Challenges and Opportunities in ESG Investments

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Abstract. Environmental, Social, and Governance (ESG) criteria gain increasing attention by governments and corporations to assess how advanced countries and companies are with sustainability. The adoption of the ESG in-vestment approach addresses risk management issues and sets goals to-ward more responsible behavior. Sustainable development goals adopted by the United Nations in 2015 include a call for action to end poverty, save the planet, and ensure peace and prosperity for all by 2030. This paper studies advanced machine learning methodologies to assess, analyze, and suggest improvements in corporate behavior to comply with global sustainable development goals.

Keywords: ESG (Environmental · Social · And Governance) Investments · Machine learning · AI-based systems · Sustainable development · Financial and economic stability

1 Introduction

In the past, considerations about the environmental, social, and governance (ESG) aspects have been limited to specific interest groups concerned with ethical and socially responsible investing. More recently, ESG is becoming an integral part of investment considerations by the broader investment community. Table 1**.** Examples of ESG Issues (source: www.albertgoodman.co.uk) shows examples of ESG issues considered in environmental, social, and governance areas, including Greenhouse gas emissions, employment rights, and ethics in business. The importance of ESG factors is global, a responsibility not only of corporations but countries themselves. The awareness of today's investment community about the "dangerous human interference with the climate system" was built on The United Nations Framework Convention on Climate Change (UNFCCC), signed by 154 countries at the Earth Summit held in Rio de Janeiro in June 1992. The

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Kyoto Protocol followed in 1997 and was superseded by the Paris Agreement, which entered into force in 2016. By 2020, the UNFCCC had 197 state parties, and the parties (COP) meet annually to assess progress in dealing with climate change.

Table 1. Examples of ESG Issues (source: www.albertgoodman.co.uk)

Environmental	Social	Governance
Biodiversity loss	Mass migration	Executive compensation
Greenhouse gas emissions	Wealth distribution	Bribery and corruption
Energy efficiency	Access to healthcare	Independent directors
Renewable energy	Workplace health and safety	Ethics in business
Resource depletion	Diversity	Transparent disclosure of ESG criteria
Ocean acidification	Employment rights, child labor, and slavery	Whistle-blowing policies
Ozone depletion	Controversial weapons such as cluster bombs	Implications of business strategy on social and sustainability issues

Todd Stern, the US Climate Change envoy, expressed the challenges with the UNFCCC process, stating: "Climate change is not a conventional environmental issue. It implicates virtually every aspect of a state's economy, making countries nervous about growth and development. This is an economic issue every bit as it is an environmental one." He explained that the United Nations Framework Convention on Climate Change is a multilateral body concerned with climate change and can be an inefficient system for enacting international policy. Because the framework system includes over 190 countries and negotiations are governed by consensus, small groups of countries can often block progress"[1]. Another criticism of the UNFCCC came from the National Geographic magazine, stating: "Since 1992, when the world's nations agreed at Rio de Janeiro to avoid 'dangerous anthropogenic interference with the climate system,' they've met 20 times without moving the needle on carbon emissions. Between 1992 and 2015, we've added almost as much carbon to the atmosphere as we did in the previous century" [1].

A flicker of hope appeared recently during the 26th Annual Summit on Climate Change, COP26. By the end of the COP26[2] meeting in Glasgow in November 2021, 151 countries have submitted their climate plans to reduce their GHG[3] emissions by 2030 to contribute to the goal of limiting the temperature increase to 1.5 degrees Celsius. The world's largest CO2 emitters, US and China, pledged to cooperate more over the decade between 2020 and 2030 to switch to clean energy. Leaders in over 100 countries

[1] https://en.wikipedia.org/wiki/United_Nations_Framework_Convention_on_Climate_Change.

[2] COP26 – The 26th United Nations Climate Change Conference Annual Summit held in November 2021 in Glasgow, Scotland. COP stands for "Conference of the Parties.".

[3] GHG – Greenhouse gasses which cause climate change.

covering about 85% of the world's forests promised to stop deforestation by 2030. Financial organizations controlling $130 trillion agreed to back clean technologies such as renewable energy and reduce their financing in fossil fuel burning industries[4].

On March 21, 2022, the US Securities and Exchange Commission (the "SEC") proposed rules governing the "Enhancement and Standardization of Climate-Related Disclosures for Investors"[4]. The proposed rule will require companies to disclose climate-related risks, how material these risks are, and how the risks might affect corporations' business outlook. The United Nations Principles for Responsible Investment (PRI) have been a strong motivating force behind fundamental changes in shaping the decision-making process for investors to actively and explicitly involve ESG considerations to manage portfolio risks better. Societal pressure has been instrumental in implementing ESG factors in shaping corporate behavior.

In this paper, we address the challenges that investors and investment funds face in light of the non-standardized reporting of climate-related risks, the social responsibilities of corporations, and their governance practices. We propose an AI-powered solution to understand the difference between corporate reporting and the public perception of corporate social responsibility. We develop a model to identify these discrepancies based on machine learning approaches, including natural language processing and sentiment analysis of corporate filings with the SEC and mainstream or social media reports.

The rest of the paper is organized as follows: In Sect. 2, we give an overview of responsible investment. In Sect. 3, we present technology-based solutions to improving ESG investment outcomes. In Sect. 4, we describe the future opportunities. In Sect. 5, we present the ExxonMobil ESG-related study, and in Sect. 6, we offer our discussion and concluding remarks.

2 Responsible Investment

ESG is an investment approach that explicitly incorporates the environmental, social, and governance factors in investment decisions, keeping an investment portfolio's long-term return at the forefront [14]. Environmental factors concern the natural world, including using and interacting with renewable and nonrenewable resources. Essential considerations include biodiversity, deforestation, water security, pollution, and climate change. Social factors include human capital management, local communities, Labor Standards, human rights, health and safety, and customer responsibility. Last but not least, the governance factors involve issues tied to the interest of the broader stakeholder community, risk management, corporate governance, anti-corruption, and tax transparency. The ESG investment is a part of investing approaches collectively named responsible investment [12]. To invest responsibly means to intend to impact the environment or society positively. Being socially responsible considers the issue of sustainability in the investment decision-making thinking about green investment, such as allocating capital to assets that mitigate climate change or biodiversity loss [11]. Social investment

[4] COP26: What was agreed at the Glasgow climate conference? https://www.bbc.com/news/science-environment-56901261.

intends to address social challenges faced by the bottom of the pyramid (BOP)[5] [15]. The responsible investment framework is built around the UN Sustainable Development Goals (SDGs)[6], shown in Fig. 1. UN Sustainable Development Goals, defined in 2015, at the 70th anniversary of the foundation of the United Nations, addressing global challenges such as poverty, inequality, environmental issues, peace, and justice.

Fig. 1. UN sustainable development goals, defined in 2015, at the 70th anniversary of the foundation of the United Nations

To enhance investment philosophy and measure companies' impact on global development goals, the mapping of the SDGs to the companies' ESG indicators could be performed [16]. The proposed mapping of SDG to ESG is shown in Fig. 2. Mapping the SDGs across the three ESG factor groups (SDGs that appear more than once are relevant across two or even all three groups) [16]. SDGs that appear more than once are relevant across two or even all three factors.

3 Technology-Based Solutions for ESG Investment Outcomes

When considering ESG investments, portfolio managers look into companies or funds with high ESG ratings. Several companies, including MSCI, S&P, Sustainalytics, CDP, ISS, Bloomberg, and others, provide ESG ratings [13]. However, the consensus level regarding the ratings is relatively low, making ESG-focused investments challenging.

Existing solutions from technology-based providers offer insights into how companies can improve their ESG index or score and get a better overall view of their index of sustainability [6]. The insights are generated by building a specific model for the company based on accessing, organizing, and analyzing relevant company files. Another interdisciplinary, analytical solution to increasing the ESG transparency is to provide

[5] BOP refers to the poorest 2/3 of the economic human pyramid including more than four billion people leaving in poverty.

[6] https://sdgs.un.org/goals.

Fig. 2. Mapping the SDGs across the three ESG factor groups (SDGs that appear more than once are relevant across two or even all three groups) [16].

datasets of raw ESG indicators. This solution involves collecting company data from various sources, such as company documents, news, social media, and alternative data sources. The data can then be used either in a row format or in a more insightful report based on collaboration between data scientists and high-level investor knowledge of market insights and company ESG involvement. This model offers excellent synergetic and profitable cooperation for influencing corporate behavior and contributing to enhanced sustainability and financial stability.

Machine learning and AI-based solutions can contribute to the meaningful representation of each company's most critical ESG factors [5, 18]. Dashboards can effectively emphasize corporate dedication to ESG factors by comparing annual reports and company-related news about ESG actions. The dashboard would extract and visualize the overall corporate commitment and involvement in ESG causes. The insight is generated by collecting every data point for the company from internal and external sources and giving more profound insight into the company sustainability index. The AI-based solution could model dynamic changes and go beyond ESG reporting by providing a future estimated outlook on corporate ESG risks [5, 17]. On the other hand, the AI-based solution could offer positive impacts indices and explainable results from machine learning analysis and extract insights about how social and environmental trends will impact the company. A similar study could offer insights into how negative scenarios (e.g., climate or social disasters) will affect the company's future and determine its resilience to adverse events.

4 Future Opportunities

Research shows a significant upward trend of institutional investors in the last fifteen years, directing funds toward ESG-related investments and funds. In 2005, institutional investors held $1.5 trillion in ESG-based funds, while by 2020, the level of ESG-based assets quadrupled to reach $6.2 trillion [3]. This trend is a solid indicator of the need to develop reliable tools to distinguish between the companies and funds that are genuinely ESG-related and the companies involved in "Greenwashing." We believe that the trend shown in Fig. 4 will rise even faster if investors can determine whether a company or a fund is taking steps to improve its ESG profile with high confidence (Fig. 3).

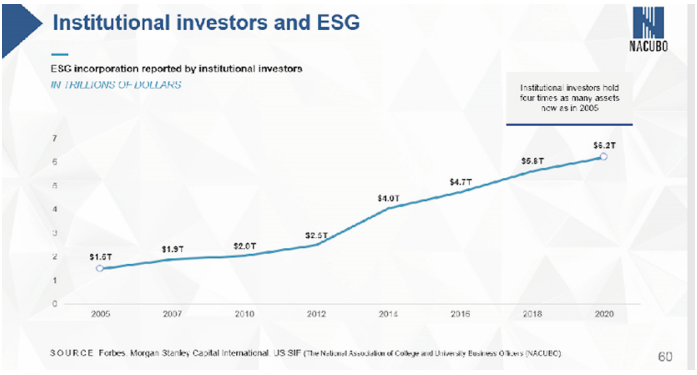

Fig. 3. Institutional investor funds directed towards ESG-related investments and funds [3].

The challenges with ESG Data create opportunities for interdisciplinary approaches to developing and offering tools for disentangling the information from the noise in reporting ESG metrics and unraveling the truth about corporate dedication and actions toward becoming more socially responsible. The newly developed methodologies could measure the "environmental legitimacy" of the corporations and offer evidence of "Greenwashing," a term describing companies that are "talking the talk, but not walking the walk."

To provide a good understanding of Greenwashing, we need to collect and analyze a large amount of data, including market-based and specific company-based data. We consider different data sources combining specific corporate news articles, company filings, and alternative data sources. The main challenge of data gathering is that high-quality data sources are often proprietary and inaccessible. Hence, we focus on publicly available data from reputable data sources. One of the most valuable data sources in the US is the SEC's Electronic Data Gathering, Analysis, and Retrieval[7], which contains all company filings of publicly-traded companies on the stock exchanges. Using these documents, we can identify companies' perspectives on their involvement in ESG-related actions.

[7] EDGAR. US Securities and Exchange Commission (Filings & Forms) https://www.sec.gov/edgar.shtml.

In addition to companies' perspectives offered in their annual reports, we collect media-based stories to obtain an enhanced insight into the public perception of companies' ESG involvement. We intend to gather corporate news articles from various media websites, such as GDELT, Google RSS services, and Yahoo Finance news. We also consider social media portals such as Reddit and Twitter as supplementary data. These two platforms offer APIs that give access to their content, accessible under certain limits. We also use APIs like Yahoo finance which provide financial information about a company like stock prices, trading volumes, and ESG risk scores.

Before offering any Machine Learning, Artificial Intelligence, or other technological solution in finance, a crucial part of our research is to understand the regulatory environment and the repercussions of technology-based solutions within the securities and investment regulatory framework. Another important aspect is finding definitions and rules for determining ESG-related metrics used as benchmarks for company ESG rankings. The European Union and the United States have issued guidelines about greenhouse gas emissions and carbon neutralization diversity. These documents offer recommendations about various aspects of ESG, explaining considerations for improving corporate ESG rating, and outlining sanctions for the company's negative impacts on specific aspects of ESG.

One of the challenges in tackling the ESG-related challenges and determining whether companies' trajectories are improving or deteriorating is to define a taxonomy of words that will represent the main topics of our environmental, social, and corporate governance (ESG) investment research.

We establish a list of words and phrases that can be used when searching for relevant news articles, social media posts, and regulatory mandated corporate disclosure documents.

We finally connect the search terms and phrases with selected corporations to extract information such as the frequency of co-occurrence between the company names and a set of ESG terms. We then map out the sentiments for the extracted text to understand the relationship between ESG-related topics and companies. This information gives us a timestamp with frequencies and sentiments where we observe the company's good or bad ESG decisions. We could then overlap the frequency and sentiment graphs with the stock price return information to relate the ESG (qualitative) and the price (quantitative) indicators of company performance.

5 Case Study: ExxonMobil

In this section, we present a case study about ExxonMobil (EM) as a representative company of the energy sector. We perform and explain an end-to-end process of the ESG-related reporting and news about EM corporate behavior.

Firstly, we gathered the data needed for the analysis by developing crawlers that accumulate data into our datasets from alternative sources and company filing reports. As sources for the alternative data, we use Google RSS news feed, GDELT, and Yahoo Finance API. We collect specific news that is related to targeted ESG topics. We extract the news based on co-occurrence between the company we analyze and the topics we predefine (ex. Exxon climate change). We store the news title, content, date, domain site,

and search query metadata. We then store the company documents gathered through the portal of the US Securities and Exchange Commission (the "SEC").

We filter and preprocess the news considering the frequency of appearances of our customized taxonomy words. Based on a predefined minimum word occurrence threshold, we classify the company news as ESG related or not. After filtering the news, we calculate the news sentiment by using a predefined Hugging Face pipeline, "sentiment-analysis." The pipeline creates the embeddings, and afterward, leveraging the transformer architecture, it calculates the test sentiment scores between −1 (most negative) and 1 (most positive). We define a threshold for the certainty of the sentiment and classify the news as positive if the sentiment score is above 0.7. We classify the news as negative if the sentiment score is below −0.7.

For a better insight into the results, we create several charts for the short-term sentiment data collected between 05/01/2022 and 06/15/2022. Using the frequency of appearances of our taxonomy words, we map the values on the chart and color them by their sentiment, with red representing a negative and green expressing a positive sentiment, as shown in Fig. 4. The line indicates the frequency of the term present in the news. We repeat this analysis for the three ESG categories: environmental, social, and corporate governance.

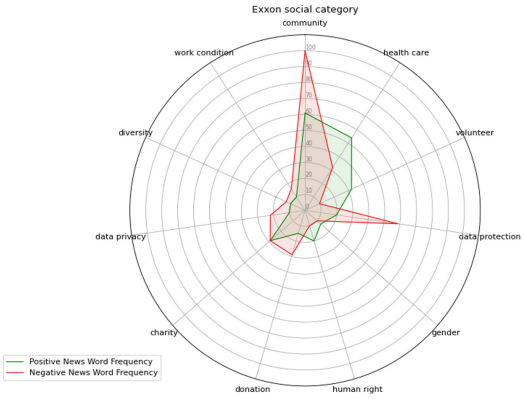

Fig. 4. Sentiment on words in the news in the social category from 05/01/2022 to 06/15/2022

As shown in Fig. 4, ExxonMobil has more negative than positive news related to community behavior. On the other hand, they have more positive than negative news for health care, volunteering, and their involvement in human rights movements.

In Fig. 5, we observe the number of appearances of the term "ESG" in the news with negative and positive sentiments. The red bar indicates the number of occurrences of "ESG" in the news with negative sentiment related to EM for the week starting with the date on the x-axis. The green bar indicates the appearance of the "ESG" word in the news with positive sentiments.

Relation Extraction helps extract meaningful connections between entities from unprocessed texts and use the relations to create a Knowledge Base. Using this method, we generate a Knowledge Graph (Fig. 6) from the text in Def 14A, a proxy statement

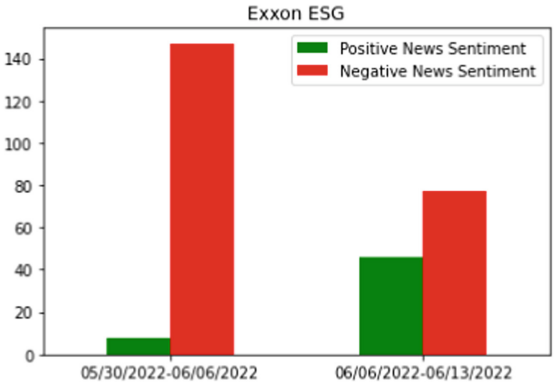

Fig. 5. Sentiment of the news where ESG was mentioned aggregated weekly.

filed by EM for 2022. The model has detected that, in their proxy statement (Def 14A), EM specifies that they are founders of an organization called Alliance to End Plastic Waste Figure.

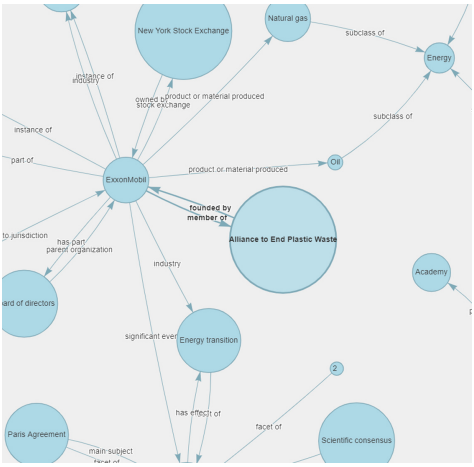

Fig. 6. Knowledge Graph generated by the text from EM's Def 14A (Proxy Statement) filing for 2022, related to Plastic-based Pollution

To compare this graph with the news, we create a knowledge graph from the news gathered by the "Exxon Alliance to end Plastic Waste" query, shown in Fig. 8, where we could detect a potential greenwashing. We find a connection between a parent organization, "American Chemistry Council," and "Lobbying." (Fig. 7)

We then create a Knowledge Graph from the news results of the search query "American Chemistry Council Lobbying," shown in Fig. 8. The news that resulted in the relationship between American Chemistry Council and Lobbying has a headline: "Oil-backed trade group is lobbying the Trump administration to push plastics across Africa" [2].

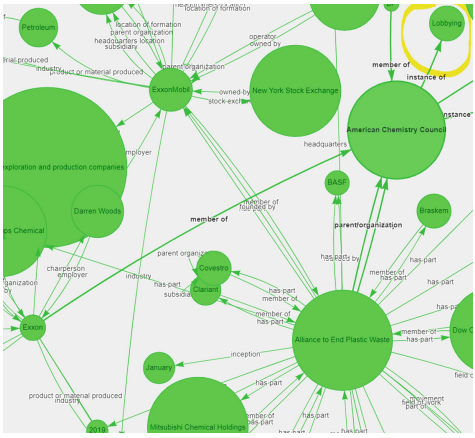

Fig. 7. Knowledge Graph generated from the news results by the search query: "Exxon Alliance to end Plastic Waste"

The news is indicative of the lobbying activities of EM aiming to proceed with using plastic products, which is adverse to environmental issues and corporate governance.

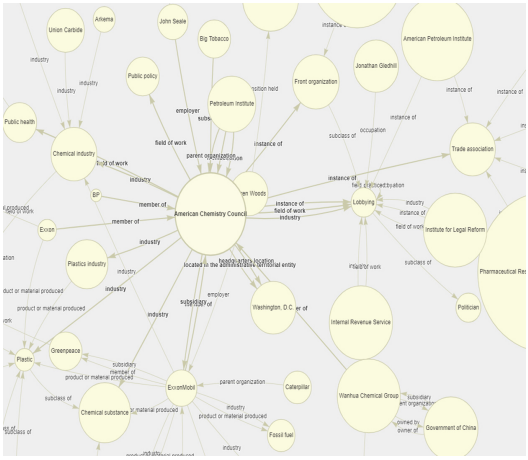

Fig. 8. Knowledge Graph created by searching the news related to "American Chemistry Council Lobbying."

6 Discussion and Conclusion

This paper analyzes the challenges investors face in selecting ESG investments in their quest to impact environmental, social, and governance matters positively. While the corporations are required to disclose their actions and describe their contribution to

becoming more socially responsible, the challenges include a lack of standard in reporting and a lack of enforcement of fines in case of misreporting. We offer an insight into a significant issue of ESG-related investments and propose an AI-based, machine learning solution to identify corporations that do not behave responsibly besides reporting their dedication to ESG-related matters in their annual reports. We use Natural Language Processing and Sentiment Analysis tools to unravel corporate (company-based) and media (public-based) reporting discrepancies. We aim to assess the ESG risk and understand the business outlook of corporations we investigate. This study intends to increase corporate responsibility in taking steps towards improving their positive impact on society and the environment contributing to a better future for all.

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