   | 0.074132 |
| FY 2018                               | -8.25E+02 | 2.15E+03       | -3.838 | 0.07018  |
| FY 2019                               | -4.00E+02 | 2.16E+03       | -1.855 | 0.065105 |
| FY 2020                               | -1.32E+03 | 2.16E+03       | -0.609 | 0.542667 |
| Presence of a Public Auditor          | -3.19E+03 | 2.49E+03       | -1.279 | 0.201562 |
| IT Sector                             | -2.41E+03 | 2.36E+03       | -1.019 | 0.308882 |
| Energy Sector                         | 2.44E+04  | 3.22E+03       | 7.58   | 2.30E-13 |
| Residual Standard Error               | 1.62E+04  |                |        |        |
| Multiple R-squared                    | 3.77E-01  |                |        |        |
| Adjusted R-squared                    | 3.60E-01  |                |        |        |
| P-value                               | 2.20E-16  |                |        |        |

**Regression Model (Free Cash Flow)**

\[
\text{Total GHG Emissions} = \beta_0 + \beta_1 \text{Free Cash Flow} + \beta_2 \text{Total Assets} + \beta_3 \text{Capital Expenditures} + \beta_4 \text{Sustainability Reporting Initiated Between 2005-2010} + \beta_5 \text{Sustainability Reporting Initiated Between 2011-2016} + \beta_6 \text{FY 2018} + \beta_7 \text{FY 2019} + \beta_8 \text{FY 2020} + \beta_9 \text{Auditor} + \beta_{10} \text{IT Sector} + \beta_{11} \text{Energy Sector}
\]

In testing Hypothesis I, using an alpha level of 0.05, we find a statistically significant relationship between free cash flow (FCF) and total GHG emissions. Thus, we reject Null Hypothesis I and conclude that firms with greater FCF levels also have lower GHG emissions. With higher free cash flows, companies report 0.0000003566 times lower GHG emissions. Therefore, S&P 100 companies with greater access to cash after paying their operating expenses and capital expenditures reflect a small, yet significantly lower GHG emissions than their lower-FCF counterparts.
In testing Hypothesis II, we find a statistically significant relationship between net income and total GHG emissions. Thus, we reject Null Hypothesis II and conclude that firms with greater net income levels also have lower GHG emissions. With higher net income levels, companies report 0.0000004424 times lower GHG emissions. Therefore, S&P 100 companies with greater access to cash after paying all expenses and capital expenditures reflect a small, yet significantly lower GHG emissions than their lower-net income counterparts.
In testing Hypothesis III, we do not find a statistically significant relationship between market capitalization and total GHG emissions. Thus, we fail to reject Null Hypothesis III and cannot conclude a relationship between firms’ net income levels and GHG emissions.
Operating Net Cash Flow

Regression Results (Operating Net Cash Flow)

| Variable                                      | Estimate | Standard Error | t     | P>|t| |
|-----------------------------------------------|----------|----------------|-------|------|
| Operating Net Cash Flow                       | -2.16E-07| 7.97E-08       | -2.705| 0.007122 |
| Total Assets                                  | -3.60E-10| 1.78E-09       | -0.202| 8.40E-01 |
| Capital Expenditures                          | 1.80E-06 | 1.92E-07       | 9.356 | 2.00E-16 |
| Sustainability Reporting Initiated Between 2005-2010 | 7.94E+03 | 2.04E+03       | 3.894 | 0.000115 |
| Sustainability Reporting Initiated Between 2011-2016 | 3.98E+03 | 2.12E+03       | 1.875 | 0.061441 |
| FY 2018                                       | -3.16E+02| 2.18E+03       | -0.145| 0.884798 |
| FY 2019                                       | -4.37E+02| 2.18E+03       | -0.2  | 0.841476 |
| FY 2020                                       | -1.67E+03| 2.18E+03       | -0.769| 0.442245 |
| Presence of a Public Auditor                  | -3.65E+03| 2.55E+03       | -1.426| 0.15476 |
| Energy Sector                                 | -3.71E+03| 2.34E+03       | -1.589| 0.112838 |

Residual Standard Error                         | 1.64E+04 |
Multiple R-squared                             | 3.65E-01 |
Adjusted R-squared                             | 3.48E-01 |
P-value                                        | 2.20E-16 |

Regression Model (Operating Net Cash Flow)

Total GHG Emissions = β0 + β1 Operating Net Cash Flow + β2 Total Assets + β3 Capital Expenditures + β4 Sustainability Reporting Initiated Between 2005-2010 + β5 Sustainability Reporting Initiated Between 2011-2016 + β6 FY 2018 + β7 FY 2019 + β8 FY 2020 + β9 Auditor + β10 IT Sector + β11 Energy Sector

Figure 22: Regression Results & Model (Operating Net Cash Flow)

In testing Hypothesis IV, we find a statistically significant relationship between operating net cash flow and total GHG emissions. Thus, we reject Null Hypothesis IV and conclude that firms with greater net income levels also have lower GHG emissions. With higher operating net cash flow levels, companies report 0.0000002156 times lower GHG emissions. Therefore, S&P 100 companies with greater cash inflows from operations reflect a small, yet significantly lower GHG emissions than their lower operating net cash flow counterparts.
In testing Hypothesis V, we find a statistically significant relationship between retention ratio and total GHG emissions. Thus, we reject Null Hypothesis V and conclude that firms with greater retention ratios also have lower GHG emissions. With higher levels of retained net income that is not paid as dividends, companies report 130.7 times lower GHG emissions. Therefore, S&P 100 companies with greater retention ratios reflect a large and significantly lower GHG emissions than their lower retention ratio counterparts.
**Return on Assets**

*Figure 24: Regression Results & Model (Return on Assets)*

In testing Hypothesis VI, we do not find a statistically significant relationship between return on assets and total GHG emissions. Thus, we fail to reject Null Hypothesis VI and cannot conclude a relationship between firms’ return on asset levels and GHG emissions.

### Regression Results (Return on Assets)

| Variable | Estimate | Standard Error | t | P>|t| |
|----------|----------|----------------|---|-----|
| Return on Assets | -8.20E+01 | 1.26E+02 | -0.649 | 5.17E-01 |
| Total Assets | -8.87E-10 | 1.88E-09 | -0.472 | 6.37E-01 |
| Capital Expenditures | 1.49E-06 | 1.58E-07 | 9.435 | 2.00E-16 |
| Sustainability Reporting Initiated Between 2005-2010 | 7.36E+03 | 2.05E+03 | 3.595 | 0.000364 |
| Sustainability Reporting Initiated Between 2011-2016 | 3.96E+03 | 2.15E+03 | 1.841 | 0.066284 |
| FY 2018 | -8.03E+02 | 2.19E+03 | -0.366 | 0.714571 |
| FY 2019 | -8.38E+02 | 2.19E+03 | -0.382 | 0.702799 |
| FY 2020 | -1.71E+03 | 2.19E+03 | -0.78 | 0.43568 |
| Presence of a Public Auditor | -5.96E+03 | 2.44E+03 | -2 | 0.014919 |
| IT Sector | -4.65E+03 | 2.41E+03 | -2 | 0.054884 |
| Energy Sector | 2.55E+04 | 3.33E+03 | 7.66 | 1.33E-13 |

Residual Standard Error 1.65E+04
Multiple R-squared 3.55E-01
Adjusted R-squared 3.37E-01
P-value 2.20E-16

### Regression Model (Return on Assets)

Total GHG Emissions = β0 + β1 Return on Assets + β2 Total Assets + β3 Capital Expenditures + β4 Sustainability Reporting Initiated Between 2005-2010 + β5 Sustainability Reporting Initiated Between 2011-2016 + β6 FY 2018 + β7 FY 2019 + β8 FY 2020 + β9 Auditor + β10 IT Sector + β11 Energy Sector

**Return on Equity**

*Figure 24: Regression Results & Model (Return on Equity)*

In testing Hypothesis VI, we do not find a statistically significant relationship between return on assets and total GHG emissions. Thus, we fail to reject Null Hypothesis VI and cannot conclude a relationship between firms’ return on asset levels and GHG emissions.

### Regression Results (Return on Equity)

| Variable | Estimate | Standard Error | t | P>|t| |
|----------|----------|----------------|---|-----|
| Return on Equity | 4.38E-01 | 8.46E+00 | 0.052 | 9.59E-01 |
| Total Assets | -5.00E+00 | 1.80E-09 | -0.289 | 7.73E-01 |
| Capital Expenditures | 1.50E-06 | 1.58E-07 | 9 | 2.00E-16 |
| Sustainability Reporting Initiated Between 2005-2010 | 7.44E+03 | 2.06E+03 | 3.611 | 0.000342 |
| Sustainability Reporting Initiated Between 2011-2016 | 4.13E+03 | 2.15E+03 | 1.921 | 0.055424 |
| FY 2018 | -7.57E+02 | 2.20E+03 | -0.345 | 0.730402 |
| FY 2019 | -8.93E+02 | 2.20E+03 | -0.406 | 0.684615 |
| FY 2020 | -1.72E+03 | 2.20E+03 | -0.781 | 0.435345 |
| Presence of a Public Auditor | -5.90E+03 | 2.44E+03 | -2 | 0.015921 |
| IT Sector | -5.13E+03 | 2.30E+03 | -2 | 0.026284 |
| Energy Sector | 2.60E+04 | 3.26E+03 | 7.986 | 1.40E-14 |

Residual Standard Error 1.65E+04
Multiple R-squared 3.54E-01
Adjusted R-squared 3.37E-01
P-value 2.20E-16

### Regression Model (Return on Equity)

Total GHG Emissions = β0 + β1 Return on Equity + β2 Total Assets + β3 Capital Expenditures + β4 Sustainability Reporting Initiated Between 2005-2010 + β5 Sustainability Reporting Initiated Between 2011-2016 + β6 FY 2018 + β7 FY 2019 + β8 FY 2020 + β9 Auditor + β10 IT Sector + β11 Energy Sector

29
In testing Hypothesis VII, we do not find a statistically significant relationship between return on equity and total GHG emissions. Thus, we fail to reject Null Hypothesis VII and cannot conclude a relationship between firms’ return on equity levels and GHG emissions.

**Current Ratio**

**Regression Results (Current Ratio)**

| Variable                        | Estimate  | Standard Error | t      | P>|t| |
|--------------------------------|-----------|----------------|--------|-----|
| Current Ratio                  | -1.39E+03 | 6.25E+02       | -2.229 | 2.63E-02 |
| Total Assets                   | -1.07E-09 | 1.80E-09       | -0.594 | 5.33E-01 |
| Capital Expenditures           | 1.50E-06  | 1.57E-07       | 10     | 2.00E-16  |
| Sustainability Reporting Initiated Between 2005-2010 | 6.94E+03 | 2.05E+03       | 3.39   | 0.000765  |
| Sustainability Reporting Initiated Between 2011-2016 | 3.53E+03 | 2.14E+03       | 1.646  | 0.100598  |
| FY 2018                        | -7.53E+02 | 2.18E+03       | -3.45  | 0.730108  |
| FY 2019                        | -1.14E+03 | 2.18E+03       | -0.522 | 0.602275  |
| FY 2020                        | -1.85E+03 | 2.18E+03       | -0.849 | 0.396632  |
| Presence of a Public Auditor   | -6.05E+03 | 2.42E+03       | -2     | 0.01296   |
| IT Sector                      | -4.04E+03 | 2.34E+03       | -2     | 0.084197  |
| Energy Sector                  | 2.56E+04  | 3.23E+03       | 7.922  | 2.19E-14  |

Residual Standard Error         | 16400     |
Multiple R-squared              | 0.3616    |
Adjusted R-squared              | 0.3446    |
P-value                         | 2.20E-16  |

**Regression Model (Current Ratio)**

\[
\text{Total GHG Emissions} = \beta_0 + \beta_1 \text{Current Ratio} + \beta_2 \text{Total Assets} + \beta_3 \text{Capital Expenditures} + \beta_4 \text{Sustainability Reporting Initiated Between 2005-2010} + \beta_5 \text{Sustainability Reporting Initiated Between 2011-2016} + \beta_6 \text{FY 2018} + \beta_7 \text{FY 2019} + \beta_8 \text{FY 2020} + \beta_9 \text{Auditor} + \beta_{10} \text{IT Sector} + \beta_{11} \text{Energy Sector}
\]

In testing Hypothesis VIII, we find a statistically significant relationship between current ratio and total GHG emissions. Thus, we reject Null Hypothesis VIII and conclude that firms with greater current ratios also have lower GHG emissions. With a higher proportion of current assets to current liabilities, companies report 1393 times lower GHG emissions. Therefore, S&P 100 companies with greater current ratios reflect a large and significantly lower GHG emissions than their lower current ratio counterparts. Thus, the elevated ability to pay off short-term obligations with current assets yields the greatest reduction in GHG emissions, in comparison to the other significant variables. While a higher current ratio is often desirable due to its association with greater liquidity, a high current ratio could also be indicative of inefficient use of current assets. Despite this variable’s statistical significance, the current ratio is highly influenced by industry primarily because of the large role inventory plays in the determination of this ratio.
In testing Hypothesis IX, we do not find a statistically significant relationship between the degree of financial leverage and total GHG emissions. Thus, we fail to reject Null Hypothesis IX and cannot conclude a relationship between firms’ financial leverage and GHG emissions.

### Dividend Payout Ratio

| Variable             | Estimate | Standard Error | t       | P>|t|  |
|----------------------|----------|----------------|---------|---------|
| Dividend Payout Ratio| -4.17E-01| 1.74E+00       | -0.24   | 8.10E-01|
| Total Assets         | -5.34E-10| 1.80E-09       | -0.297  | 7.66E-01|
| Capital Expenditures | 1.49E-06 | 1.58E-07       | 9.00E-01|
| Sustainability       | 7.42E+03 | 2.05E+03       | 3.626   | 0.000324|
| Reporting Initiated  | 4.13E+03 | 2.14E+03       | 1.932   | 0.054035|
| FY 2018              | -6.87E+02| 2.21E+03       | -3.111  | 0.755966|
| FY 2019              | -8.70E+02| 2.20E+03       | -0.396  | 0.692191|
| FY 2020              | -1.68E+03| 2.20E+03       | -0.766  | 0.44403  |
| Presence of a Public Auditor | -5.87E+03 | 2.44E+03       | -2.016573|
| IT Sector            | -5.11E+03| 2.30E+03       | -2.026618|
| Energy Sector        | 2.61E+04 | 3.27E+03       | 7.985   | 1.41E-14|

Residual Standard Error 16500
Multiple R-squared 0.3541
Adjusted R-squared 0.3368
P-value 2.20E-16
In testing Hypothesis X, we do not find a statistically significant relationship between the dividend payout ratio and total GHG emissions. Thus, we fail to reject Null Hypothesis X and cannot conclude a relationship between firms’ dividend payout ratio and GHG emissions.

**Discussion: Regression Results**

The reduction in GHG emissions is an indirect, metaphorical means of “paying dividends” to stakeholders, particularly communities in which companies have inflicted a negative environmental impact. As evidenced by the above statistical significance, S&P 100’ companies are dedicated to allocating a small portion of their excess cash (free cash flow) or profit (net income) to reduce their environmental impact. This interpretation is heavily contingent on the confounding variable of industry impact. However, the indicator variable of whether the companies are in the energy industry is statistically significant with a positive coefficient, unsurprisingly demonstrating that companies in the energy industry have higher GHG emissions.

Companies with a higher free cash flow or net income likely have achieved strong economies of scale and naturally have more resources available to reduce their GHG emissions, explaining their statistically significant negative coefficients. Although we tried to account for company maturity by using total assets and capital expenditures as control variables, there are likely other confounds influencing these results. Nevertheless, the capital expenditures control variable consistently has a very small (<0.00001), positive, statistically significant coefficient. Thus, a greater capital investment occurs simultaneously to greater GHG emissions. This relationship could possibly be explained by expanded operations that yield greater environmentally-damaging activities. Or, greater long-term investments are being made to offset GHG emissions in the future at the expense of not reducing emissions in the short term.

With greater financial health, firms likely also have the greater ability to invest in hiring experts and advisors to help them manage their ESG reporting such that they can demonstrate steady declines in their emissions. However, Initiated 1 (the first time range, 2005-2010, in which we measured companies creating ESG reports) is consistently statistically significant with a positive coefficient. Thus, firms that have invested in researching and publishing their environmental impact for longer have higher GHG emissions. This finding is likely attributable to the fact that firms in higher emission-producing businesses were pressured to track environmental pressures before the widespread adoption of ESG reporting. Firms in industries where there are regulatory requirements or where their environmental activities have a material impact on their financial statements have been required to report such metrics for years prior to the rising popularity in ESG reports (The Center for Audit Quality, 2020).

The presence of a public ESG auditor is statistically significant in each of the regressions with a ratio as the independent variable (retention ratio, return on assets, return on equity, current ratio,
financial leverage, and dividend payout ratio) and when market capitalization is the independent variable. Each of these regressions yielded a negative, significant coefficient, demonstrating that the presence of a public ESG auditor aligns with lower GHG emissions. This relationship may be attributed to three primary possibilities:

1. Firms that seek out an ESG auditor are voluntarily seeking assurance on their reporting. Thus, their leadership is likely already committed to promoting sustainable business practices, so the presence of the auditor is not the driver of emissions reduction but likely rather the byproduct.

2. The assurance provided by an ESG auditor is likely paired with the company marketing their investment in sustainability. Thus, the companies seeking out an auditor also have the incentive to decrease their GHG emissions. Therefore, the marketing benefits likely are driving the reduction in emissions, with the auditor bolstering that.

3. The presence of a public ESG auditor will likely align with the hiring of other consultants and advisors who can offer expertise in environmental reporting frameworks that best align with the companies’ current operations and emissions output. There are five widely-used frameworks that guide sustainability reporting⁴ and each varies with the approach and output that influences values and decisions. In fact, many companies reference more than one of these frameworks and most companies use at least four of these frameworks (The Center for Audit Quality, 2021). Additionally, amongst public ESGs auditors, there are two primary standards that auditors use — AICPA Attestation Standards or ISAE 3000 — that can create variance in their reports and auditor opinion (The Center for Audit Quality, 2021).

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⁴ CDP (Carbon Disclosure Project), Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB), The Task Force on Climate Change (TCFD), and Integrated Reporting (IR)
Exploratory Research: Sustainability Report Analysis

We identified firms with the largest and smallest annual percentage change in GHG emissions. We sought to analyze patterns in sustainability reports of the top 98% and bottom 2% of GHG emissions by firm, as seen below in Figure 29.

![Percentage Change in GHG Emissions 2017-2020](image)

*Figure 29: Percentage Change in GHG Emissions 2017-2020*

This analysis was done in an attempt to distinguish between firms that are “greenwashing” versus those whose GHG emission reduction matches their messaging. In the era of the conscientious stakeholder, 83% of consumers think companies should be actively shaping ESG best practices, 91% of business leaders believe their company has a responsibility to act on ESG issues and 86% of employees prefer to support or work for companies that care about green issues (Atkins, 2022). Being labeled as a firm that engages in “greenwashing” can deeply fracture the relationship with all stakeholders and irreparably damage consumer trust in a firm.

A qualitative analysis of the communication of both the sustainability reports and Twitter posts of the firms with the highest and lowest change in GHG emissions yielded significant variation in their messaging, initiatives, and actualized change in GHG reductions.

**Qualitative Analysis of Firm with Lowest Change in GHG Emissions**

Our analysis found Apple to have made the least progress in decreasing its GHG emissions in 2020. The firm’s GHG emissions rose by 91% in 2020 compared to the prior fiscal year. Their 2020 environmental progress report indicates that they have seen consistent reductions in their carbon footprint, even as net revenue increased. Upon further research, Apple has committed to becoming carbon neutral by 2030 and has established a first-of-its-kind carbon removal initiatives to reduce the firm’s GHG output. Launched by Apple in April 2021, The Restore Fund seeks to remove at least 1 million metric tons of CO2 annually from the atmosphere (Apple,
The fund makes investments in forestry projects while generating a financial return for investors. Apple's Vice President of Environment, Policy, and Social initiatives, Lisa Jackson, stated that:

“Nature provides some of the best tools to remove carbon from the atmosphere. Forests, wetlands, and grasslands draw carbon from the atmosphere and store it away permanently in their soils, roots, and branches … Through creating a fund that generates both a financial return as well as real, and measurable carbon impacts, we aim to drive broader change in the future — encouraging investment in carbon removal around the globe. Our hope is that others share our goals and contribute their resources to support and protect critical ecosystems” (Apple, 2021).

The financial returns component of The Restore Fund indicates it is as much of an investment vehicle as a philanthropic organization dedicated to reducing carbon emissions. Forestry projects take significant time to capture emissions; however, firms such as Apple receive immediate carbon offsets to offset GHG emissions in the firm's supply chain.

Apple’s environmental initiatives are marketed in a manner that can be perceived as greenwashing. Apple’s significant investments in reducing GHG emissions have shifted to seeking carbon credits rather than focusing on reducing their output. Apple does not have an extensive Twitter presence; however, a 2021 Twitter post from Apple CEO Tim Cook (figure 30) further indicates the company’s commitment to sustainability, as seen in Figure 30.

As the CEO of Apple, Cook’s Twitter post is a prime example of greenwashing; he is portraying an image that the firm is driven toward decreasing its carbon footprint, as depicted through the graphic of forestry. However, Apple reported a significant increase in its GHG output, as observed in our panel data from 2020. Apple’s marketing of its sustainability initiatives is done to maximize its bottom line rather than to provide a course of action to reduce its carbon footprint.
Qualitative Analysis of Firm with Highest Change in GHG Emissions

Our research found Boeing to have made significant strides in reducing its GHG emissions in both 2018 and 2020. Boeing achieved net-zero carbon emissions from manufacturing and worksites in 2020 via the expansion of renewable energy and conservation efforts. The firm’s 2020 Global Environment Report indicates that the firm is committed to reporting its GHG emissions and reducing its emissions via a highly integrated and coordinated approach. The language of the Global Environmental Report is highly transparent to their successes and pitfalls in their sustainability initiatives. The firm named its first Chief Sustainability Officer in 2020, which could have assisted in the 2720% decrease in carbon emissions in 2020 compared to the fiscal year 2019.

In 2018, Boeing launched its Global 2025 Strategy for Environmental Leadership to achieve progress in environmental initiatives in three overarching pillars: product innovation, sustainable operations, and global collaboration. The messaging in their Global Environment Report aligns with their significant strides in reducing GHG emissions. Additionally, an analysis of Boeing’s Twitter presence indicates they are regularly keeping their sphere of influence abreast with the progress of new carbon emission reduction initiatives, partnerships, and updates on existing green initiatives.

Figure 31: Boeing Twitter Post #1
(The Boeing Company, 2022)

Figure 32: Boeing Twitter Post #2
(The Boeing Company, 2022)

Figure 33: Boeing 2020 Global Environment Report
(Boeing, 2020)
Research Implications: Practical

Involvement of the SEC

The recent stakeholder ESG pressure on corporations has sparked regulators to analyze their contributing role to mitigating GHG emissions and stabilizing climate change. The US Securities and Exchange Commission (SEC) proposed a rule in March 2022 that, if enacted, would require registrants to include climate-related disclosures in their registration statements and periodic reports. These disclosures would also have the registrant’s Scope 1, Scope 2, and, if applicable, Scope 3 GHG emissions.

Our research utilized the total GHG emissions of each firm calculated via the Bloomberg Terminal, which includes data for Scope 1 and Scope 2 emissions measured by thousands of metric tonnes of CO2e using the location-based method. This push to standardize climate-related disclosures is incredibly timely for our research. It provides a path for increased environmental awareness that would provide investors with consistent and comparable information that can be useful in making investment decisions.

This shift in disclosure policy would benefit public firms in more efficiently disclosing climate-centric risks. The standardization of climate-related disclosures would have made our data aggregation process more streamlined and accurate. The financial implications of this proposal, if enacted, are significant. Physical and transition risks from climate change can materialize in financial markets, notably in the form of credit, market, and liquidity risks among others. A requirement to disclose climate-related impacts and metrics, expenditures, estimates, and assumptions in a company’s financial statements would ensure the reliability and transparency of this data. Additionally, we believe that this proposal will lead to an uptick in demand for assurance of ESG information from public company audit firms. This increased demand is a result of heightened investor interest and regulatory focus (Tysiac, 2021).

Using financial liquidity measures in our research as our independent variable provides valuable insights to executives and shareholders alike if their investments in ESG initiatives directly correlate to reducing GHG emissions. This research contributes to the literature on carbon emission reduction and firm financial performance.

Research Implications: Further Recommendations

Limited by time, expertise, and resources, our recommendations for further research speak to the opportunities to expand the scope of our study.

Larger Sample Size: Future research should include non-public firms and a larger sample size as the S&P 100 maintains homogeneity of organizational structure, firm size, professionalism, and specialization. With a sample size with greater variability, future research would be able to assess our research question with more variance.

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5 The location-based method calculates emissions based on the emissions intensity of the local grid area where the usage occurs.
Twitter API: It is recommended that the Twitter API tool be utilized in further research on the topic to yield results to address our research question further. The Twitter Application Programming Interface (API), allows one to read and write Twitter data, thus granting us access to analyze the frequency and keywords of each firm’s respective posts over 2016-2020. In our preliminary research, we intended to examine the frequency of Twitter posts that mention ESG initiatives and analyze each firm’s shareholder statement frequency. Since social media platforms allow companies to engage with their interest groups, solidifying corporate social responsibility policies (Kvasničková et al., 2020). A 2020 study by Benitez et al. also found that, unlike traditional advertising tools, social media communication gives businesses greater visibility and credibility and improves the employer’s reputation (Benitez et al., 2020). Due to timing constraints, we could not use the Twitter API as our request for an academic account was not approved until the final weeks of our project (Appendix 2).

Limitations

While our work has significant potential for future research; we acknowledge some limitations in our methods. We initially sought to examine the frequency of Twitter and LinkedIn posts that mention ESG initiatives and analyze each firm’s shareholder statement frequency. We researched and identified Netlytic, a community-supported text and social network analyzer for social media, as being a valuable tool for our research. However, it was deemed to be misaligned with our historical data approach due to its limitation of only collecting very recent (past 30 days) or running daily data).

Rather than using a Twitter API or Netlytic, we added three indicator variables (sustainability efforts initiated, the presence of a public ESG auditor, and industry) to gain a holistic understanding of the impact sustainability initiatives may have on S&P 100 firms.

We included two indicator variables, firms in the energy industry and IT industry, to account for an industry that is not known for its green initiatives and the largest sector representation in our sample size, respectively. A limitation of our research is not conducting a comprehensive industry analysis of all 11 sectors in the S&P 100.

Further, this research concerns a limited time period, suggesting that further studies should aim to build more comprehensive panel data. There is a need to gather a wider or different interval of data to limit any effects of the COVID shock on economic output. The COVID shock during the time of our panel data raises liquidity and capital risks in both the financial system and the real economy simultaneously. Liquidity problems hampered credit intermediation and investment while capital problems shut credit channels, damaging capital formation and growth. Despite massive governmental stimulus packages designed to soften the financial blow of the pandemic, economic output was severely dampened during the observed period.
**Conclusion**

The companies who have reached the S&P 100 list have outperformed their competitors in operational efficiency and profitability. These top companies are positioned as the motorcade, escorting ESG and CSR commitments in their journey to integration with core business activities. Just as the motorcade draws the public’s attention to the person of importance while still successfully transporting them, the intertwinement of ESG with business operations will not come without the promotional activities. However, it is the legitimate positive social impact that is the end goal, with financial investments as the means and publicity as the byproduct. The authentic investment and promotion of sustainability initiatives is achieved through green investments being proportional to excess cash flows. Our research taps into this key relationship that will deeply influence the degree to which businesses immerse themselves in halting climate change. Through a continuation of research by analysts and strategists, as ESG reporting regulations come to fruition, major strides can be made in the corporate social responsibility domain.

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- Annie Shi (Ph.D. Student in Quantitative Marketing)
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Appendix

Appendix 1

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<tbody>
<tr>
<td><img src="image1" alt="ExxonMobil CSR Report Excerpt" /></td>
<td><img src="image2" alt="Boeing CSR Report Excerpt" /></td>
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- The reality of the firm’s business model is to exploit, develop and sell oil and gas yet their advertising and communications make it seem as if they are committed to sustainability and renewable energy.

- 21 States have taken Exxon and other oil giants to court for deceiving consumers citing ‘greenwashing’ and investors about the damage caused by their products in the state citing decades-long disinformation campaigns (Client Earth).
Hello,
We're happy to let you know that your request has been approved, and we've enabled your access to utilize the academic level of the Twitter API.
Please complete the setup of your developer profile to get started!
Thanks,
The Twitter Dev team