Introducing the new ESG-based Sustainability Uncertainty Index (ESGUI)

Abstract

Rising uncertainties can affect countries' sustainability efforts. Therefore, this study develops and introduces a new *ESG-based sustainability uncertainty index (metric)* called *ESGUI* for the first time. This new index is necessary to better analyze how uncertainties based on ESG (environmental, social, governance) factors, increasingly prominent in the modern business world, are reflected in investment processes. Accurate ESG risks are critical for investors and policymakers. To create this index, we employed text mining techniques on the Economist Intelligence Unit's monthly country reports, analyzing the frequency of ESG-related keywords and uncertainty indicators. Specifically, the world uncertainty index was integrated into the ESG for 25 countries between 2002M11-2024M09. The index's reliability was validated through a vector autoregression model and cross-referenced with control variables graphically. The findings indicate that the *ESGUI* exhibits common changes with these relevant control variables, particularly showing significant correlations with existing measures such as the World Uncertainty Index (WUI) and Economic Policy Uncertainty (EPU) index, thus evidencing the index's robustness. This new index will help policymakers better manage sustainability uncertainties, develop sustainable economic policies, and help investors evaluate ESG-related risks and opportunities more effectively.

Jel codes: D8, Q01, Q56.
Keywords: ESGUI, ESG metrics, uncertainty index, sustainable development, text mining analysis, economic policy, SDG.

1. INTRODUCTION

The impact of uncertainty on sustainability may be more important than its impact on economic growth. Uncertainties may prevent achieving sustainability goals and prolong sustainable development, wasting time and resources. On the other hand, environmental, social, and governance (ESG) factors are crucial sustainability metrics that help companies and governments evaluate their environmental (E) and governance (G), as well as their social (S) responsibility.

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Therefore, the economic policy uncertainty (EPU), developed by Baker et al. (2016), monitoring major newspapers and scanning the frequencies of some specific keywords (economy, policy, and uncertainty) and ESG have been examined in some studies based on these potential relationships above. The literature review section of this study provides these studies between EPU and each ESG factor separately.

On the other hand, combining these three factors, E, S, and G, with the uncertainty concept may offer a new innovative approach to investigating sustainability. This approach also reveals the need to develop a new sustainability-related uncertainty index. In this direction, the main contribution of this study is to develop and introduce a new index (metric), ESGUI, by adding the uncertainty concept to ESG-based sustainability. In other words, the ESGUI expression developed and introduced in this study consists of Environment, Social, Governance, Uncertainty, and Index initials. E, S, and G correspond to the concept of sustainability in this expression, and ESGUI means sustainability uncertainty index.

The rationale for needing this new index is that uncertainties directly or indirectly affect each pilar of the ESG (E, S, G) factors and vice versa, i.e., from ESG to uncertainty.

This study utilizes the World Uncertainty Index (WUI), a new measurement created by Ahir et al. (2022) that monitors uncertainty worldwide. While the EPU index is computed from a broad set of newspaper news sources, the WUI relies on the Economist Intelligence Unit (EIU) monthly country reports.

These reports follow standardized structures, the production process, and the subject scope of country reports. Therefore, this feature can make the WUI comparable across countries and reduce some concerns about ideological bias and consistency of the data Ahir et al. (2022).

Therefore, for the first time, this study develops and introduces the ESG-based sustainability uncertainty index (metric) as the ESGUI combining ESG and world uncertainty index (WUI) for 25 developed and developing sample country level and global level. This new index can be used as a new independent or dependent variable in empirical studies that examine the concepts of sustainability and uncertainty separately or together and can contribute to the relevant literature. A rise in this index will indicate increased challenges and risks to sustainability efforts for the countries. This metric (index) can help firms and policymakers understand how the changing uncertainty affects ESG performance to tailor sustainability and investment strategies. Therefore, this index may fill a gap in the literature on this subject by adding uncertainty to the concept of sustainability, which is in line with its increasing importance.

The need for a new ESG-based sustainability index can be summarized as follows:

(i) ESGUI is necessary to better analyze how ESG factors increasingly emerging in the modern business world and investment processes are reflected in economic uncertainties. Accurately capturing environmental, social, and governance risks is critical for investors and policymakers. All these make this index an essential tool in understanding the risks companies and the market face regarding sustainability.

(ii) Investors have recently begun focusing more on ESG risks and opportunities than traditional financial risks. Institutional investors may think investing in companies with low ESG performance is riskier in the long run. Therefore, an ESG-based uncertainty index (ESGUI) becomes a critical tool that shows investors how impactful sustainability-related risks are.

(iii) The concept of sustainability has evolved over time from an environmental perspective to a more comprehensive approach that includes economic, welfare, and social pillars. (Purvis et al., 2019; D'Adamo et al. 2024a; D'Adamo et al. 2024b). In this regard, many governments and firms have started developing sustainable policies within the United Nations's Sustainable Development Goals (SDGs) framework. Therefore, an ESG-based uncertainty index (ESGUI) could help monitor companies' ability to comply with these goals. Since sustainable development includes not only economic but also environmental and social sustainability, it will be essential to evaluate such uncertainties. This relationship implies a transition from ESG to SDGs (Bekaert et al., 2023; Isik et al., 2024).

(iv) Related to item iii above, while the ESGUI is primarily designed to measure uncertainties related to ESG factors, it also provides valuable insight into the challenges and opportunities for achieving SDGs. In other words, the ESGUI can be directly linked to the SDGs as it generally represents the combination of ESG factors for different thematic goals such as SDG 13 (Climate Action), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and

Economic Growth), SDG 4 (Quality Education) and SDG 16 (Peace, Justice, and Strong Institutions). For instance, the data provided by ESGUI allows policymakers to understand and prioritize risks related to climate change in terms of SDG 13 (Climate Action). Similarly, stakeholders, particularly regional governments and private investors, are essential in aligning ESG practices with SDGs. For example, investments in social infrastructure can directly address SDG 9 (Industry, Innovation, and Infrastructure) while reducing social uncertainties (S). As a result, the ESGUI will directly impact progress toward achieving the SDGs by measuring uncertainties in ESG factors. In doing so, ESGUI goes beyond merely assessing risks; it significantly contributes to the related literature by aligning with broader SDG targets.

(v) There is a steady increase in ESG-related regulations. For example, the European Union's sustainability reporting mandates and other regulatory developments require companies to comply with ESG criteria. Because such regulations can create uncertainty, an index that measures ESG uncertainties could help investors and policymakers better understand how companies and markets respond to such changes.

Despite the increasing importance of Environmental, Social, and Governance (ESG) factors in today's economic and business landscape, as listed above, there is a lack of an index that combines ESG with uncertainty as a single composite index (ESGUI). Existing uncertainty indices generally measure broader economic uncertainties (such as WUI) or economic policy-related uncertainties (such as the EPU index), but a specific index has not been developed to focus on ESG factors. Therefore, we believe that the development of ESGUI will contribute to closing this gap in existing literature.

The rest of the study is structured as follows: Sections 2 and 3 present the background and empirical model-methodology, respectively. Section 4 provides empirical findings. Lastly, Section 5 provides conclusions, the study’s limitations, and recommendations for future studies.

2. BACKGROUND

2.1. EPU and environmental factors (E)

Studies on the relationship between EPU and the environment can be examined under two groups. In the first group of studies, findings were found that high EPU harms the environment, while in the other group of studies, this effect is in the direction of reducing pollution. For example, Jiang et al. (2019) employed the novel parametric Granger causality test in quantiles for the USA. They found a causal relationship between the EPU and CO_2 emission in the industrial, residential, electric, and transportation sectors. Danish et al. (2020) used a dynamic ARDL (autoregressive distributed lag) approach for the USA and found that the EPU negatively affects environmental quality. Pirgaip & Dincergok (2020) used the bootstrap panel Granger causality test for G7 countries. They found causal relationships between EPU and CO_2 emissions in the USA, Germany, and Canada. Yu et al. (2021) employed the unbalanced panel data, revealing that China's provincial EPU increases firms' carbon emissions. Nakhli et al. (2022) used the Granger causality for the USA and concluded that there is a bidirectional causality between the EPU and CO_2 emissions. Sarwono (2022) examined banking performance in Far East Asia using the Fixed Effect Model on 89 stock exchange-listed companies and found that ESG used as a proxy for environmental sustainability, had a detrimental effect on banking performance. Wen & Zang (2022) used the difference-in-differences (DID) model for China and revealed that rising EPU causes industrial pollution to increase. Zhou et al. (2022) applied the cross-sectionally augmented autoregressive distributed lag (CS-ARDL) and augmented mean group (AMG) models for China, India, Japan, Russia, and the USA. They found that rises in EPU harm the environment in these countries. Sohail et al. (2022) applied the cross-sectionally-augmented nonlinear ARDL (CS-NARDL) for the USA, China, India, Russia, Japan, Germany, Canada, and South Korea. They concluded that positive shocks in EPU harm green economic growth.

On the other hand, Syed & Bouri (2022) used the bootstrap ARDL approach for the USA and revealed that high EPU reduces CO_2 emissions in the long run. Udeagha & Muchapondwa (2022) employed a cointegration test for South Africa and found that EPU harms ecological sustainability. Yang et al. (2023) employed the Fixed Effects Model for China, revealing that high EPU diminishes regional pollution. Barra & Falcone (2024) used a parametric approach and found that EPU reduces environmental inefficiency in South Asia. Muhammad Irfan & Yu Hao (2024) employed the autoregressive distributed lag (ARDL) model with bootstrap rolling window causality analysis for China. They found that economic policy uncertainty increases CO_2 emissions. Aslan et al. (2024) used the Moments Quantile Regression (MMQR) model for G7 countries and found that EPU reduces emissions at all quantile levels. Balsalobre-Lorente et al. (2024) used the FMOLS estimator for G20 and found that EPU reduces environmental pollution.

Borojo et al. (2024) used the Pooled Mean Group Autoregressive Distributed Lag estimator -PMG) for 25 emerging countries and found that EPU adversely impacts green growth (GG). Song et al. (2024) applied the STIRPAT (STochastic Impacts by Regression on Population, Affluence, and Technology) model for China and found that EPU increases CO_2 emissions.

2.2. EPU and social factors (S)

Ongan and Gocer (2017) used a panel unit root and cointegration test for the US housing market and found that increases in the EPU index decrease the Case Shiller index (home prices). Ongan and Gozgor (2018) utilized a cointegration test and found that one standard deviation increase in the EPU index leads to a more than 1% decrease in the number of Japanese tourist arrivals to the USA in the long run. Vandoros et al. (2019) used the ordinary least squares (OLS) approach for England and Wales and found that increasing EPU leads to a rise in suicide rates in these countries. Caggiano et al. (2020) employed the nonlinear vector autoregression (VAR) model for Canada and concluded that high EPU increases unemployment rates in this country. Isik et al. (2020) used a cointegration approach for the US tourism demand and found that EPU decreases tourist vacations to the USA from Mexico and Canada. Zhao et al. (2021) used multivariate analysis for China and concluded that rises in EPU restrain enterprises' social responsibility behaviors. Naidenova (2021) employed panel data analysis for the UK, Germany, France, Spain, and Italy and found that rises in EPU lowers the companies' human capital. Chen et al. (2022) used regression analysis for China and found that rising EPU lowers household consumption and non-durable goods spending. Alenezy (2022) used the error correction model (ECM) for Gulf Cooperation Council (GCC) countries and found that EPU widens the income inequality gaps in these countries. Farooq et al. (2023) utilized the fixed effects model, Driscoll and Kraay, and panel quantile regression analysis for 20 countries. They found that high EPU worsens income inequality (GINI index). Ou et al. (2023) used baseline regression for China and concluded that a rise in EPU diminishes business performance. Kebalo & Zouri (2024) used the generalized method of moments (GMM) estimator for 66 countries and found that EPU increases income inequality. Choi and Phi (2024) utilized the VAR model for the US and found that EPU increases labor income inequality through higher unemployment rates while simultaneously decreasing nonlabor income inequality by reducing business and interest income. Gomado (2024) utilized the OLS estimator for 61 developing countries and found that changes in uncertainty significantly reduce GDP per capita growth in different percentages in different countries.

2.3. EPU and governance factors (G)

Shi et al. (2020) used the panel data model for China and found that increasing EPU worsens the government's ability to enforce regulations and generates uncertainties in companies' operations. Iqbal et al. (2020) used the System-GMM estimation for US non-financial firms and found that EPU negatively impacts firm performance. Vural-Yavas (2021) employed fixed effect panel data estimation for 15 developed European countries and concluded that high EPU increases firms' governance performances. Ongsakul et al. (2021) used a baseline regression model for the USA and concluded that high EPU causes firms to strengthen their corporate governance by reducing their board sizes. Wang et al. (2022) used panel data, quantile regression, and Channel analysis for China and found a positive relationship between ESG disclosure and corporate sustainable growth. Darsono et al. (2022) used the panel ARDL model for some countries and the negative impacts of EPU on the returns of sustainable stocks in the long run. Qamruzzaman (2022) utilized the DF-GLS and Zivot–Andrew. ARDL bound test, nonlinear ARDL, and directional causal tests for India and Pakistan. They found that rises in EPU worsen the institutional quality in these countries. Asimakopoulos et al. (2023) applied the partial (incomplete) adjustment model for 135,059 US firms. They revealed that high EPU forces companies to increase compliance speed due to increasingly stringent financing requirements. Hoang et al. (2022) used panel regression for UK non-financial firms and found that EPU increases the firms' corporate social responsibilities. Cakir & Ova (2024) used panel data methodology for BRIC countries and found that EPU negatively impacts profitability through the institutional quality channels at the macro level. Ilyas et al. (2024) used the Generalized Method of Moments (GMM) for 2,017 US. Firms found that high EPU increases the firms' corporate social responsibilities. Chen and Masron (2024) used various estimation techniques for China and found that EPU worsens corporate challenges by intensifying financial constraints and amplifying risks in specific types of firms. Huang et al. (2024) conducted the heterogeneity analysis for China and found that the positive effect of EPU on corporate ESG disclosure is more significant in state-owned enterprises. Wu et al. (2024) used a baseline regression model for China and found that EPU has a relatively weak effect on internal governance performance.

3. EMPIRICAL MODEL-METHODOLOGY

To construct the composite ESGUI (ESG-based sustainability uncertainty index), we first measure ESG and uncertainty sub-indices in the following forms.

3.1. Measuring ESG sub-index

To construct the ESG sub-index for each sample country listed at the end of the study, we build the environmental index (E), social index (S), and governance index (G) separately and respectively derived from the specific selected keywords (indicators) that represent E, S, and G factors in Table 1. The reports in PDF format were made searchable by scanning the keywords using the Fitz module of the PyMuPDF library in NLP (Natural Language Processing). Then, using the NLTK (Natural Language Toolkit) library from NLP, stop words such as "the, in, and, or" that are not important for text analysis were removed from the text file. We explored advanced NLP approaches like LDA (Latent Dirichlet Allocation) and BERT (Bidirectional Encoder Representations from Transformers); however, we opted for a transparent, keyword-based method using PyMuPDF and NLTK, as advanced models posed interpretability challenges and risked diluting the specificity of ESG-related findings.

The rationale for country selection is as follows. Sustainability is a global issue that affects both developed and developing countries. In this study, we aimed to include as many countries as possible and analyze the most extended available observation period. Based on the regularity of reports from the Economist Intelligence Unit's (EIU) monthly country reports, we selected 25 countries. These countries were chosen because they provided comprehensive data and extended observation periods.

TABLE 1 E, S, and G related keywords (indicators)

Environment (E)	Social (S)	Governance (G)
Acid, Agriculture, Biodiversity, Carbon, Clean, CO2, Conservation, Deforestation, Depletion, Drought, Ecofriendly,	Agility, Career, Charitableness, Collaboration, Communication, Conscience, Corruption, Crime,	Accountability, Adaptability, Agility, Audit, Autonomy, Board, Coherence, Collaboration, Communication, Compensation, Compliance,

Ecology, Emission, Energy, Erosion, Flood, Footprint, Fossil, Geothermal, Green, Greenhouse, Hydro, Landfill, Methane, Microplastics, Monoxide, Natural, Noise, Oil, Organic, Overconsumption, Overfishing, Overpopulation, Ozone, Pesticide, Plastic, Poison, Pollution, Radiation, Recycling, Renewable, Resources, SO2, Smog, Soil, Solar, Storm, Sustainability, Toxicity, Trash, Waste, Wastewater, Wind energy.	Culture, Dialogue, Discrimination, Donation, Donations, Elderly, Empathy, Employment, Entrepreneurship, Equal, Female, Flexibility, Freedom, Gender, Harassment, Harmony, Honesty, Humanity, Innovation, Integration, Mentorship, Morality, Participation, Profession, Respect, Responsibility.	Consistency, Corporate, Culture, Corruption, Data, Protection, Decisions, Diligence, Diversity, Efficiency, Ethics, Evaluation, Fairness, Leadership, Legitimacy, Meritocracy, Objectivity, Oversight, Performance, Principle, Prudence, Quality, Reciprocity, Relations, Reliability, Resilience, Responsibility, Risk, Stakeholders, Stewardship, Strategy, Sustainability, Transparency.

Note: Keywords were selected based on a review of ESG and sustainability literature comprised of various studies, as shown in Section 2 of the study.

These keywords (indicators) are monitored and scanned from the Economist Intelligence Unit's (EIU) monthly country reports. In constructing E, S, and G indices, we divide the total keyword frequencies for each E, S, and G by the total number of words per EUI report and get the row monthly E, S, and G indices.

$$Environmental\ index\ (E) = \frac{Total\ keyword\ frequencies\ for\ E}{Total\ number\ of\ words\ per\ EUI\ report} \quad (1)$$

$$Social\ Index\ (S) = \frac{Total\ keyword\ frequencies\ for\ S}{Total\ number\ of\ words\ per\ EUI\ report} \quad (2)$$

$$Governance\ index\ (G) = \frac{Total\ keyword\ frequencies\ for\ G}{Total\ number\ of\ words\ per\ EUI\ report} \quad (3)$$

These indices were standardized according to the method described by Ahir et al. (2022). The relevant words were divided by the total number of words in the report. Following the approach of Dang et al. (2023) and Chung et al. (2022), the values were scaled to ensure that the maximum value is 100 and the minimum value is 0, as shown in the following form.

$$X_{norm} = [(X - X_{min})/(X_{max} - X_{min})\ ] * 100 \quad (4)$$

In the Data Science literature, this is called a Min-Max Scaler, and especially when there are 1 and 0 values in the series, the Min-Max Scaler can preserve these values better. In our study, it was thought that it would be more appropriate to use the Min-Max Scaler method since the series occasionally had 0 values.

To obtain the following composite ESG sub-index in Eqn. 5, we sum the environmental index (E), social index (S), and governance index (G) from Eqns. 1, 2, and 3, equally:

$$ESG\ sub - Index\ (ESG) = \frac{1}{3}E + \frac{1}{3}S + \frac{1}{3}G \quad (5)$$

3.2. Measuring uncertainty sub-index (UI)

To construct the uncertainty sub-index (UI) for each sample country, we follow the same instructions as we did for E, S, and G in Eqns. 1, 2, and 3 involve monitored monthly reports for specific keywords such as "Uncertain," "Uncertainty," and "Uncertainties," as suggested by Ahir et al. (2022) in their WUI index:

$$Uncertainty\ sub\ sub - \ Index\ (UI) = \frac{Total\ keyword\ frequencies\ for\ U}{Total\ number\ of\ words\ per\ EUI\ report} \quad (6)$$

Finally, to obtain the *ESG-based sustainability uncertainty index* (ESGUI) for each sample country in Eqn. 7, we add the ESG sub-index in Eqn. 5 to the uncertainty sub-index (UI) in Eqn.6 equally $(\frac{1}{2})$ in the following form:

$$ESGUI = \frac{1}{2}\ ESG\ Index + \frac{1}{2}UI \quad (7)$$

The global ESGUI index (global-ESGUI) is calculated based on the ESGUI indices of 25 sample countries between 2002M11 and 2024M09. Two methods are used for calculation: equally weighted and GDP-weighted. The equally weighted index was calculated by taking the arithmetic average of the countries' values (assuming each country has equal weight). The GDP-weighted index shows the global index obtained by multiplying (weighting) the index value of each country by the share of that country's GDP in the total GDP value of this country basket (GDP-country-i / GDP-total-of 25 countries) in the relevant t period.

The methodological advantages of evaluating and computing ESG components separately, as seen in Equations 1, 2, and 3, can be listed as follows:

(i) Researchers who need and use only the environmental (E)-based sustainability uncertainty index (EUI) in their models will be able to use only the EUI index (EUI = $\frac{1}{2}\ E + \frac{1}{2}UI$).

(ii) Researchers who need and use only the social (S)-based sustainability uncertainty index (SUI) in their study models will be able to use only the SUI index (SUI = $\frac{1}{2}\ S + \frac{1}{2}UI$).

(iii) Researchers who need and use only the governance (G)-based sustainability uncertainty index (GUI) will be using only the GUI index (GUI = $\frac{1}{2}\ G + \frac{1}{2}UI$).

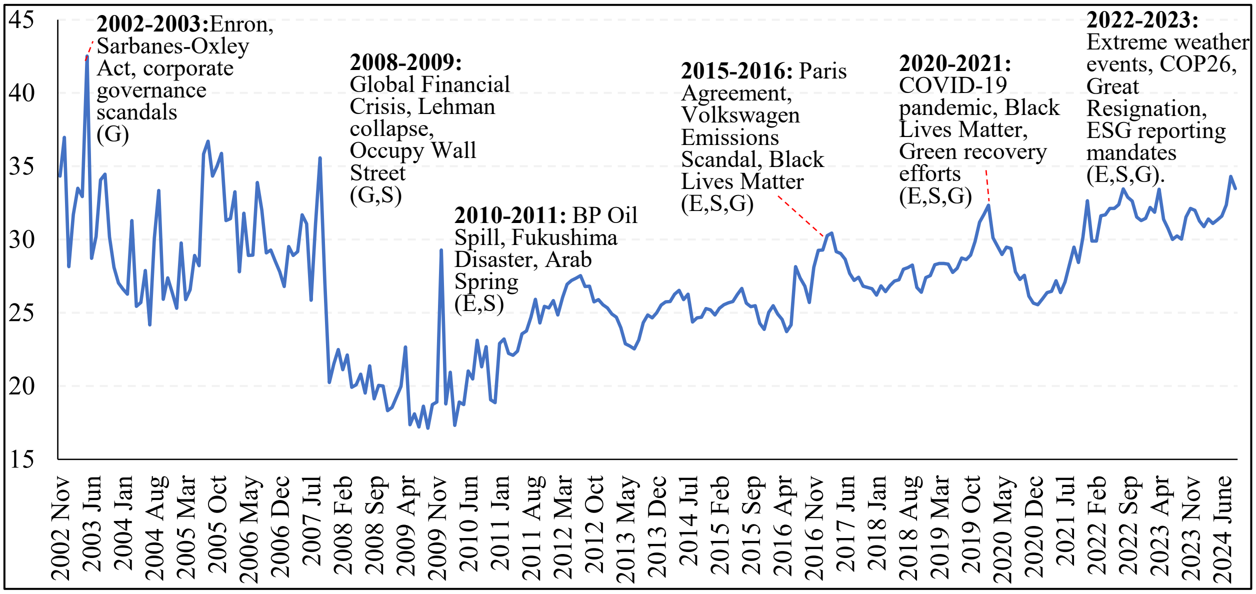
(iv) Researchers working on sustainability, defined through the whole of ESG, will also be able to use composite ESGUI in their models. Therefore, this method would expand the index usage in various subjects by contributing to the relevant literature separately through E, S, G, and ESG.

4. EMPIRICAL FINDINGS

This section of the study compares the ESGUI, developed in this study, with other uncertainty indices to assess the robustness of our index. Additionally, it provides some macroeconomic impulse-response functions in ESGUI based on the standard VAR (vector autoregression) model. The Cholesky forecast-error variance decomposition (FEVD) test results are also provided.

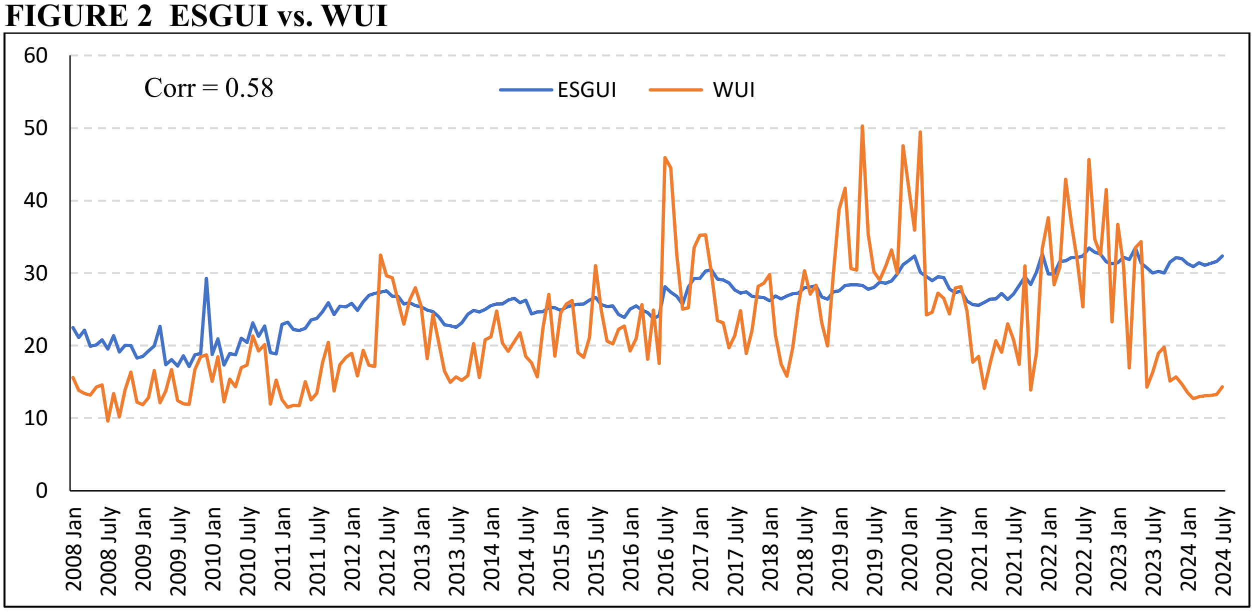
Figure 1 shows significant fluctuations in our equal-weighted global ESGUI, with numerous significant spikes and drops from 2002M11 to 2024M9. We observed correlations between our index and various major global events.

FIGURE 1 ESGUI and potential ESG-based events caused fluctuation in global ESGUI



For the robustness of our index, ESGUI is compared to other measures of uncertainties, such as Ahir et al. (2022)'s World Uncertainty Index (WUI) in Figure 2, Dang et al. (2023)'s Energy-Related Uncertainty Index (EUI) in Figure 3, and Baker et al. (2016)' EPU index in Figure 4.

FIGURE 2 ESGUI vs. WUI

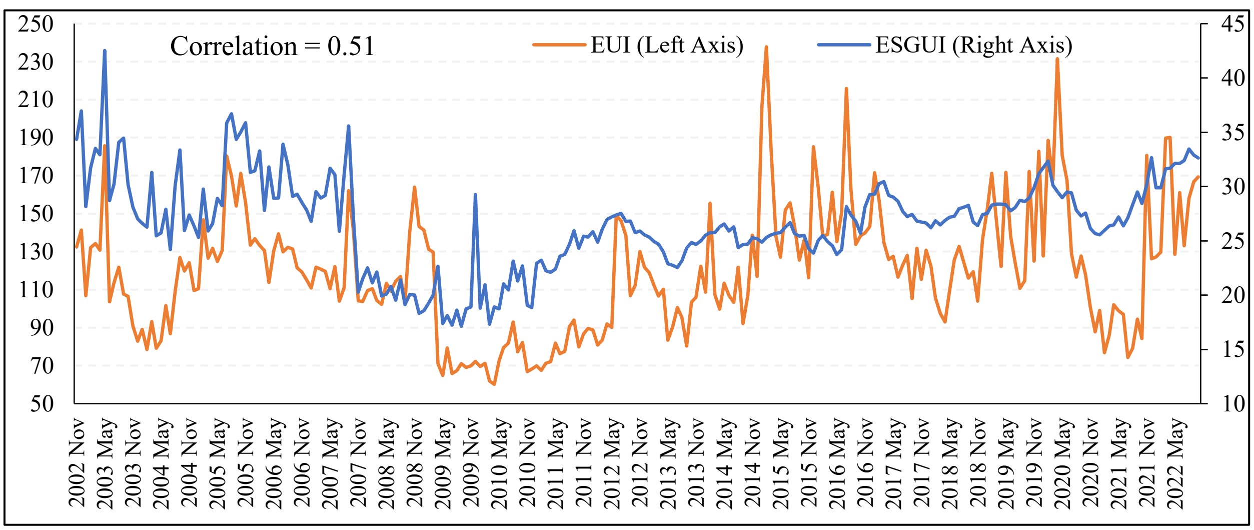


Note: For comparability, this figure is based on the dates of the WUI study developed by Ahir et al. (2022). In addition, the average of the data from 25 countries included in our study, among the countries included in the same study, was used.

WUI is an index based on general uncertainty expressions such as "uncertainty," "uncertainty," and "uncertainties," and it takes a broad approach to measuring global uncertainties. ESGUI focuses on more specific environmental, social, and governance (ESG)-based uncertainties. However, they move in parallel, indicating that both indices accurately capture key economic and market uncertainties. This proves that ESGUI is also related to general uncertainties and is not limited to ESG only.

Figure 2 shows a relatively high correlation between ESGUI and WUI. The differences between the fluctuations of the two series may be due to differences in the method used to read and make the reports in PDF format. While Ahir et al. (2022:8) used Optical Character Recognition (OCR) for this process, we utilized the Fitz module of the PyMuPDF library in NLP, making reports in PDF format searchable. We observed that the PyMuPDF library for NLP, specifically developed for text mining, produced more accurate results in this area. We recommend that future researchers also use the PyMuPDF library from the NLP method. The trends of ESGUI and EUI are shown in the following Figure 3.

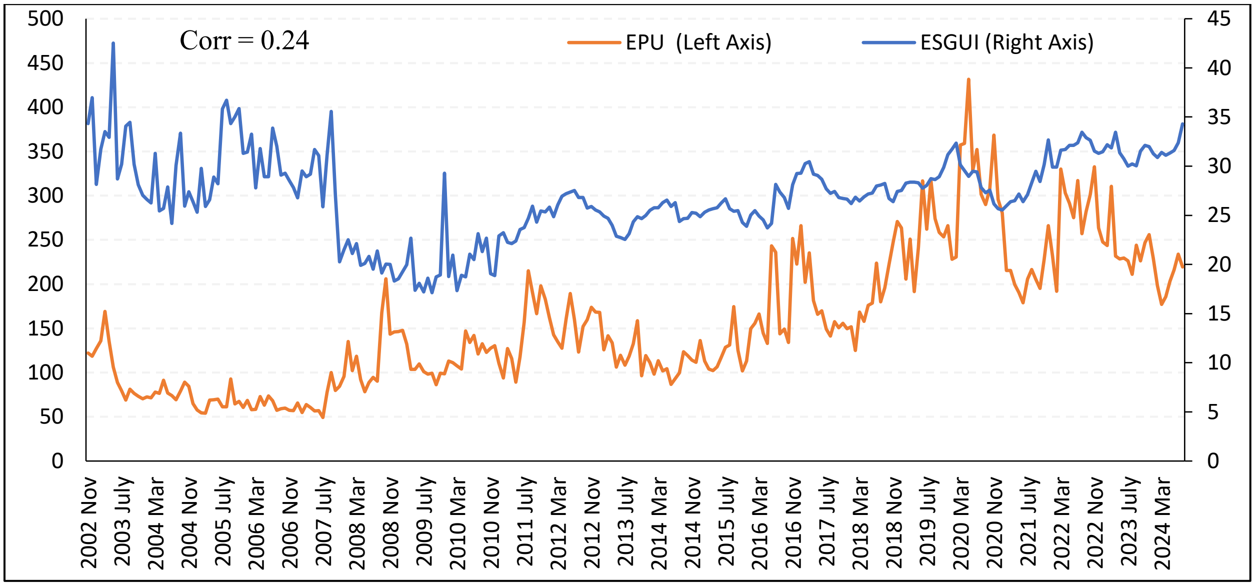
FIGURE 3 ESGUI vs. EUI



Note: This figure is based on the dates of the Energy Uncertainty Index (EUI) study developed by Dang et al. (2023). Since the ESGUI and EUI series have different scales, a dual axis was used.

While ESGUI focuses on sustainability and ESG factors, EUI addresses energy-related uncertainties. However, both indices exhibit parallel movements in specific periods, indicating they accurately capture market and economic uncertainties. Moreover, both ESGUI and EUI respond to global events (e.g., financial crises, oil price shocks, geopolitical tensions, climate disasters). Such events impact both indices, suggesting that ESGUI can capture significant market risks like EUI. Shortly, ESGUI includes not only energy uncertainties but also broader ESG factors such as climate change, social governance, and regulatory changes. This can be interpreted as the ESGUI accurately reflecting general uncertainties in the market by providing a more comprehensive risk assessment. The ESGUI and EPU comparison is presented in Figure 4.

FIGURE 4 ESGUI vs. EPU



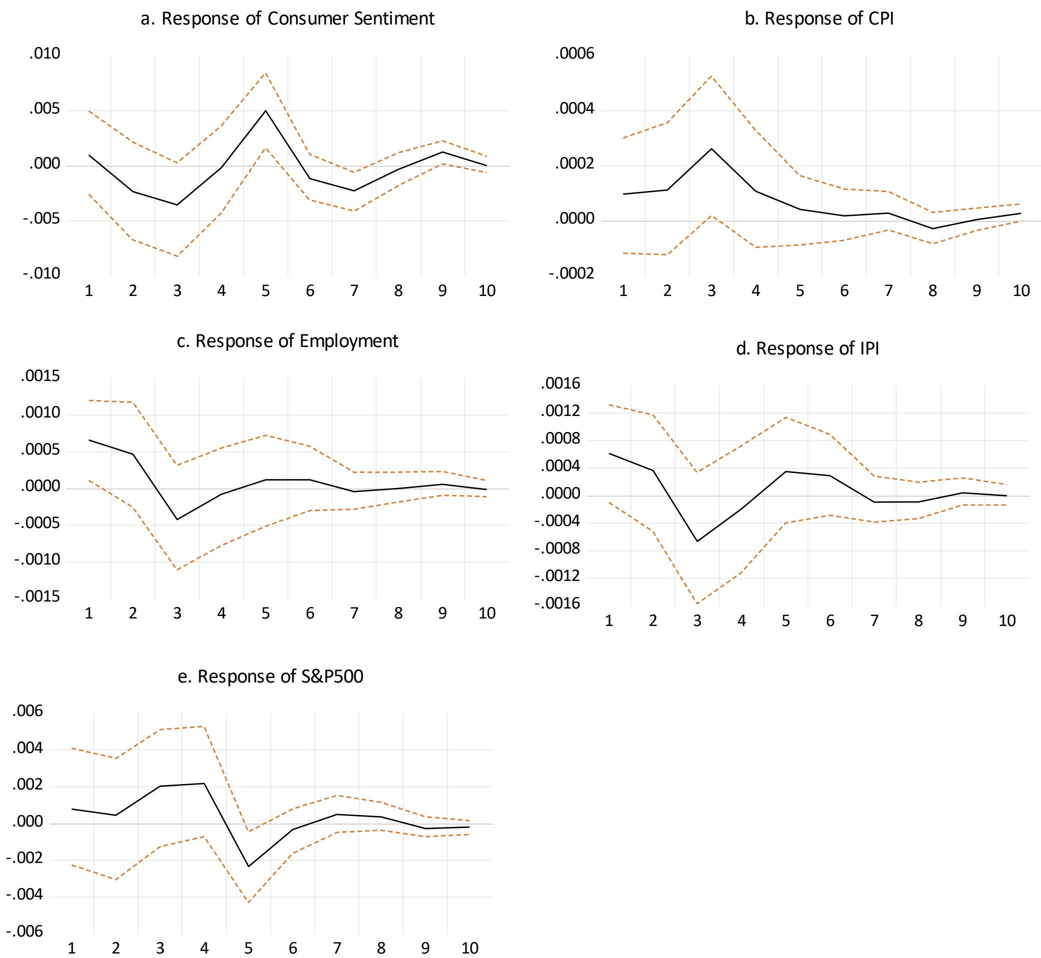
Note: Since the ESGUI and EPU series have different scales, a dual axis was used.

When comparing the ESGUI and EPU indices, it is observed that, despite focusing on different themes, they generally move in parallel. However, in some periods, the correlation is low. This may be because ESG-related uncertainties have different dynamics than economic policy uncertainties. In particular, ESG risks are based on long-term sustainability and environmental factors, whereas EPU may be linked to shorter-term economic policies (response delays). Another possible reason may be the nature of the data sources and the methodology used. ESGUI is produced from the Economist Intelligence Unit (EIU)'s monthly country reports, while EPU is compiled from 10 large US newspapers. While EPU focuses on economic policy uncertainty-related keywords (e.g., “economic” or “economy”; “uncertain” or “uncertainty”; and one or more of “congress,” “deficit,” “Federal Reserve,” “legislation,” “regulation,” or “White House”), ESGUI focuses on environmental (E), governance (G), and social (S) topics and uncertainty related to these topics.

Additionally, comparatively, one reason the correlation between ESGUI and EPU is lower than the correlations between ESGUI and WUI and ESGUI and EUI may be that while ESGUI, WUI, and EUI use the same data source, the Economist Intelligence Unit (EIU)'s monthly country reports, EPU uses newspapers.

Following the comparison of ESGU with WUI, EUI, and EPU, we conducted standard VAR analysis using US data for 2002M11-2024M07 to examine the model-implied responses of some macroeconomic variables such as consumer sentiment, consumer price index (CPI), employment, industrial production index (as proxy of GDP), and S&P500 in ESGUI. The impulse-response functions are shown in Figure 5.

FIGURE 5 Responses of macroeconomic factors to a shock in the ESGUI.



Note: The impulse-response functions are estimated using standard VAR, with 90% confidence intervals.
We used IPI as a proxy of GDP at monthly frequency to obtain more detailed results.

According to Figure 5, consumer sentiment and employment respond to an increased shock in ESGUI by decreasing, while CPI responds by increasing. The responses of IPI and S&P500 are not statistically significant. The confidence intervals (represented by the dashed lines) completely cover the y = 0 line, indicating that the effect is not statistically significant.

The Cholesky forecast-error variance decomposition (FEVD) test was applied to determine how much of a variable's forecast error variance is due to shocks to other variables. The test results are reported in Table 2.

TABLE 2 Cholesky forecast-error variance decomposition test results.

Month	Consumer Sentiment	CPI	Employment	IPI	S&P500
1	0.000	0.000	0.000	0.000	0.000
2	0.008	0.240	0.097	0.353	0.038
3	0.023	0.392	0.238	0.581	0.142

4	0.032	0.394	0.243	0.571	0.249
5	0.037	0.402	0.341	0.606	0.492
6	0.112	0.425	0.341	0.610	0.501
7	0.124	0.429	0.342	0.617	0.509
8	0.143	0.432	0.345	0.621	0.537

The Cholesky forecast-error variance decompositions (FEVDs) in Table 2 show that a single shock in ESGUI can explain nearly 0.14% of the variance in consumer sentiment, 0.43% of the variance in CPI, 0.34% of the variance in employment, 0.62% of the variance in IPI, and 0.53% of the variance in S&P500 in the eighth month. The results indicate that shocks in the US Environmental, Social, and Governance Uncertainty Index (ESGUI) slightly affect US macroeconomic variables. ESGUI specifically focuses on sustainability-related uncertainties, which may have a limited impact on broader macroeconomic indicators. The percentages observed suggest that the ESGUI can indirectly influence various macroeconomic metrics. For example, indicators such as the Consumer Price Index (CPI), employment rates, and the Industrial Production Index (IPI) are affected not only by sustainability concerns but also by other factors, including energy prices, trade balances, monetary policies, and sectoral dynamics within the US economy. The relatively low percentages reflect the complex nature of these variables and are considered normal and expected in this context.

5. CONCLUSIONS

Policymakers and investors have recently begun focusing more on ESG-based uncertainty risks and opportunities than traditional financial risks, in line with their increasing importance in the modern business world and investment processes. This study reveals that the new ESG-based Sustainability Uncertainty Index (ESGUI), developed in this study, is a critical tool for measuring the economic and financial consequences of environmental, social, and governance-related uncertainties. Unlike existing uncertainty indices, ESGUI specifically focuses on ESG-considered factors and examines how uncertainties in these areas are reflected in markets and investment decisions. The fact that this new index moves in parallel with broader uncertainty indices such as the WUI, EPU, and EUI demonstrates its ability to capture both broad economic uncertainties and accurately represent specific ESG risks. As a result, ESGUI provides a reliable guide for policymakers to strengthen sustainability policies and for investors to assess ESG risks.

5.1. Study limitations and future studies

One limitation of the study is that the selected keywords used in creating the ESGUI may not comprehensively capture all ESG-related uncertainties, as it is based only on specific sources and words. It would be helpful for future studies to use different ESG data sources to compare the results. Although sustainability is a global issue impacting both developed and developing countries, ESG-related uncertainties may manifest differently in different geographies. More specifically, it would be valuable to examine how this new index performs in developing countries compared to developed countries. Furthermore, future studies aimed at improving ESGUI should explore its effects on a sectoral basis and reveal which sectors are more affected by ESG uncertainties. An in-depth analysis of the dynamics of ESG uncertainties, especially in the energy, finance, and technology sectors, can expand the scope of this index. All of the above can be considered limitations of the study within the framework of this constitutive index. Future studies should aim to address these limitations to gain a deeper understanding of the index's applicability within the literature.

Sample Countries:

The Study's sample countries, which include a diverse range of economies and social structures, are Australia, Belgium, Brazil, Canada, Chile, China, Colombia, France, Germany, Greece, India, Ireland, Italy, Japan, Mexico, Netherlands, Pakistan, Russia, Singapore, South Korea, Spain, Sweden, the UK, the USA, and Vietnam.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The ESGUI series, generated by the authors Ongan, Serdar, Gocer, Ismet, and Isik, Cem, is available at https://www.policyuncertainty.com

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