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*Original Article*

# Differential Impacts of ESG Investing on Emissions: A Comparative Time-Series Analysis of the US and India (2000–2023)

Shravan Harish

*Singapore American School.*

*Corresponding Author : shravan.hsv@gmail.com*

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***Abstract -*** *Environmental, Social, and Governance (ESG) investing has emerged as a popular strategy to align financial decisions with sustainability goals in the face of climate change and rising emissions. However, the actual effectiveness of ESG investing in reducing greenhouse gas emissions remains debated. This study examines the relationship between ESG-related factors and emissions in two distinct economies—the United States, a developed country, and India, an emerging one—over the period 2000–2023. Using time-series data and the Autoregressive Distributed Lag (ARDL) model, the research explores both short- and long-term effects of renewable energy investment, healthcare spending, and governance quality on emissions. In the US, results suggest that healthcare spending contributes modestly to emission reductions over time, while economic growth increases emissions. Interestingly, stronger governance in the short term is associated with rising emissions, possibly due to growth-oriented policies or initial costs of cleaner technologies. In India, renewable energy investment increases emissions in the short term, likely due to infrastructure development. However, healthcare spending, manufacturing output, foreign investment, and trade are associated with short-term emissions reductions, reflecting efficiency and technology use gains. Over the long term, trade and governance correlate with rising emissions, while manufacturing continues to mitigate them. The findings highlight that ESG outcomes are shaped by a country's development context, infrastructure maturity, and policy frameworks. While ESG factors can promote emission reductions, their overall effectiveness is contingent upon targeted, well-implemented strategies. The study underscores the need for context-specific ESG policies to ensure meaningful progress toward climate goals.*

***Keywords -*** *ESG Investment, Greenhouse Gas Emissions, ARDL, Renewable Energy.*

## 1. Introduction

ESG investing, short for environmental, social, and governance, is a method of investing that considers financial returns and looks at how businesses impact the planet, treat their workers and communities, and govern themselves. What started as a means for individuals to bring investments in line with sustainability and their principles has expanded into a larger movement that is influencing our economy today. When governments and institutions invest with ESG factors in mind, they help generate sustainable business models, reduce climate risks, and improve corporate accountability. ESG investing goes beyond personal decisions and is becoming a tool that supports greener and fairer businesses, thus ensuring a more accountable economy.

Today, investments in these metrics have picked up at a rapid pace. For example, the UK has significantly increased its focus on green finance through its updated Green Finance Strategy. The strategy estimates that an additional $50-60 billion is needed to meet the UK's net zero targets, showing the involvement in sustainable initiatives [1]. Furthermore, ESG frameworks are becoming more and more common in government policymaking and corporate regulations. The SEC (Securities and Exchange Commission) has proposed climate risk disclosure rules, requiring publicly traded companies to report their overall carbon emissions and ESG-related financial risks [2]. This rapid growth in the use of ESG, and overall ESG investment as a metric to measure the growth in certain aspects of an economy and a country, shows that sustainability is becoming an increasingly central priority for national policy.

The 2015 Paris Agreement aimed to limit warming to well below 2°C, planning to try to remain at 1.5°C or below pre-industrial levels [3]. This was to be achieved by nations developing national climate plans of action that, as ever, would entail massive investments. ESG investments aim towards such goals by mobilizing funds into state projects that

together reduce carbon footprints and remain true to the Paris agreement. Furthermore, during the COP-26 convention in 2021, global leaders solidified the role of ESG investment by committing to action such as the Global Methane Pledge, where over 150 countries signed up to reduce methane production by 30% by 2030 [4].

Yet, a question has sparked growing debate among policymakers, investors, and environmental advocates: Does ESG investment actually impact our overall sustainability? Or is it just a form of financial rebranding with no actual impact?

A study explored the relationship between a country's ESG performance and its Greenhouse Gas (GHG) emissions, with a focus on the impact of environmental policy stringency. It employs panel data from 41 countries between 1990 and 2010 to analyze how national ESG performance influences emission reductions. The results show that there is a strong negative correlation between improving environmental performance and reducing GHG emissions. In contrast, improvements in social performance (such as education and public health) were found to correlate with an increase in GHG emissions.

The study also notes that more developed countries (especially OECD members) tend to benefit more from stringent environmental policies due to their superior economic development, better governance, and more efficient policy implementation. In contrast, non-OECD countries exhibit weaker links between ESG performance and emission reductions, likely due to resource and governance constraints [5].

A second study focuses on firm-level ESG performance in the United States from 2005 to 2018. This research critically evaluates whether higher ESG scores, particularly environmental ratings, lead to actual reductions in carbon emissions. Using carbon intensity (emissions per unit of revenue) as the primary dependent variable, the authors found little evidence of a causal link between strong ESG scores and low emissions.

Instead, they discover that their results indicate that firms with high ESG scores would more likely resort to "cheap talk," signalling intentions towards sustainability through the vehicle of public relations activities but without actually changing the carbon footprint of their operations [6].

Another study examines the impact of environmental, social, and governance investment on carbon emissions in different regions of China. With the use of panel regression analysis of firm-level 2014-2019 data, this study follows the direct and indirect influences of ESG investment on environmental performance. The findings indicate that green investments, such as spending in clean technology and infrastructure that is low-carbon, boosted carbon productivity in the eastern region of the nation, allowing for greater economic output per unit of $CO_2$ emitted. On the other hand, in the central and western areas, ESG investment had a direct relationship that led to the reduction of absolute $CO_2$ emissions and emissions intensity (emissions per unit of GDP), which corresponds to the region's lower economic base and greater need for the environment to improve [7].

Similarly, another study examined Latin American firms and how ESG performance relates to corporate greenhouse gas emissions. ESG practices are recognized to capture the broader sustainability ambitions of a company, such as environmental management, social responsibility, and governance frameworks.

The performance of ESG is quantified in this study using overall scores and further disaggregated into the three ESG pillars to determine their individual and collective impacts on firms' emission performance. These findings suggest a positive relationship between higher ESG scores and improved GHG emissions scores, indicating that companies with stronger ESG commitments are normally more effective at mitigating carbon emissions.

The environmental pillar, in particular, plays a central role, but social and governance factors also contribute with more complex and sometimes weirder effects. For instance, improvements in social performance may increase emissions due to the expansion of infrastructure or services. This can show how Latin America plays a crucial unique context, as it is a place where environmental regulation is weak, and companies play critical roles in mitigating and managing GHG emissions in high-emitting sectors [8].

Though ESG investing has gained immense popularity globally, a prominent gap exists in the literature regarding how its effect differs in economic and policy settings. Most of the literature is concentrated on firm-level processes, with hardly any room for comprehending how ESG mechanisms operate at the macroeconomic level among emerging economies. Furthermore, although the environmental dimension of ESG has been associated with quantifiable decreases in carbon emissions, the social and governance dimensions have weaker links to emission results, especially in nations with low policy implementation capacity.

Contrasting developed and emerging economies can help reveal interesting differences in how country-level ESG investment plays out in practice on climate matters. Thus, this study aims to cross the literature gap and analyze the impact of ESG investment on GHG emissions across two contrasting economies, the United States and India.

By applying an Autoregressive Distributed Lag (ARDL) model to time series data from 2000 to 2023, the research examines both short-run and long-run relationships between ESG variables and national emission trends.

## 2. Methodology

### *2.1. Aim of the Study*

This paper aims to explore the role of ESG investing in reducing Greenhouse Gas (GHG) emissions, focusing specifically on two distinct economies: the United States of America, as a representation of a developed market, and India, as an emerging market. The main objective is to analyze how ESG investments are influencing emission reduction within each country for the time period 2000 to 2023. By doing so, this paper will give us insight into whether ESG investing can serve as a viable tool for achieving global climate targets, and whether its effectiveness changes based on the stage of economic development and policy landscape in different regions. This study sets out to investigate whether ESG investment significantly influences Greenhouse Gas (GHG) emissions in both the United States and India. It seeks to assess how the individual components of ESG contribute to emission outcomes, and whether these effects differ across a developed and an emerging economy.

### *2.2. Data and Variables*

Our study uses secondary, time series data from 2000 to 2023 for both India and the United States. "Secondary" refers to data that was originally collected by other institutions, such as the World Bank, but repurposed here for analysis. "Time series" means that the data consists of observations of the same variables recorded at regular time intervals (in this case, annually from 2000 to 2023). The two countries, India and the United States, were deliberately chosen to allow for a comparative analysis between an emerging economy (India) with evolving ESG frameworks and an advanced economy (the United States) with more established ESG frameworks. These opposite economies represent how ESG investment performs under differing developmental, regulatory, and economic contexts. The study period has been chosen to understand the past two decades during which ESG was initially introduced. Over this period, climate change has rapidly increased, and the understanding of sustainable finance and climate awareness has skyrocketed.

**Table 1. Variables of the study**

| Variable Type | Variable | Symbol | Description | Data Source |
|---|---|---|---|---|
| Dependent Variable | Greenhouse Gas Emissions | GHG | Logarithm of Greenhouse Gas Emissions ($CO_2$ per metric ton) | EDGAR, European Commission [9, 10] |
| Independent Variables | Environmental Investment | REI | Logarithm of Investment in Renewable Energy as a % of GDP | US: BloombergNEF and UNEP<br>India: UNEP and IEEFA<br>[11, 12, 13, 14, 15] |
| | Social Investment | CHE | Government spending in healthcare (% of GDP) | World Bank Database<br>[16, 17, 18, 19] |
| | Governance Investment | WGI | Worldwide Governance Index - measures institutional quality and regulatory control (standardized score) | World Bank Database<br>[20] |
| Control Variables | Economic Growth | GDPGR | Reflects economic activity (% annual growth) | World Bank Database<br>[21] |
| | Manufacturing Output | MOP | Logarithm of Manufacturing Output ($) | US: Bureau Of Economic Analysis (BEA)<br>India: Macrotrends<br>[22, 23, 24, 25] |
| | Foreign Direct Investment | FDI | Logarithmic Transformation of FDI displays international capital influence ($) | US: World Bank Database<br>India: Macrotrends<br>[26] |
| | Trade Volume | TRADE | Trade (% of GDP) | US: World Bank Database<br>India: Macrotrends [27, 28] |

### *2.3. Model Specification and Diagnostics*

To begin the analysis, the study tested the stationarity of each variable using the Augmented Dickey Fuller (ADF) test. An important step in time series analysis is checking whether the variables are stationary. Stationarity is the idea that a variable's statistical properties remain constant over time. This is important because most time series models, including the Autoregressive Distributed Lag (ARDL) model used in this study, assume that the underlying data are either stationary at level 0 or become stationary after differencing to level 1. If a variable is non-stationary and not properly transformed, the model could produce false results, meaning relationships may appear statistically significant when they are actually not.

**Table 2. Augmented Dickey Fuller (ADF) Stationarity Tests (Level)**

| Variable | P value (US) | | P value (India) | |
|---|---|---|---|---|
| | Level | First Difference | Level | First Difference |
| GHG | 0.6753 | 0.0000*** | 0.5255 | 0.0090*** |
| REI | 0.0284** | - | 0.0048*** | - |
| CHE | 0.4472 | 0.0000*** | 0.8239 | 0.0010*** |
| WGI | 0.5857 | 0.0000*** | 0.5979 | 0.0000*** |
| GDPGR | 0.0001*** | - | 0.0008*** | |
| MOP | 0.0003*** | - | 0.0140** | - |
| FDI | 0.0003*** | - | 0.0044*** | - |
| TRADE | 0.1445 | 0.0001*** | 0.2108 | 0.0036*** |

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

For both countries, results showed that all variables were either stationary at the level or at first difference, with none requiring second differencing. For example, India's GHG emissions (GHG) were non-stationary at the level ($p = 0.5255$) but became stationary when differenced (GHG1, $p = 0.0090$). Similar patterns were found for variables like CHE and WGI, where stationarity was achieved after the first difference. The ARDL model was then used to estimate both short-run and long-run relationships between GHG emissions and the variables. Two separate ARDL models were specified, one for India and one for the USA, with the log of GHG emissions (GHG) as the dependent variable in both. The ARDL output includes both short-run coefficients, which capture the immediate year-to-year effects of changes in variables (e.g. D.REI, D.CHE), and long-run coefficients, which show the relationship when variables adjust over time. In summary, by making sure the data met stationarity requirements using the Dickey-Fuller test and applying an ARDL model, the study was able to estimate how ESG-related investments and governance factors affect GHG emissions across two very different countries and contexts.

## 3. Results and Discussion

This section presents the results and discussion of the paper, focusing on the trends and findings that show the relationship between ESG investment and Greenhouse Gas (GHG) emissions in the United States and India over the period 2005 to 2025. It begins with a trend analysis of key variables—GHG emissions, Renewable Energy Investment (REI), Current Health Expenditure (CHE), and governance indicators (WGI). Visual trend graphs have been constructed to examine the historical patterns in key dependent and independent variables. These trends provided initial explanations for the possible relationships and helped identify any visible structural breaks or massive shifts.

### *3.1. Trend Analysis*

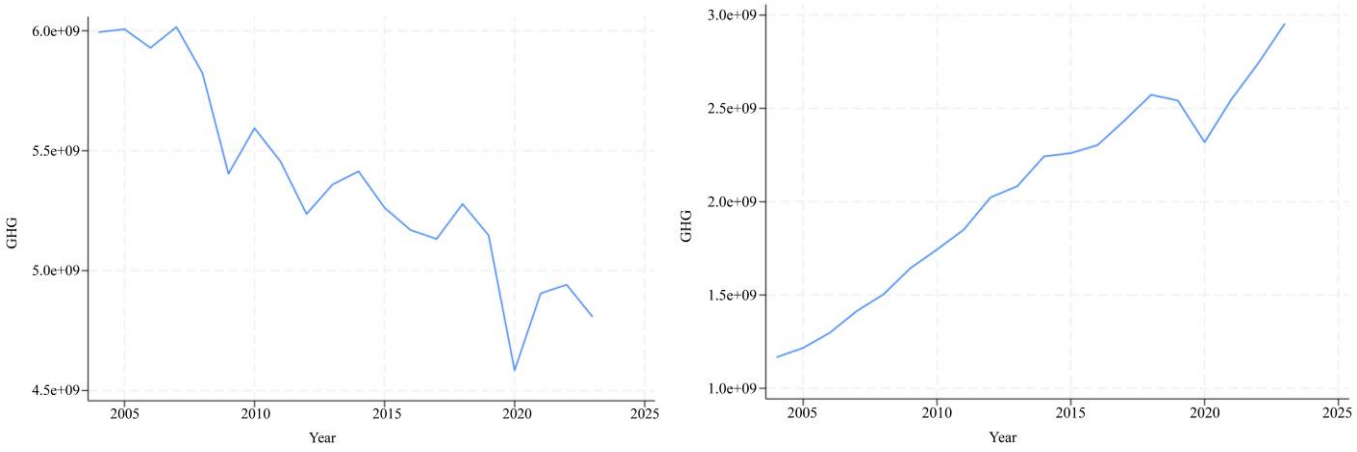
Overall, the total gross greenhouse gas emissions in the United States from 2004 to 2025 showed a decreasing trend. There have been some volatile changes, yet the total emissions have shown a decrease over this period. One of the reasons for the major drop in GHG, especially in 2020, could have been the Coronavirus pandemic. The strict measures implemented to curb the virus led to a significant slowdown in economic activity, reducing greenhouse gas emissions, particularly lowering atmospheric CO2 levels [29]. Another year where GHG emissions took an overall large decrease (Figure 1a) was 2009, when CO2 levels dropped due to the financial recession, which led to a decrease in industrial production and overall energy use [30].

On the other hand, India has seen a large uptake in GHG emissions (Figure 1b) (CO2 per million metric tons), as India is still industrializing. There have not been any sharp falls, except during covid, where the amount of CO2 in metric tons fell by a large amount. However, this is in accordance with the US, where the coronavirus pandemic is the most likely cause [31]. The main reason that emissions in India are growing is due to population growth. Since India is still a developing nation, it rely heavily on fossil fuels to support their growing infrastructure. In fact, India holds 18% of the world's population but only houses 2.4% of the total land area, thus putting a major strain on India's natural resources [32].

REI in the US has seen multiple significant rises and falls—the largest of which, during the year 2010, was when the investment in renewable energy shot up significantly. One of the driving factors of this was the American Recovery and Reinvestment Act (ARRA) of 2009. The ARRA allocated over 90 billion dollars to "lay the foundation for a clean economy" [33]. Furthermore, the 2015 rise (Figure 2a) is most likely because of the tax credits laid out by Congress for wind and solar energy. In December 2015 (when the huge spike started), Congress extended the production and investment tax credits, benefiting solar and wind energy. This caused renewable energy investment to rise sharply. [34]. Finally, the reason for the large drop from around 2017 to 2021 could be policy shifts. Around 2017, the newly inaugurated Trump

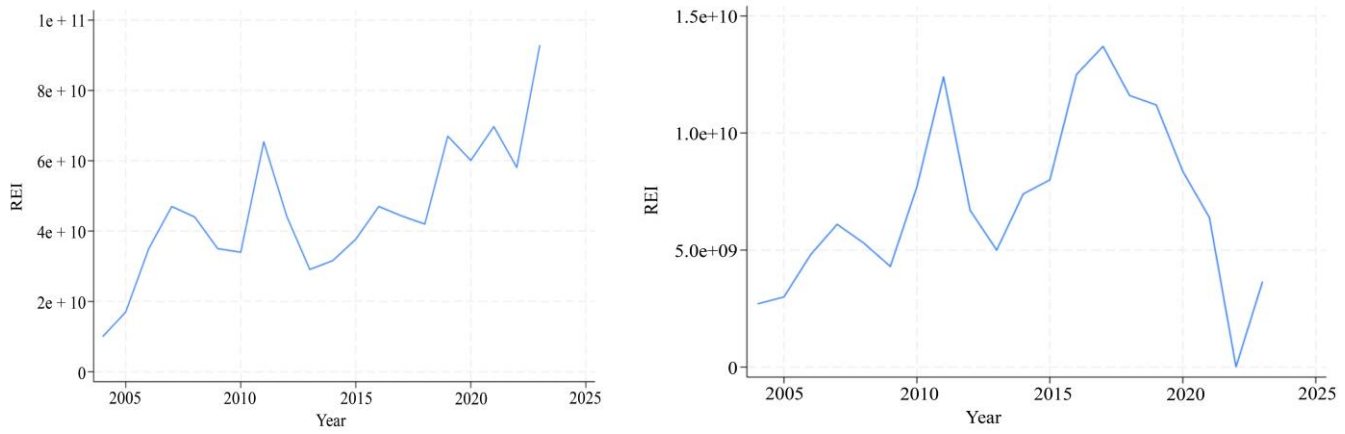
administration began rolling back key climate and clean energy initiatives, such as announcing his intention to leave the Paris climate agreement, etc. [35].

REI in India has seen many rises and falls, one of the biggest being during 2009 - 2010. This can most likely be attributed to the Launch of the Jawaharlal Nehru National Solar Mission (JNNSM) in 2010. This was a major government initiative aimed at helping promote solar power more [36]. Next, a similar rise from 2016 to 2018 as India announced its new solar target, to hit 175 GW of renewable capacity by 2022, with solar parks, wind zones, etc., announced during this period, thus causing increased investment (Figure 2b). [37]. Finally, the steep decline from 2018 to 2021 can be attributed to the COVID-19 disruption, as this caused a rise in project delays and overall solar module cost. This deeply drove down the overall investment in renewable energy in this period [38].




**(a)** **(b)**

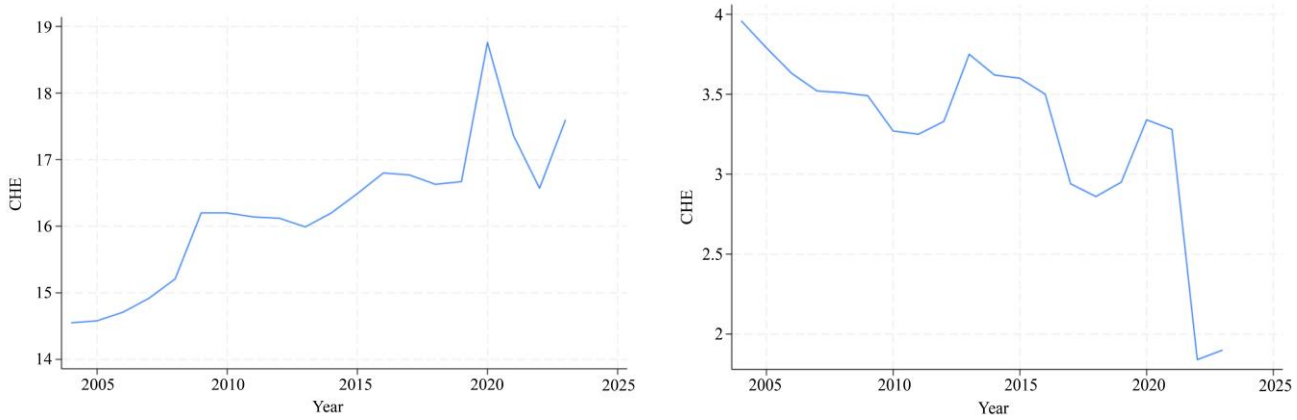
**Fig. 1 Trendline for Greenhouse Gas Emissions in the US (a) & India (b) (2005-25)**




**(a)** **(b)**

**Fig. 2 Trendline for Renewable Energy Investment in the US (a) and India (b) (2005-25)**

Health expenditure as a percentage of GDP has been consistently high in the US, with the only drastic spike during the COVID-19 Pandemic. During this period, billions of dollars were pumped into the economy through government expenditures in vaccines, testing, [39] etc. Yet otherwise, the overall health expenditure has stayed relatively stable, with a slight increasing trend. Notably, despite fluctuations, the overall CHE trend has maintained a gradual increase (see Figure 3a). This reflects the really uphill nature of high US healthcare spending, rather than temporary changes. In 2022, health spending accounted for around 17.3% of GDP, showing the country's position as having the highest health expenditure share among developed economies [40]. While India's healthcare spending hasn't changed much overall, its GDP has grown quite fast, which could be a reason for the consistently declining CHE Values. Of course, there was a small spike in 2020 due to the coronavirus; however, it was not sustained over time. Between 2013 and 2015, there was a small rebound in CHE, which was due to initiatives under India's 12th Five-Year Plan, which aimed to strengthen public health infrastructure [41]. Furthermore, India's GDP rebounded strongly in 2021–22 (see Figure 3b) (over 8% annual growth), which further reduced CHE [42].

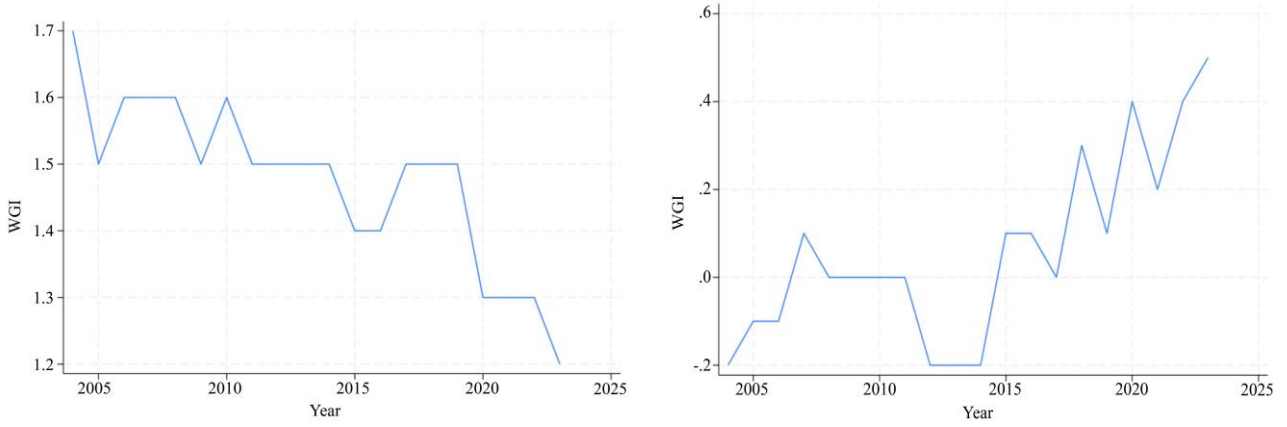



**(a)** **(b)**

**Fig. 3 Trendline for Health Expenditure as a percentage of GDP in the US (a) & India (b) (2005-25)**

From 2010 onwards, the USA's WGI scores began to slip, which might not have been too noticeable initially but eventually became a more serious concern. This decline steepened after 2019, (see Figure 4a) when events like the highly contested 2020 election and the shocking events of the January 6th Capitol riot really shook people's faith in the government's ability to function fairly and effectively, thus intense political debates over issues like voting rights and rule of law only added to the sense that governance in the US was becoming more fragile, effectively decreasing faith in the ability of the government. These challenges and the loss of trust in key democratic institutions have left a real mark on how US governance is perceived at home and around the world. [43]

India's steady improvement in WGI from 2014 onward can be seen as the result of several important governance efforts and a broader push to make the country more modern. The Digital India program played a crucial role by making government services more accessible and transparent, which helped people feel that the system was working better for them [44]. The passage of the Lokpal and Lokayuktas Act in 2013 was another major milestone, showing a real commitment to tackling corruption head-on. These measures helped restore trust among citizens who had become increasingly frustrated with the system's inefficiencies, [45] helping increase the population's faith that the government could rule fairly and righteously. Around 2011–2013, frustration boiled over into public movements and mass protests, which likely explains the dip in WGI (see Figure 4b) during those years [46]. However, once these issues were addressed, India's governance steadily improved, and that progress is reflected in the sharp upward trend in WGI seen in recent years.




**(a)** **(b)**

**Fig. 4 Trendline for World Governance Index in the US (a) & India (b) (2005-25)**

### *3.2. Autoregressive Distributed Lag (ARDL) Model Results*

The long and short run estimates from the ARDL model are presented for both India and the United States. The dependent variable is the natural log of Greenhouse Gas Emissions (GHG), and the regressors include Renewable Energy Investment (REI), Current Health Expenditure (CHE), governance index (WGI), GDP growth (GDPGR), Manufacturing Output (MOP), foreign direct investment (FDI), and trade (TRADE). Model 1 discusses the impact of ESG investment on GHG emissions in the United States, while Model 2 pertains to the same analysis conducted for India over the same period, 2005–2023.

**Table 1. Autoregressive Distributed Lag (ARDL) Results for Impact of ESG Investment on GHG Emissions in USA (Model 1) (2005-23)**

| Variable | β | SE | t | p |
|---|---|---|---|---|
| **DV = GHG** | **Long Run Equation** | | | |
| **REI** | -0.006 | 0.017 | -0.350 | 0.739 |
| **CHE** | -0.028 | 0.012 | -2.320 | 0.059* |
| **WGI** | 0.099 | 0.094 | 1.050 | 0.334 |
| **GDPGR** | 0.008 | 0.004 | 2.180 | 0.072* |
| **MOP** | 0.013 | 0.007 | 1.760 | 0.129 |
| **TRADE** | 0.002 | 0.002 | 0.760 | 0.478 |
| **DV = GHG** | **Short Run Equation** | | | |
| **L1.REI** | -0.018 | 0.019 | -0.970 | 0.371 |
| **L1.CHE** | -0.021 | 0.015 | -1.460 | 0.195 |
| **L1.WGI** | 0.171 | 0.048 | 3.570 | 0.012** |
| **L1.TRADE** | -0.003 | 0.002 | -1.380 | 0.216 |

| $R^2$ | Adj $R^2$ | Root MSE | Log Likelihood |
|---|---|---|---|
| 0.9697 | 0.9141 | 0.0123 | 63.55 |

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

*Long Run*

In the USA, healthcare expenditure (CHE) has a marginally significant negative effect on emissions (β = -0.028, p = 0.059), possibly reflecting improvements in hospital efficiency, sustainable infrastructure, and green procurement practices. Increased spending may support cleaner technologies, stricter waste management, and energy-efficient operations that collectively help reduce the carbon footprint of the healthcare sector. [47] Thus, this shows that investment in the healthcare sector can help marginally offset GHG emissions. Furthermore, GDP growth (GDPGR) shows a marginally significant positive effect (β = 0.008, p = 0.072), indicating that sustained economic growth tends to increase emissions in developed nations, as economic activities in the industrial and agricultural sectors expand. [48]. As our economy rapidly grows, so will the agricultural and industrial sectors that produce a large amount of emissions, and thus, GDP growth can cause a slight increase in CO2 emissions. Renewable energy investment (LREI), governance (WGI), trade, and manufacturing output (MOP) are not statistically significant, suggesting that these factors alone may not effectively reduce emissions without stronger policy mechanisms or greater international cooperation [49].

*Short Run*

Governance (L1.WGI) is the only variable with a statistically significant positive impact on emissions (β = 0.171, p = 0.012), which may seem counterintuitive but could reflect that stronger governance often coincides with pro-business reforms that increase production and energy use, thus raising emissions [50]. This means that, when there is greater public confidence in the government's ability to rule, it often leads to increased freedom within industries, which in turn can cause higher emissions. Other short-run variables, such as renewable energy investment (L1.REI), healthcare expenditure (L1.CHE), and trade (L1.TRADE), are not statistically significant, showing weak or delayed short-term impacts. These findings show that US emissions are mainly influenced by domestic production and consumption patterns, with healthcare spending showing some potential to reduce emissions both short-term and long-term, while governance and economic growth play complex roles in the emission dynamics.

**Table 2. Autoregressive Distributed Lag (ARDL) Results for Impact of ESG Investment on GHG Emissions in India (Model 2) (2005-25)**

| Variable | β | SE | t | p |
|---|---|---|---|---|
| **DV = GHG** | **Long Run Equation** | | | |
| **REI** | 0.015 | 0.010 | 1.490 | 0.232 |
| **CHE** | -0.063 | 0.067 | -0.940 | 0.416 |
| **WGI** | 0.146 | 0.059 | 2.490 | 0.089 |
| **GDPGR** | 0.000 | 0.006 | 0.040 | 0.970 |
| **MOP** | -0.117 | 0.038 | 3.060 | 0.055 |
| **FDI** | -0.029 | 0.036 | -0.830 | 0.468 |
| **TRADE** | 0.010 | 0.004 | 2.710 | 0.073 |
| **DV = GHG** | **Short Run Equation** | | | |
| **D1.REI** | 0.022 | 0.006 | 3.560 | 0.038 |
| **D1.CHE** | -0.085 | 0.029 | -2.940 | 0.060 |
| **D1.GDPGR** | 0.007 | 0.004 | 1.740 | 0.181 |

| | | | | |
|---|---|---|---|---|
| **D1.MOP** | -0.326 | 0.111 | -2.940 | 0.060 |
| **D1.FDI** | -0.051 | 0.018 | -2.870 | 0.064 |
| **D1.TRADE** | -0.004 | 0.002 | -2.560 | 0.083 |
| **Constant** | 2.957 | 1.082 | 2.730 | 0.072 |

| $R^2$ | Adj $R^2$ | Root MSE | Log Likelihood |
|---|---|---|---|
| 0.9917 | 0.9532 | 0.0130 | 68.744347 |

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

*Long Run*

In the long run, the lagged value of GHG emissions (GHG) is strongly negative and statistically significant ($\beta$ = -0.833, p = 0.024), suggesting that emissions in India show self-correcting behavior over time, likely due to policy responses or technological improvements following high-emission years [51]. Renewable Energy Investment (REI) is positive but not statistically significant (p = 0.232), indicating that long-term investments in renewables have not yet translated into clear emissions reductions. This may be because renewable investments are still too small to outweigh India's heavy dependence on fossil fuels, or because their benefits take time to show. Additionally, since innovation currently seems to drive industrial growth more than environmental protection, it may be increasing emissions instead of reducing them [52]. Healthcare expenditure (CHE) is also negative but insignificant (p = 0.416), suggesting that there is a possible link to emissions reduction. GDP growth (GDPGR) is not significant in the long run, implying that economic growth does not have a stable long-term impact on emissions. Governance (WGI) is positively associated with emissions and marginally significant (p = 0.089), meaning that improvements in governance may currently be aligned with policies that prioritize economic or industrial expansion over environmental sustainability, thus only increasing emissions. This counterintuitive result suggests that stronger governance alone does not guarantee lower emissions [53]. Manufacturing Output (MOP) is negative and marginally significant (p = 0.055), suggesting that higher production levels may be associated with reduced emissions, likely due to improvements in energy efficiency or cleaner production technologies. This indicates a shift toward more sustainable industrial practices where output grows without a proportional increase in emissions [54]. Trade (TRADE) is positively and marginally significant (p = 0.073), indicating that trade liberalization might be fueling emissions, possibly due to increased industrial activity and production to meet higher export demands. This expansion can lead to greater use of fossil fuels and pollution-intensive processes [55]. Foreign direct investment (FDI) becomes insignificant in the long run, suggesting that international capital flows do not have a measurable lasting effect on emissions in India.

*Short Run*

In the short run, renewable energy investment (D.REI) has a moderately significant positive impact on emissions ($\beta$ = 0.022, p = 0.038), which is counterintuitive given India's move toward clean energy. This could be explained by emissions from land-use changes, material transportation, and construction activities involved in developing renewable infrastructure [56]. Healthcare expenditure (D.CHE) is negatively associated with emissions and marginally significant (p = 0.060), suggesting that short-term increases in health spending may help reduce emissions. Though this may seem unexpected, it could be tied to investments in energy-efficient infrastructure within healthcare systems that help lower the carbon footprint despite increased spending [57]. Manufacturing output (D.MOP) is also negative and marginally significant (p = 0.060), possibly showing increased industrial efficiency or movement toward less polluting sectors. Trade (D.TRADE) shows a marginally significant negative effect (p = 0.083), indicating that short-term trade activity may reduce emissions—perhaps through the import of cleaner technology or more efficient practices. Foreign direct investment (D.FDI) is marginally negative as well (p = 0.064), suggesting that globalization may bring environmentally sound technologies or stricter standards, helping to lower emissions. GDP growth (D.GDPGR), while showing a positive but insignificant effect (p = 0.181), agrees with the theory that early-stage economic expansion in developing economies can drive emissions through industrial activity. In this case, the effect is not statistically significant.

## 4. Conclusion

This research aimed to determine if ESG investment significantly impacts greenhouse gas emissions, focusing on comparing two economies, the United States of America and India, from 2000 to 2023. The study, using time series data and the ARDL model, examined the significance of ESG variables such as renewable energy investment, spending on healthcare, and effective governance in the impact of emissions in both the short term and long term. The findings suggest that ESG investing has mixed effects on emissions in countries according to their development status.

United States healthcare expenditure was found to have a marginally significant long-run negative effect on emissions, suggesting that investment in public health infrastructure can support environmental objectives. Surprisingly, governance had a counterintuitive positive relationship with emissions in the short term, perhaps due to increased economic activity and industrial efficiency. In India, investment in renewable energy was linked with an increase in emissions in the short term, likely due to infrastructure emissions; however, social investments (health care) and manufactured production had negative correlations with reduced emissions in the short run.

Governance and trade both had weak positive long-run correlations with emissions. The implications of these findings are both practical and policy relevant. For policymakers, this means that policymaking needs to focus on aligning ESG investments with broader and broader sustainability goals rather than making assumptions about immediate and inherent environmental benefits.

Governments in emerging economies, particularly, will have to consider the cost of transitioning to renewable energy infrastructure and invest in clean manufacturing and health systems. For investors and international development organizations, this study highlights the need to tailor ESG investment strategies to country-specific contexts rather than applying uniform models to countries without acknowledging their state of development. Nonetheless, this study acknowledges that it has several limitations that offer opportunities for future research. First, although the time frame captures more than two decades of data, ESG investing is a relatively recent trend, and some variables, such as investment in renewable energy, may take longer to show tangible effects on emissions. Second, the study is limited to national data, which may hide regional variations within each country that could offer further insights. Third, ESG measurements, particularly governance measurements, are difficult to measure comprehensively, and their significance may vary between providers. Despite these limitations, the study makes a valuable contribution to the relatively scarce literature on ESG performance at the macroeconomic level, especially in emerging markets. It shows the importance of ESG investment not just in theory but in measurable outcomes like emissions and encouraging context-specific approaches in both academic research and policy implementation.

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