Journal of Forensic and Investigative Accounting
Volume 17: Issue 1, January–June 2025

Assessing the Intersection of Climate and Tax Risk: Insights from Utility Firms Using AI

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Introduction

The intersection of environmental, social, and governance (ESG) principles with financial reporting and tax strategies has garnered escalating interest in accounting and finance research. This interest is particularly salient within the utility sector, which has a pronounced environmental footprint and a substantial regulatory framework to navigate. The utility industry is especially vulnerable to climate risks due to its reliance on water resources for cooling systems, exposure to extreme weather events, and significant capital investment in long-lived assets (McKinsey, 2021; S and P Global, 2021). These factors make it crucial to study utility firms to understand the broader implications of climate risk on financial strategies (Gerlak et al., 2017; McMahan and Gerlak, 2020). As these regulatory frameworks are in flux and there is an ascent in investor awareness about climate-related financial risks, research in this domain is increasingly imperative.

The period from 2019 to 2020 is a critical window for examining climate risk disclosures in utility firms. This period was marked by a global push for climate risk transparency and was punctuated by the global COVID-19 pandemic. The pandemic amplified the call for environmental action and escalated the demand for corporate environmental accountability, making this time frame salient for our investigation.

The year 2019 is particularly notable as it saw a surge in the adoption of the recommendations made by the Task Force on Climate-related Financial Disclosures (TCFD). The TCFD's 2020 Status Report underscores this surge, revealing a discernible uptick in the disclosure of climate-related financial information in the 2019 fiscal year reports. This pivotal movement provides a fertile backdrop for our case study. Our research draws on the comprehensive climate risk disclosure analysis pioneered by Berkman et al. (2023), integrating it with the contemporary discourse on artificial intelligence (AI) in accounting. Utilizing the analytical capabilities of the Generative Pre-trained Transformer 4 (GPT-4), we delve into the tax footnotes of utility firms within the Russell 3000 Index to calculate tax risk scores, contrasting these against climate risk scores from the Ceres Climate Risk database. Preliminary insights reveal a correlative trend where firms with higher climate risks exhibit elevated tax risks, paving the way for further investigation within the realm of investigative accounting—a field increasingly embracing methodological advancements.

This exploratory case study aims to deepen the dialogue on the nexus of climate risk, tax strategy, and the innovative application of AI in accounting practices. By conducting a rigorous literature review, delineating our methodology, and engaging in an analytical discourse, we aspire to shed light on the implications of our findings for forensic accounting and the broader academic landscape.

The primary research question guiding this study is: How do climate risk scores correlate with tax risk scores among utility firms in the Russell 3000 Index during the fiscal years 2019 to 2020? We hypothesize that firms with higher climate risk scores will exhibit higher tax risk scores due to the increased regulatory and operational complexities associated with higher environmental risks. Recent research by Kim et al. (2024) has demonstrated the significant potential of Large Language Models (LLMs) in performing financial statement analysis. Their study shows that LLMs can outperform human analysts in predicting earnings changes using only numerical data from financial statements. This study underscores the innovative use of AI in our study and highlights the importance of employing advanced AI methodologies for financial analysis.

Literature Review

Evolving Assessments of Climate Risk in the Financial Sector

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The assessment of climate risk has become a pivotal element in the financial sector, integral to understanding the economic impacts of environmental change. Academic scholarship and global initiatives have catalyzed the evolution of a more methodical approach to evaluating these risks. A notable example is the work by Fiedler et al. (2021), which underscores the increasing incorporation of climate risk analytics into the evaluation of business risks, thus drawing a connection between the viability of environmental and economic systems. These research efforts have significantly influenced the development of regulatory guidelines and standards, particularly the recommendations by the Task Force on Climate-related Financial Disclosures (TCFD, 2020), which advocate for the transparent disclosure of climate-related financial information. The United Nations Framework Convention on Climate Change (UNFCCC, 2015), in its 2015 action plan, reinforced the urgency of addressing climate risks with the same rigor as other global risks, such as national security and public health, highlighting the imperative for immediate and comprehensive action.

Financial Implications of Climate Risks: Market Valuations and Taxation Strategies

The interconnection between climate risks, market valuations, and corporate tax strategies is increasingly prominent within the corporate arena. The Harvard Business Review in 2021 sheds light on this phenomenon, illustrating that market valuations are progressively aligned with companies' climate risk management strategies, thereby acknowledging the growing pertinence of environmental considerations in corporate governance. This perspective is echoed by the Climate-Related Market Risk Subcommittee of the Commodity Futures Trading Commission (CFTC), which, as Deloitte reported in 2020, highlights the substantial effects that climate risks may impose on the financial markets in the United States, prompting an essential dialogue on this complex nexus. Insights from Brinkman, Hoffman, and Oppenheim (2008) in the McKinsey Quarterly suggest that mechanisms such as carbon pricing and emissions trading schemes are pivotal in determining corporate valuations, thereby bridging climate risks with the extensive financial strategies of companies. Supporting this view, the research by Pellerin and Rodriguez (2021) confirms the synergy, indicating that adept climate risk management transcends market valuation implications, extending perspectives in various tax strategies and financial reporting.

Leveraging AI in Financial Risk Analysis: A New Frontier

The burgeoning application of Artificial Intelligence (AI) in financial risk analysis marks a transformative era in this domain. As evidenced by its instrumental role in climate risk analysis, AI catalyzes innovative methodologies and tools for risk assessment, monitoring, and mitigation. The potential of AI to refine climate risk disclosures and its utility in identifying greenwashing practices has been highlighted by Imperial College Business School. SpringerOpen (2019) further discusses the disruptive impact of AI on climate risk prediction and adaptation, illustrating its multifaceted applications. Cervest (2022) showcases AI's capabilities in dynamic climate risk analysis for diverse assets and portfolios. IBM Research (2021) emphasizes AI’s role in quantifying the hazards, impacts, and risks induced by climate change.

In the accounting sector, the emergence of GPT-4 has introduced new opportunities for innovation. Vasarhelyi et al. (2023) underscore the model's proficiency in a range of language tasks, from data extraction to semantic clustering of financial statements, highlighting its adaptability to the nuanced needs of accounting research and practice. GPT-4's capabilities in developing XBRL-like taxonomies from corporate disclosures further demonstrate its potential in standardizing and streamlining financial reporting (de Kok, 2023).

Building on this foundation, AI's reach extends to broader financial risk analysis, such as tax risk investigation, where it can similarly revolutionize traditional approaches. AI’s analytical prowess can decipher complex patterns in financial data, offering fresh perspectives on risk management and compliance strategies. This multifunctional technology is poised to become an indispensable tool across various facets of financial risk, from enhancing transparency in reporting to providing forward-looking risk assessments.

Kim et al. (2024) provided compelling evidence of the efficacy of LLMs in financial statement analysis, showcasing their ability to predict earnings with greater accuracy than human analysts and specialized machine learning models. Their findings support the use of GPT-4 in our study to analyze tax footnotes and climate risk scores, as LLMs have proven to generate valuable narrative insights and accurate predictions. This review of the current literature on climate and tax risks sets the stage for our investigation into the relationship between these two concepts. Building on the insights from previous studies, we aim to answer the following research question: How do climate risk scores correlate with tax risk scores among utility firms in the Russell 3000 Index during the fiscal years 2019 to 2020?

Methodology

Selection of Utility Firms and Data Collection Process

This case study examines utility firms from the Russell 3000 Index during the fiscal years 2019 to 2020, a period critical for the surge in environmental sustainability awareness and corresponding regulatory measures. During this period, the demand for climate risk transparency increased significantly, driven by heightened regulatory scrutiny and stakeholder awareness. For instance, the Task Force on Climate-related Financial Disclosures (TCFD, 2020) highlighted a growing emphasis on climate-related risk disclosures in their 2020 status report (TCFD, 2020). Furthermore, major regulatory developments such as the European Union's Green Deal, which was announced in 2019, underscored the urgency for transparent climate risk reporting (European Commission, 2019). Additionally, Berkman et al. (2023) found that firm-specific measures based on 10-K disclosures of climate risk, updated until 2020, provide significant explanatory power for firm valuation. The utility sector is particularly pertinent for this study because utilities face the highest combined physical risk from climate hazards like water stress, storms, and wildfires compared to other industries (S and P Global, 2021). The reliance on extensive infrastructure and the high capital intensity of utility operations mean that these firms are significantly affected by climate-related events, making them an ideal focus for examining the intersection of climate and tax risks (McKinsey, 2021). Additionally, the financial impact on utilities due to storm damage and extreme weather events underscores the importance of understanding climate risks in this sector (Gerlak et al., 2017; McMahan and Gerlak, 2020). The climate risk score data from Berkman et al. (2023) covers the period up to 2020, which aligns with our study's timeframe and ensures the relevance and accuracy of our analysis. Due to data availability, we are currently examining these concepts up to 2020, acknowledging that future research could extend the time horizon to include additional years for robustness testing.

Therefore, the study examines utility firms from the Russell 3000 Index during the fiscal years 2019 to 2020, a period critical for the surge in environmental sustainability awareness and corresponding regulatory measures. Our analysis revolves around two primary variables: climate risk scores and tax risk scores. The climate risk scores are derived directly from the Ceres Climate Risk database accessible at https://sites.google.com/view/climateriskdata/research, a repository established by Berkman et al. (2023). This resource employs the SEC Climate Disclosure Search Tool—developed collaboratively by Ceres and CookESG Research[1]—applying a sophisticated text analysis algorithm to quantify and score climate risk disclosures within 10-K filings. These scores encapsulate both the volume and specificity of climate risk-related language in these disclosures, placing a premium on terms that directly engage with climate risks.

The scoring methodology is rooted in a comprehensive examination of the literature surrounding environmental risk disclosures. According to Berkman et al. (2023), the climate risk scores are calculated by assessing the frequency and context of climate-related keywords and phrases within the financial disclosures. The algorithm identifies mentions of climate risk, regulatory actions, and other relevant environmental factors. The resulting scores provide a quantitative measure of a firm's exposure to climate risk, considering both the extent and specificity of the disclosures (Clarkson et al., 2008; Ceres, 2018).

Additionally, the methodology incorporates factors such as the geographical location of the firm's operations, the nature of its industry, and its historical response to climate-related events. This comprehensive approach ensures that the scores reflect a holistic view of the firm's climate risk profile. The analysis is based on a vast dataset, allowing for robust comparisons across firms and industries.

The effectiveness and reliability of these climate risk scores have been validated through empirical research. Berkman et al. (2023) demonstrated that these scores significantly explain variations in firm valuation, highlighting their importance and utility in financial analysis. Sautner et al. (2020) also emphasized the role of carbon disclosure in determining the cost of capital, reinforcing the relevance and accuracy of the climate risk scores used in our study.

Building on the methodological advancements of Kim et al. (2024), we implemented a Chain-of-Thought (CoT) prompting approach in our use of GPT-4. This method involves a step-by-step analysis that mimics human reasoning, enhancing the model's ability to generate actionable insights from financial data. As this is an exploratory case study, we did not aim to

[1] See https://www.ceres.org/issues/resources/tools/sec-sustainability-disclosure. Data are also available in tabular form provided by Berkman et al. (2023) at https://sites.google.com/view/climateriskdata/research.

provide a comprehensive statistical analysis of all observations. Instead, our goal was to identify patterns and relationships that could inform future, more detailed investigations.

Tax risk scores, on the other hand, are ascertained through a granular analysis of tax footnotes from annual financial reports. Such an examination is enhanced by the analytical capabilities of the GPT-4 model, which aids in evaluating the transparency and intricacies of tax strategies and commitments. The import of such disclosures on investor risk perception and the reflection of the firm's risk factors have been well-documented in prior research, notably by Campbell et al. (2014) and Hope et al. (2016).

Our study utilizes these articulated scores to probe the potential correlations between climate and tax risks within the utility sector. This endeavor is supported by advanced data collection methods, which include the innovative use of AI and natural language processing for a nuanced interpretation of complex narrative disclosures.

Operationalizing GPT-4 for Tax Risk Analysis: A Methodological Innovation

The introduction of OpenAI's Generative Pre-Trained Transformer 4 (GPT-4) represents a groundbreaking shift in financial analysis, particularly in scrutinizing tax footnotes within corporate financial statements. This advanced language model enables a structured point-based system for evaluating tax risk indicators such as Losses Before Income Taxes, Effective Tax Rate Variance, and other crucial tax-related factors. GPT-4's expanded parameters, as discussed by Brown et al. (2020) and OpenAI (2023), facilitate a depth of analysis that surpasses traditional methods, offering nuanced interpretations that were once a formidable challenge requiring specialized expertise.

By rigorously assessing and assigning points to each tax-related factor and normalizing these on a scale from 0 to 5, GPT-4 provides a clear, actionable understanding of a firm's tax risk profile. This approach, informed by the imperative of readability highlighted by Inger et al. (2018), democratizes access to complex tax information, enhancing transparency and aiding in strategic decision-making. The highest tax risk is indicated by a score of 5, reflecting the culmination of GPT-4's analytical prowess in evaluating the multifaceted aspects of tax footnotes. This innovation not only propels scholarly research but also revolutionizes practical applications, shaping the future of tax risk analysis and investor engagement in the financial marketplace.

Developing Robust Scoring Criteria for Climate and Tax Risks

Climate risk scoring in our analysis is rooted in a comprehensive examination of the literature surrounding environmental risk disclosures. It is explicitly executed using data from the Ceres Climate Risk measure, as collected from the SEC Climate Disclosure Search Tool developed by Ceres and CookESG Research. This tool implements a rules-based text analysis algorithm to systematically identify and evaluate climate risk disclosures within 10-K filings. The resulting scores are a synthesis, reflecting both the extent and specificity of language that directly addresses climate risks.

For tax risk scoring, we utilize the GPT-4 model to conduct an in-depth analysis of the tax footnote disclosures. The model's advanced interpretive abilities are leveraged to scrutinize the subtleties of tax-related disclosures. The scoring methodology is underpinned by the comprehensive insights provided by GPT-4, establishing a uniform framework to evaluate tax risks across various firms. Each tax-related factor is meticulously scored based on its significance to the overall tax risk, culminating in an aggregated score that is then normalized on a scale from 0 to 5 to enable comparison.

Together, these scoring frameworks offer a structured method to quantitatively appraise the confluence of climate and tax risks within the utility sector, thereby enriching our understanding of the financial ramifications of these intertwined risks.

Case Study Analysis

Presentation of Climate Risk Data for Selected Utility Firms

In this section, we examine the climate risk data for utility firms in the Russell 3000 Index during the pivotal years of 2019 to 2020. This period, marked by heightened environmental regulation and the onset of the COVID-19 pandemic, offers critical insights into these firms' environmental governance. The climate risk scores, derived from public disclosures and relevant literature, are pivotal in evaluating their environmental performance. Figure 1 gives a visual summary of these scores, thereby providing a comprehensive view of the sector's environmental risk profile during this significant timeframe. For this investigation, we selected the two utility sector firms with the highest and the two with the lowest non-zero climate risk scores. Employing GPT-4's advanced linguistic analysis, we sought to illuminate the tax risk landscape for these firms, chosen to represent a range of environmental risk engagements during the study period. *[See Figure 1, pg. 12]*

Tax Risk Dissection via GPT-4: Engaging a Sophisticated Tax Footnote Analysis

Instructing GPT-4 to function as a senior audit and tax specialist, we analyzed the tax footnotes from the selected utility firms' 10-K statements within the Russell 3000 Index. GPT-4's expertise in textual analysis was pivotal in deconstructing the intricacies of tax-related disclosures, enabling a systematic evaluation on a scale from 0 to 5, where 0 indicates negligible tax risk, and 5 represents the highest tax risk.

The prompt provided to GPT-4 was meticulously crafted and vetted to ensure accuracy and relevance. It included specific instructions to analyze key tax-related items such as Losses Before Income Taxes, Effective Tax Rate Variance, Deferred Tax Assets and Liabilities, Unrecognized Tax Benefits, Tax Contingencies, Regulatory and Legislative Changes, and the Geographical Distribution of Earnings. Additionally, we set the temperature parameter to 0.1 to minimize variation and creativity in the AI's responses, ensuring consistency and reliability in the results.

To verify the information provided by GPT-4, we conducted a thorough audit of a sample of the results by comparing the AI-generated tax risk scores with the corresponding firm's public financial statements. This process involved cross-referencing the AI's output with the actual disclosures in the 10-K filings to ensure accuracy. Moreover, we used SIC codes and fiscal year data from the climate risk database (Berkman et al., 2023) to confirm the industry and year of interest for each firm-year observation in our dataset.

Our methodological approach leverages GPT-4's demonstrated capability in financial statement analysis, as evidenced by the empirical research of Kim et al. (2024). To further enhance the reliability of our tax risk assessments, a financial expert conducted a thorough review of both the AI-generated scores and the corresponding financial statements. This additional layer of human oversight confirms the accuracy of our results and ensures that our AI outputs are consistently dependable and valid.

Results

Comparative Analysis of the Scores Across Firms

In this section, we delve into the comparative analysis of the climate risk scores and tax risk scores across the four firms that were meticulously evaluated. The analysis is structured to showcase the firms starting from the highest climate risk score to the lowest (non-zero) climate risk score, facilitating a coherent understanding of the interplay between climate risk and tax risk across a spectrum of environmental risk profiles.

Firms with the Highest Climate Risk Scores:

The two companies with the highest climate risk scores were PNM Resources, Inc. (PNM) and TerraForm Power, Inc. (TERP). PNM led all companies with the highest climate risk raw score of 780, reflecting significant exposure to climate risks potentially due to its operational footprint, regulatory challenges, or carbon intensity. TERP had a substantial raw score of 690, which also presents a high climate risk, reflecting its significant environmental risk exposure. With respect to the tax risk scores, PNM had a 3.1 out of 5. This score indicates a moderate level of tax risk that seems to align with its high climate risk profile, suggesting a proportionate relationship between environmental challenges and tax risk management. TERP, on the other hand, had a 4.2 out of 5, indicating that the firm's tax risk is notably high and consistent with the elevated climate risk score. This score supports the notion that higher environmental risks could be linked to more complex tax risk profiles.

PNM's moderate tax risk score of 3.1, although lower than TERP, is consistent with its substantial climate risk score, suggesting that companies facing extensive climate-related financial exposures may exhibit a correspondingly elevated tax risk. The strong correlation between high climate and tax risk scores for TERP provides evidence for the proposition that firms with greater environmental risks may manage more nuanced and potentially higher tax risks.

Firms with the Lowest (Non-Zero) Climate Risk Scores:

Now, Gold Resource Corp (GORO) and ITC Holding Corp. (ITC) were the two companies with the lowest climate risk scores. GORO had the lowest raw score of 3, signaling minimal yet acknowledged environmental risk exposure. ITC, on the other hand, had a raw score of 8, which exhibits a recognized but manageable level of climate risk.

With respect to tax risk, both companies have scores that are nearly the same. GORO had a score of 2.0 out of 5, illustrating a lower tax risk that aligns with its minimal climate risk score. ITC had a score of 2.1 out of 5, which, like its climate risk

score, is on the lower side, suggesting a cautious and balanced approach to both climate and tax risk. These results support the position that a low but non-zero climate risk score, accompanied by a low tax risk score, exemplifies the tendency for firms with reduced environmental risks to also demonstrate lower tax risks, potentially indicating a direct correlation between the two risk assessments.

The results of this exploratory case study suggest a correlation between climate risk and tax risk among utility firms. The tax risk scores are determined on a scale from 0 to 5, where 0 represents negligible tax risk, and 5 represents the highest tax risk. Scores above 2.5 indicate a higher tax risk, while scores below 2.5 indicate a lower tax risk. For example, firms with scores of 3.1 and 4.2 are considered to have moderate to high tax risk, while scores of 2.1 and 2.0 suggest lower tax risk. These categorizations are based on the midpoint of our scale, which is a standard approach in exploratory studies to provide a preliminary understanding of relative risk levels.

Examining the Interplay Between Climate and Tax Risks

The analysis of climate risk and tax risk scores within the utility sector highlights a discernible, albeit complex, relationship. As anticipated, firms like PNM Resources, Inc. and TerraForm Power, Inc., which exhibit higher climate risk scores, also display proportionately higher tax risk scores. This trend suggests that greater exposure to climate-related challenges could be associated with more complex tax liabilities, potentially affecting their market valuation negatively due to the increased financial uncertainty.

Conversely, companies such as Gold Resource Corp and ITC Holdings Corp, with notably lower climate risk scores, also demonstrate lower tax risk scores. This observation aligns with the initial hypothesis, indicating that firms with lesser climate risk may face less financial complexity, which could translate to a more favorable market valuation.

The adherence to the hypothesized correlation in these cases underscores the interconnectedness of environmental and financial risk management. It further suggests that a company's proactive engagement with climate issues, as reflected in its climate risk scores, may be mirrored in its approach to fiscal responsibilities, as indicated by its tax risk scores.

This pattern enriches the narrative that market valuations are not only influenced by traditional financial metrics but also by how effectively a firm navigates the evolving landscape of climate-related risks and their corresponding tax strategies. The application of the GPT-4 model in calculating tax risk scores, when considered alongside climate risk scores, affirms the value of AI in enhancing financial risk analysis and suggests that market valuation practices could benefit from integrating these ESG dimensions into their assessments.

Discussion

Interlinking Climate and Tax Risk Scores: Firm Behavior Insights

The comparative analysis of climate and tax risk scores across a selection of utility firms from the Russell 3000 Index during 2019–2020 reveals a compelling narrative about firm behavior and its implications for market valuation. The data suggests a proportionate relationship between environmental and tax risks, with firms like PNM Resources, Inc. and TerraForm Power, Inc. demonstrating a correlation between high climate risk and complex tax risk management strategies. This pattern indicates that firms with significant environmental exposure may adopt more aggressive tax strategies as a financial counterbalance.

In contrast, firms such as Gold Resource Corp and ITC Holdings Corp, with lower climate risk scores, display conservative tax risk postures, which could signal a cautious strategic approach to both environmental and fiscal responsibilities. These correlations provide a multifaceted understanding of how firms navigate the interplay between climate action and tax planning, reflecting a range of risk appetites and management strategies that could have substantive consequences for their market valuations. This nuanced interplay between climate risk and tax strategy is a critical area for further research, particularly in understanding how these dual risks inform investor perception and influence firm valuation in the broader market context.

One noteworthy observation from our study is the difference in the variability between climate risk scores and tax risk scores. The climate risk scores exhibited a wider range of values compared to the tax risk scores. This discrepancy can be attributed to several factors.

Firstly, climate risk encompasses a broader array of factors, including physical risks (such as extreme weather events), regulatory risks (such as changes in environmental regulations), and market risks (such as shifts in consumer preferences

towards more sustainable products). Each of these factors can vary significantly across firms and regions, leading to greater variability in climate risk scores.

In contrast, tax risk is often influenced by more stable and predictable factors, such as tax laws and regulations, corporate tax strategies, and financial reporting practices. While there are variations in tax risk among firms, these variations tend to be more contained compared to the diverse and dynamic nature of climate risks.

It is important to acknowledge this difference in variability when interpreting the results of our study. The wider range of climate risk scores underscores the complex and multifaceted nature of climate risk, highlighting the need for comprehensive risk management strategies that address the full spectrum of climate-related challenges.

Strategic Alignment with Climate Risks: A Corporate Analysis

Our analysis discerns a strategic alignment between corporate tax strategies and climate risk exposures. Firms with higher climate risks, such as PNM Resources, Inc. and TerraForm Power, Inc., seem to adopt aggressive tax strategies, potentially as a pre-emptive measure against financial impacts attributed to climate-related challenges. While indicative of strategic risk management, this proactive stance invites further investigation into its effectiveness. Conversely, companies like Gold Resource Corp and ITC Holdings Corp demonstrate a more conservative tax strategy, possibly due to their lower climate risk, suggesting strategic adaptation to their environmental exposure. The alignment between climate risk and tax strategy is pivotal, influencing financial stability, stakeholder confidence, and market valuation, necessitating a deeper exploration of its implications.

AI's Pivotal Role in Refining Financial Risk Assessment

The employment of the GPT-4 model in deriving tax risk scores underscored the burgeoning potential of Artificial Intelligence (AI) in elevating the reliability and precision of risk assessments. The meticulous evaluation of tax footnotes, facilitated by the GPT-4 model, unraveled nuanced tax risk profiles across the firms, showcasing AI's capacity to handle complex textual data and derive actionable insights.

While the analysis focused on the fiscal years 2019 to 2020, this period was selected due to the significant increase in climate risk transparency demands during these years. The decision to include 2020 is critical as it allows us to assess the continuation of the trends observed in 2019. Future research could extend the time horizon to include additional years, which would allow for testing the robustness of the results across different regulatory and economic environments. This extension was beyond the scope of the current study due to data availability constraints and the exploratory nature of our analysis. The climate risk score data from Berkman et al. (2023) covers the period up to 2020, which aligns with our study's timeframe and ensures the relevance and accuracy of our analysis.

Furthermore, the potential for AI extends beyond tax risk assessment to a broader spectrum of financial diagnostics, including climate risk assessment. The case study hints at a future where AI could significantly augment the clarity and accuracy of financial risk assessments, providing a robust foundation for market valuation and strategic decision-making. The integration of AI in evaluating both climate and tax risks heralds an era of enhanced transparency, informed decision-making, and robust corporate disclosures, significantly contributing to the discourse on sustainable finance and responsible business practices.

Conclusion and Implications for Stakeholders and Policy

This section synthesizes the key findings from the analysis of climate risk and tax risk scores of select utility firms, examining the implications for stakeholders such as investors, regulators, and firm management. It also discusses the transformative role of Artificial Intelligence (AI) in refining the accuracy and reliability of risk assessments.

Key Findings:

- A correlation is observed, suggesting that firms with higher climate risk scores tend to have higher tax risk scores, indicating an interdependence between environmental impact and financial risk management.
- Conversely, firms with lower climate risk scores typically exhibit lower tax risk scores, pointing to a potential alignment between environmental stewardship and fiscal prudence.

Implications:

- **For Investors:** This analysis equips investors with a dual perspective on financial risk, considering both climate and tax factors. These insights can guide investment strategies, enhancing the approach to risk diversification and portfolio management.
- **For Regulators:** The findings offer regulators a preliminary understanding of the interconnectedness between firms' climate-related disclosures and tax profiles, potentially influencing regulatory frameworks and guidelines for financial and environmental disclosures.
- **For Firm Management:** Management teams can leverage these insights to better align their tax strategies with their climate risk profiles, aiming to mitigate financial risks and adapt to the evolving landscape of ESG-focused regulatory compliance.

Recommendations for Future Research

This study serves as an exploratory investigation into the relationship between climate risk and tax risk within utility firms. While our primary focus was on identifying and analyzing patterns and relationships, we recognize the importance of incorporating comprehensive statistical analyses to strengthen the findings. The exploratory nature of this study did not include extensive statistical analyses such as correlation matrices or regression models. However, we acknowledge that these methods are crucial for providing a more in-depth understanding of the variables involved.

Future research should consider the following enhancements to build upon the foundation laid by this study:

- Correlation matrices with statistical significance to identify and quantify relationships between climate risk and tax risk.
- An expanded inquiry into the causal mechanisms linking climate risk to tax risk, potentially across diverse industries, to generalize the findings.
- Investigate the influence of specific tax and environmental policies on corporate risk postures and strategic decision-making.
- Further exploration of AI's capabilities in automating risk assessments, offering prospects for more nuanced, dynamic, and timely risk evaluations.
- Descriptive statistics of the variables of interest and any controls used in statistical models.
- T-tests, MANOVA, or linear regression to measure the statistical relationship between the variables of interest.

By incorporating these statistical analyses, future studies can provide more robust conclusions and actionable insights. We emphasize that our current study is a foundational step, and we encourage future research to expand on our work with more detailed and statistically rigorous methodologies.

The Role of AI

- AI's pivotal role in risk assessments is accentuated, with technologies enhancing the precision and swiftness of tax and climate risk evaluations.
- AI tools enable the nuanced assessment of uncertainties and the extrapolation of potential risk scenarios, bolstering decision-making processes.
- The advancement of AI is reshaping the global governance, risk, and compliance (GRC) framework, promising increased operational efficiency, improved productivity, and more focused outcomes in risk analysis and mitigation.

The use of AI tools such as GPT-4 presents both opportunities and challenges in the analysis of tax and climate risk. While the capabilities of AI offer significant advantages in processing large volumes of textual data and identifying patterns, it is crucial to acknowledge and address the potential errors and limitations inherent in these technologies.

One notable limitation of AI models, including GPT-4, is the potential for generating inaccurate or misleading information. This issue, often referred to as “hallucination,” occurs when the AI produces outputs that are not based on the input data or factual information. To mitigate this risk, we employed several strategies, including setting a low-temperature parameter (0.1) to ensure more deterministic and consistent outputs, thereby reducing the likelihood of hallucination.

Additionally, the accuracy of AI-generated analyses depends heavily on the quality and comprehensiveness of the training data. Although GPT-4 is trained on a diverse and extensive dataset, it may still lack domain-specific nuances and contextual understanding that a human expert would possess. To address this problem, we conducted a thorough validation process by cross-referencing the AI-generated tax risk scores with the actual financial statements of the firms. This validation step helped to identify and correct any discrepancies, ensuring the reliability of the results.

Furthermore, the application of AI in financial statement analysis is still an emerging field. As such, there are ongoing advancements and improvements that could enhance the accuracy and reliability of AI tools in the future. Studies such as Kim et al. (2024) have demonstrated the potential of AI in financial analysis, yet they also highlight the importance of human oversight and validation.

Lastly, it is important to note that while AI can process and analyze data at scale, it cannot fully replicate the expert judgment and contextual interpretation that human analysts provide. Therefore, the use of AI in our study is intended to complement, not replace, the expertise of financial analysts and researchers.

In sum, the convergence of AI and risk assessment represents a significant leap forward in the field of financial analysis, offering stakeholders actionable intelligence to navigate the complexities of today's market environments.

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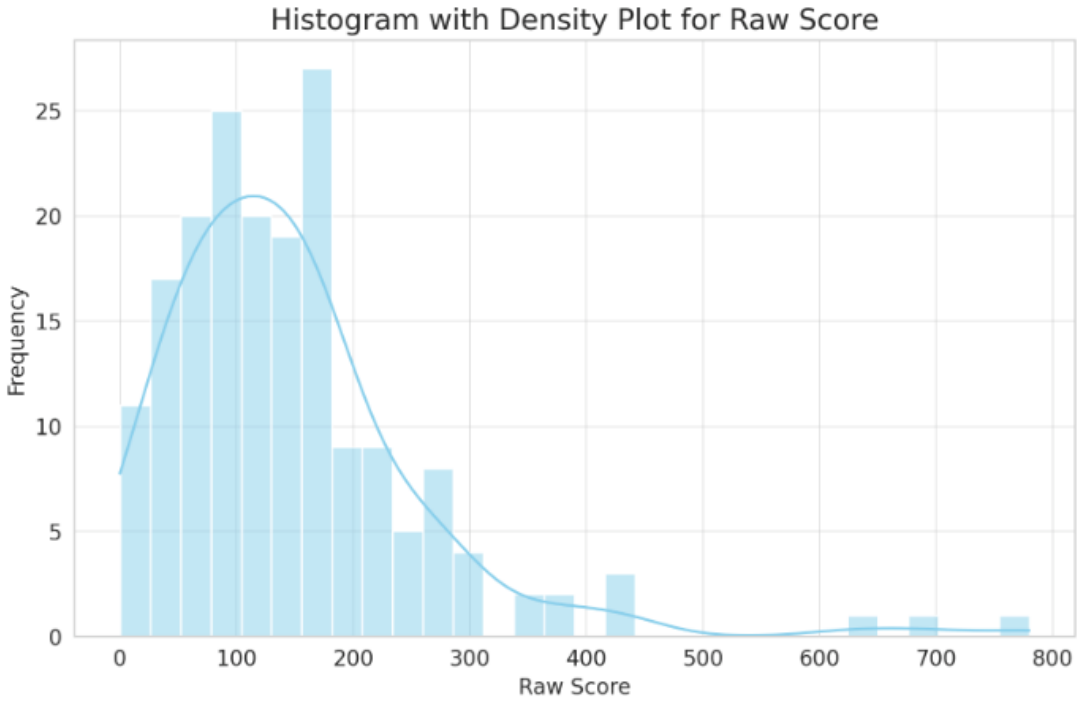
Figure 1. Climate Risk Score Distribution for the Utility Sector in the Russell 3000 Index (2019–2020)



Appendix 1. GPT-4 Prompt for the Tax Risk Score

You now act as a senior audit and tax specialist. Your task is to analyze the tax footnotes in the 10-K statements of selected utility firms from the Russell 3000 Index for the fiscal years 2019 to 2020. You will provide a tax risk score on a scale from 0 to 5, where 0 indicates negligible tax risk, and 5 represents the highest tax risk. The score should be based on the following key tax-related items:

Losses Before Income Taxes: Assess the amount and context of any reported losses before income taxes.

Effective Tax Rate Variance: Examine the variance in the effective tax rate and its implications.

Deferred Tax Assets and Liabilities: Evaluate the presence and significance of deferred tax assets and liabilities.

Unrecognized Tax Benefits: Identify any unrecognized tax benefits and their potential impact.

Tax Contingencies: Consider any disclosed tax contingencies or uncertainties.

Regulatory and Legislative Changes: Note any significant regulatory or legislative changes mentioned that could impact the firm's tax position.

Geographical Distribution of Earnings: Review the geographical distribution of earnings and related tax implications.

Instructions:

- Analyze each tax footnote thoroughly and provide a detailed explanation for the assigned tax risk score.
- Use a temperature setting of 0.1 to ensure low variation and high consistency in your responses.

Example:

"For XYZ Corporation, the Losses Before Income Taxes reported in the 10-K statement for 2020 were $50 million, significantly impacting their tax risk profile. The Effective Tax Rate showed a variance of 10% from the previous year due to changes in deferred tax liabilities. Based on these factors, XYZ Corporation's tax risk score is assessed as 4."