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Economic Development and Climate Change: Insights from Religious Countries

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ABSTRACT

Among the most pressing environmental challenges, climate change is anticipated to pose the highest global threat in the coming decade. This research examines the impact of political economic development on per capita CO_2 emissions in 29 countries with state religions, applying the frameworks of Environmental Kuznets Curve (EKC) and Pollution Haven Hypothesis (PHH). Employing the Panel Autoregressive Distributed Lag (PARDL) model, the study analyzes data from 1990 to 2022, incorporating both time series and cross-sectional information. The model's robustness is verified by replacing CO_2 emissions per capita with ecological footprint per person. Results indicate that the EKC hypothesis is not supported in most nations, particularly low-income countries still heavily dependent on fossil fuels. In contrast, the PHH hypothesis is confirmed over the long term, with foreign direct investment (FDI) inflows contributing to increase per capita CO_2 emissions, especially in countries with lax environmental regulations. Energy consumption and industrial sector contributions significantly affect emissions, while renewable energy consistently reduces CO_2 output. Furthermore, democratic political systems are associated with higher emissions, particularly in rapidly growing economies. The study suggests implementing faith-based and sustainability-oriented approaches, such as a faith-driven economy that incorporates spiritual values into green economic policies. Additionally, faith-based investing is recommended to encourage ethical and environmentally responsible business practices. These strategies aim to help countries with official religions strike a balance between economic growth and environmental conservation in the face of climate change.

Keywords: Environmental Kuznets Curve, Pollution Haven Hypothesis, Faith-Based Investing, Climate Crisis
JEL Classifications: O44, Q54, Q56, Z12

1. INTRODUCTION

In 2024, the World Economic Forum (WEF) published a report titled The Global Risks. This report states that among the ten most severe global risks for the next decade, five are related to environmental issues: extreme weather events, critical changes in Earth systems, biodiversity loss and ecosystem collapse, resource shortages, and pollution (McLennan, 2024). The Intergovernmental Panel on Climate Change (IPCC) report from 2021, in a chapter written by Eyring et al. (2021), and Forster et al.'s (2024) research on the influence of human activities on climate systems affirm that human activity is the dominant cause of global climate change.

This IPCC report is further supported by several empirical studies demonstrating that human activity is the primary driver of climate change. One study found that 91.9% of scientists agree that climate change is triggered by human activities, with an even stronger consensus among active climate scientists (Carlton et al., 2015). Human activities not only cause global warming but also exacerbate natural disasters, such as floods and landslides triggered by deforestation and urbanization (Ahmed et al., 2023; Alifu et al., 2020). Additionally, climate change driven by greenhouse gas emissions negatively impacts ecosystems, increasing the risk of toxic algae blooms and reducing primary productivity—an essential indicator of environmental health (Dokulil, 2017; Adger et al., 2003). These impacts also affect social and economic aspects, especially for vulnerable communities, such as smallholder farmers in developing countries who rely on predictable rainfall patterns (Matewos, 2019). Furthermore, Pörtner et al. (2022) in the IPCC's 2022 report state that climate governance will be highly effective if it includes meaningful and sustainable engagement from all societal actors, from the local to the global level. These actors include individuals and households, communities, governments at all levels, private sector businesses, non-governmental organizations, indigenous communities, and religious groups.

As is widely recognized, religion plays an essential role in human life by influencing how individuals think, perceive, and interact with the world. Hulme (2017) explains that each religion provides guidelines for managing relationships between humans, non-human creatures, and God, making it understandable that religion also plays a role in climate change issues. The 2016 WEF report emphasizes that religion can serve as a powerful mobilizing force for society in achieving economic justice and addressing climate change (Grim, 2016). Consequently, the WEF involves religious leaders in collaborative efforts to tackle global challenges, including the climate crisis. Additionally, the United Nations Environment Programme (UNEP) has published a report exploring the contributions of religion and culture to environmental preservation within the framework of the 2030 Agenda for Sustainable Development (Niamir-Fuller et al., 2016). This demonstrates that religion has not only a spiritual dimension but also a strategic role in environmental preservation and addressing global climate challenges. To understand the connection between religion, economics, and climate change, it is essential to study the relationship between religion and economics, economics and climate change, and religion and climate change (Agusalim and Karim, 2023).

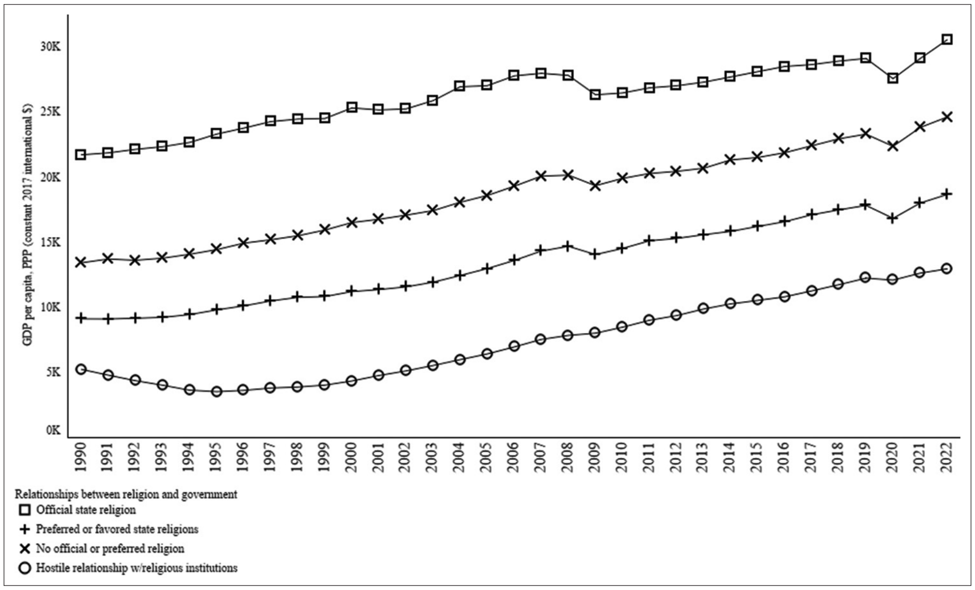
Many thinkers and researchers attempt to link religion with economics on both micro and macro levels, based on the belief that religion strongly influences individual behavior and state policy. Weber (1905) is one of the prominent scholars often cited as an early proponent of the link between religion and economics. Religion is seen as capable of stimulating economic growth by fostering character traits such as work ethic, honesty, and frugality. The work ethic directly relates to a commitment to working hard to achieve worldly success. Success in the worldly sense is also viewed as a measure of success in the afterlife. A work ethic oriented toward the world involves hard work aimed at minimizing the use of profits while pursuing profit accumulation and reinvesting earnings. This work ethic is one of the most important forces behind the emergence of modern capitalism.

Barro and McCleary (2019) state that in recent empirical research, key explanatory variables influencing economic growth include GDP per capita, human capital, savings rates, trade openness, government spending, political and institutional environment, and rule of law. They argue that to explain economic growth, it is insufficient to look only at economic, social, and political aspects; cultural aspects must also be considered. In this regard, religion is an important component of culture. This viewpoint aligns with Weber's (1905) ideas. Incorporating all aspects into research, they found that higher belief in the punishment of hell motivates people to do good, and if this belief leads to increased effort in work, saving, honesty, and similar traits, then it is reasonable to expect economic growth to increase. Essentially, similar results were found when substituting the variable of belief in hell with belief in heaven. Nelson's (2014) study states that religion has historically had a significant influence on economic growth and national development. In recent literature, economic growth and development have increasingly focused on the long-term effects of geographic, historical, and cultural factors on productivity and per capita income. These long-term factors have historically been significantly influenced by religion (Spolaore and Wacziarg, 2013).

Figure 1 illustrates the per capita GDP growth based on the relationship between religion and government from 1990 to 2022. The classification in this figure follows the framework used by Kishi et al. (2017): countries with an official religion, countries that favor a particular religion, countries with no official religion and no preference for religion, and countries in conflict with religious institutions. Over this 33-year period, global per capita income showed an upward trend across all groups of countries. Nations with an official religion consistently recorded the highest per capita GDP. In 1990, these countries had a per capita GDP of $21.74 thousand, which rose to $30.58 thousand in 2022, representing a 40.66% growth. Countries with no official religion or preference for religion held second place, with their per capita GDP increasing from $13.44 thousand in 1990 to $34.64 thousand in 2022, reflecting significant growth of 157.74%. Countries that favor a particular religion ranked third, with their per capita GDP rising from $9.13 thousand in 1990 to $18.69 thousand in 2022, growing by 104.71%. Finally, countries in conflict with religious institutions recorded an increase in per capita GDP from $5.24 thousand in 1990 to $12.98 thousand in 2022, with a growth rate of 147.71%. The data reveal that countries with high per capita GDP experience relatively low economic growth compared to countries with lower per capita GDP. This is because resources in high-income countries are already utilized optimally, limiting further per capita GDP growth. Meanwhile, low-income countries may catch up with more established economies if economic growth is continuously driven, promoting economic convergence or the narrowing of income disparities between countries in the long run.

Since the 20th century, economic activities have increasingly been associated with climate change or environmental degradation by researchers. Grossman and Krueger (1991) were early pioneers in linking these issues, discovering an inverted-U curve model between them. This phenomenon is also known as the EKC hypothesis in environmental economics literature, named after Kuznets (1955) by Panayotou (1993), which describes an inverted-U association between economic growth and income inequality. This hypothesis suggests that during the initial stages

Figure 1: Trends in GDP per capita by religion-government relationship (processed from the World Bank, 2022)



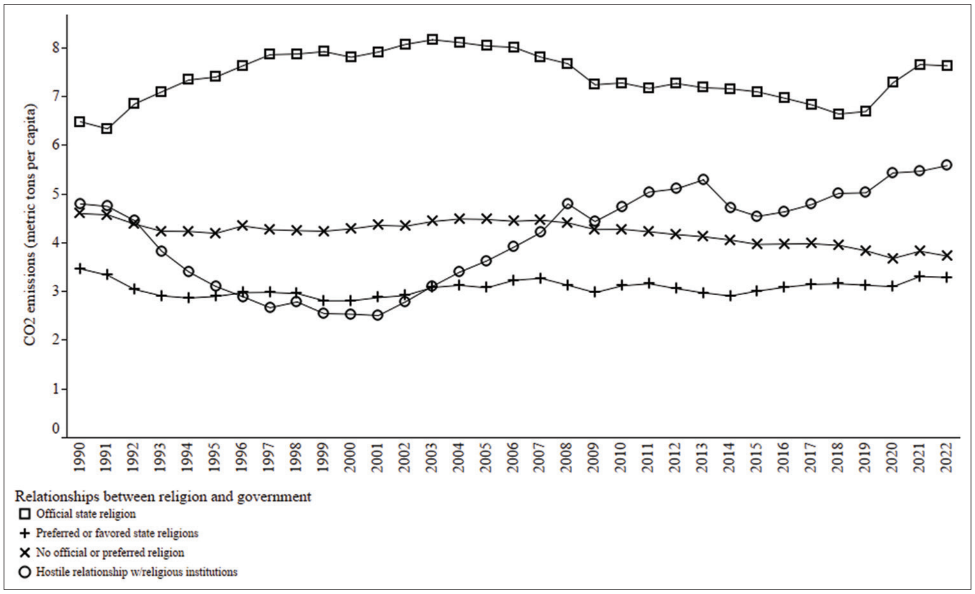
of economic growth, environmental degradation occurs, but at a peak point in growth, carbon dioxide (CO_2) emissions for the environment begin to decrease. Following the findings of Grossman and Krueger (1991), numerous researchers began estimating EKC in various contexts and using diverse methodologies (Shahbaz and Sinha, 2019). From 2000 to 2020, more than 2,218 research articles on EKC were found in the Web of Science database (Anwar et al., 2022). Existing studies on carbon emissions and the EKC hypothesis primarily focus on income, international trade, industrialization, foreign direct investment, renewable energy, government expenditure, urbanization, tourism, and environmental regulations (Ahmed et al., 2022; Farooq et al., 2022; Djellouli et al., 2022; Grodzicki and Jankiewicz, 2022; Pata et al., 2022; Kaika and Zervas, 2013; Bilgili et al., 2016; Yao et al., 2019).

Murthy and Gambhir (2018) argue that EKC studies are incomplete without considering the PHH. This is due to the idea that EKC's connection between economic development and environmental damage remains controversial regarding its form, occurrence, and determinants. Additionally, there is an acknowledged relationship between economic development and international trade, leading to the conceptualization of a trade-environment triangle among types of economic development, the environment, and trade and investment. PHH was first proposed by Copeland and Taylor (1994) within the context of North-South trade under the North American Free Trade Agreement (NAFTA). PHH posits that through international trade and FDI, developing countries have become pollution havens for developed countries. Recent studies testing PHH's validity include Apergis et al. (2022), Wen et al. (2022), Bulus and Koc (2021), Guzel and Okumus (2020), and Rahman et al. (2019). Commonly used indicators as proxies for climate change include greenhouse gas (GHG) emissions, carbon dioxide (CO_2), methane (CH□), nitrous oxide (N_2O), and ecological footprint. In many EKC and PHH studies, CO_2 is frequently used as an indicator since it is the largest contributor to GHGs and ecological footprints, which are the primary sources of climate change (Thio et al., 2022).

Figure 2 visualizes CO_2 emissions per capita based on the relationship between religion and government from 1990 to 2022. Generally, countries with an official religion consistently have the highest CO_2 emissions per capita throughout this period. In the early 1990s, these countries emitted approximately 6.48 metric tons per capita, and despite minor fluctuations, emissions remained stable at around 7.63 metric tons until 2022. Countries with a preference for religion had the lowest emissions among the country groups over the 1990-2022 period, averaging around 3 metric tons. In contrast, countries without an official religion or preference for religion displayed CO_2 emissions ranging between 3 and 4 metric tons per capita. Countries in conflict with religious institutions recorded CO_2 emissions per capita around 4 metric tons in 1990, with emissions gradually rising close to 5 metric tons by 2022, indicating a significant increase. Compared to Figure 1, a correlation between per capita GDP and CO_2 emissions per capita is evident. Countries with high per capita GDP, such as those with an official religion, tend to have higher CO_2 emissions per capita. Conversely, countries with lower per capita GDP, such as those in conflict with religious institutions, tend to have lower CO_2 emissions per capita, although emissions have risen over time. This suggests that economic prosperity is closely related to CO_2 emissions per capita in a country.

Understanding the relationship between religion and economics, as well as economics and climate change, should be followed by an understanding of how religion perceives and relates to climate change. Efforts to understand this connection must be carried out carefully and thoroughly (Taylor, 2016a). Scholars regard religion as a promising analytical lens and a microcosm of culture that serves as an exemplar for studying diverse human perceptions, thoughts, and actions (worldviews, moral systems, practices, aesthetics, ethics, lifestyles, hopes, and fears) related to global changes, especially regarding climate change (Bergmann and Gerten, 2010). Religious interpretations of climate change arise from numerous traditions explaining how climate issues are perceived within a community or tradition,

Figure 2: CO_2 emissions trends by religion-government relationship (processed from the World Bank, 2022)



as well as public interpretations of climate change that draw on religious terminology. Since climate change is deeply connected to humanity—its causes and consequences—human beings are engaged in all the ways that religion shapes and inspires human behavior. Therefore, fully understanding climate change requires not only an understanding of economic, social, and political aspects but also an appreciation of religious aspects, particularly how religion shapes human experiences and responses to climate change (Jenkins et al., 2018). Eom et al. (2021) argue that religion, as a system encompassing various beliefs, may have different implications for environmental actions. Given the large number of religious adherents worldwide, understanding this complexity is crucial for addressing current global environmental challenges.

Most scientists globally agree that humans have an impact on the global climate system (Cook et al., 2016). Steffen et al. (2004) explain that human activities are the primary cause of increased global emissions. Scientific findings linking human activity to the climate system have played a decisive role in identifying the climate change issue and justifying actions to address it. Science provides strong evidence that global warming is the result of increased greenhouse gas (GHG) emissions from human activities (Leichenko and O'Brien, 2019). Evidence of climate change also comes from observations by individuals, including ranchers, farmers, gardeners, birdwatchers, and others (Hovelsrud and Smit, 2010). In recent research, Eyring et al. (2021) emphasize that humans have been the primary cause of climate change in the last decade. This conclusion is based on a synthesis of various types of evidence, including recent direct observations of Earth's changing climate; analyses of tree rings, ice cores, and other long-term records documenting past climate changes; and computer simulations based on the fundamental physics governing the climate system.

Although there is a growing consensus that the climate is changing, beliefs about causative factors vary widely among the general public. Current research shows that causal beliefs are strongly influenced by cultural, political, and identity perspectives (Hartter et al., 2018). Modern society tends to believe that human activity is the primary cause of climate change, whereas conservative societies are much less likely to believe it. For communities that believe climate change is human-induced, this belief implies the importance of supporting state policies to address climate change. Socialization through religious institutions can influence people's worldviews, including their perspectives on environmental issues like climate change. However, communities that do not believe in human-induced climate change tend to reject new information that contradicts their beliefs. Climate skeptics dismiss scientific information that appears credible because it conflicts with their beliefs (Druckman and McGrath, 2019; Nagle, 2008). One reason that certain religious adherents disagree on climate change is that they hold different beliefs about their role in relation to others, nature, and God (Hulme, 2009).

In many climate change polls, sharp differences in opinion are evident among people of different religions (Smith and Leiserowitz, 2013; Jones et al., 2014). This raises questions about what causes these differences, whether they follow specific theological commitments, and whether they reflect religiously motivated antipathy toward scientific modes of knowledge. All these aspects require deeper examination. In this regard, the influence of religion is often seen as ambiguous and can be either positive or negative (Bergmann, 2005; Proctor and Berry, 2005). On one hand, there is a tendency for religious organizations and individuals to become 'greener,' filtering their traditions as a moral imperative to act against climate change and respect the natural environment (Taylor, 2006b). On the other hand, some groups reject this idea.

The role of religion in addressing climate change and other environmental issues is ambivalent and complex, with progressive and regressive tendencies operating simultaneously. There is a strong need for more systematic, interdisciplinary, interfaith, and cross-cultural comparative research on the role of religion and culture in global climate change to explore the pros and cons of religious engagement with climate change (Gerten and Bergmann, 2012). Additionally, religious beliefs significantly influence how followers understand and experience climate change, underscoring the need to include this information in climate education (Schuman et al., 2018).

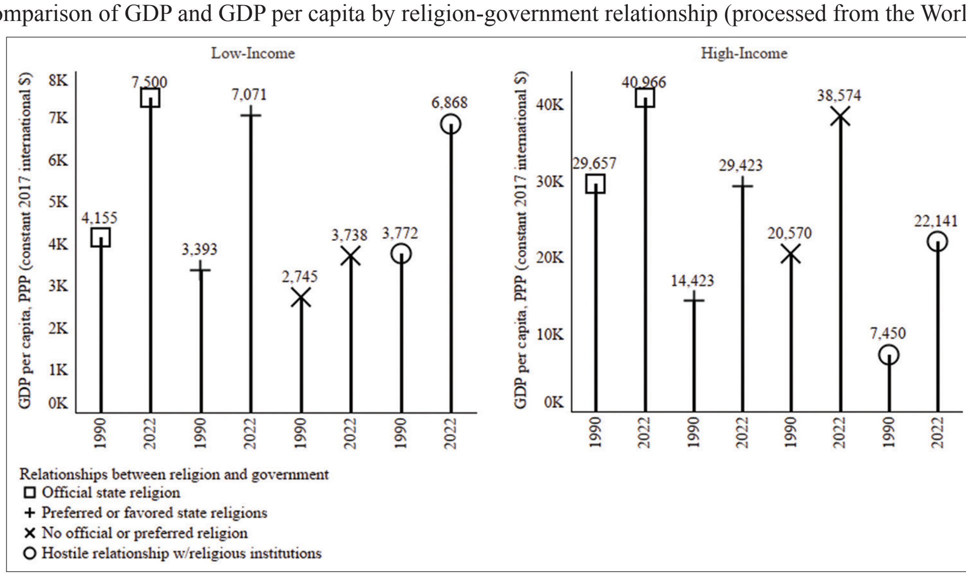
Amid debates among scientists and religious groups, and among religious groups themselves, Müller (2021) states that people of faith are allies in stopping climate change. By collaborating, religious groups and scientists can become a powerful force for a livable planet. He suggests discussing what both groups care deeply about, such as well-being and the world future generations will inherit. The power of alliances between these groups could build a new historical legacy.

The presence of religion not only influences individual or group human behavior but also can affect a country's governance system, sometimes resulting in the formation of a theocratic state. Some economic literature has attempted to link religion with economic performance (Becker et al., 2021; Barro and McCleary, 2019; Mayoral and Esteban, 2019; Karaçuka, 2018; Noland, 2005). One primary measure of a country's economic progress is through its Gross Domestic Product (GDP) and GDP per capita (Romer, 2019).

Figure 3 shows variations in per capita GDP growth in low- and high-income countries based on the relationship between religion and government from 1990 to 2022. In low-income countries, those with an official religion saw a 1.8-fold increase in per capita GDP, from \$4.15 thousand in 1990 to \$7.50 thousand in 2022. Countries with a preference for religion also saw a significant increase of 2-fold, from \$3.39 thousand in 1990 to \$7.07 thousand in 2022. Meanwhile, countries without an official religion saw a moderate increase of 1.36-fold, from \$2.74 thousand to \$3.74 thousand, and countries with hostile relations with religious institutions grew by 1.82-fold, from \$3.77 thousand to \$6.87 thousand over the same period. In high-income countries, those with an official religion continued to have the highest per capita GDP, with a 1.38-fold increase from \$29.66 thousand in 1990 to \$40.97 thousand in 2022. Countries with a preference for religion recorded a greater growth rate of 2.04-fold, from \$14.42 thousand to \$29.42 thousand. Countries without an official religion also experienced significant growth of 1.87-fold, from \$20.57 thousand to \$38.57 thousand. However, countries in conflict with religious institutions showed the largest increase, nearly 3-fold, from \$7.45 thousand in 1990 to \$22.14 thousand in 2022.

Per capita GDP is closely related to environmental degradation within the EKC hypothesis. However, according to Murthy and Gambhir (2018), besides per capita income, trade and FDI are also linked to environmental changes and degradation. Figure 4 shows a comparison of trade openness and FDI inflows based on the relationship between religion and government in 1990 and 2022. Countries with an official religion recorded a large increase in trade openness, from 78.92% in 1990 to 98.35% in 2022, along with a significant increase in FDI inflows from 1.27% to 4.10%. Countries with a preference for religion also experienced similar growth, with trade openness rising from 58.99% to 84.34%, and FDI increasing from 1.29% to 2.76%. Countries without an official religion showed the largest increase in trade openness, from 67.19% in 1990 to 97.55% in 2022, but experienced a decline in FDI inflows, from 1.46% to negative (−1.24%) in 2022, indicating greater investment outflows. Meanwhile, countries with hostile relations with religious institutions saw moderate growth in trade openness, from 82.52% to 91.80%, and an increase in FDI inflows from 0.90% to 2.35%. Overall, countries with an official religion demonstrated the largest increase in attracting foreign investment, while countries without an official religion experienced a drastic decline in FDI, even as their trade openness increased. Trade openness rose across all country categories from 1990 to 2022, with countries without an official religion recording the largest increase. However, in terms of FDI, countries with an official religion saw the greatest increase, whereas countries without an official religion experienced a decline, even turning negative. This suggests that trade openness does not always correlate directly with foreign

Figure 3: Comparison of GDP and GDP per capita by religion-government relationship (processed from the World Bank, 2022)



investment inflows, and factors such as the relationship between religion and government can influence a country's attractiveness to foreign investors.

From an environmental perspective, one of the key indicators used to measure climate change is CO_2 emissions, as CO_2 accounts for the largest share of greenhouse gas (GHG) emissions, reaching 74.40% in 2020 (Ritchie et al., 2022). Figure 5 illustrates a comparison of CO_2 emissions per capita in low- and high-income countries based on the relationship between religion and government from 1990 to 2022.

In low-income countries, nations with an official religion saw an increase in CO_2 emissions from 0.92 metric tons in 1990 to 1.67 metric tons in 2022. Similarly, countries with a preference for religion also experienced a slight increase from 1.63 metric tons to 1.81 metric tons. In contrast, countries without an official religion and those in conflict with religious institutions recorded a decrease in CO_2 emissions. Countries without an official religion saw emissions drop from 0.76 metric tons to 0.65 metric tons, while countries with hostile relations with religious institutions decreased from 2.52 metric tons to 1.98 metric tons.

In high-income countries, those with an official religion experienced a significant increase in CO_2 emissions, rising from 8.99 metric tons in 1990 to 10.31 metric tons in 2022. Countries in conflict with religious institutions saw an even larger increase, from 8.21 metric tons in 1990 to 10.99 metric tons in 2022. Conversely, countries with a preference for religion experienced a reduction in emissions, from 5.16 metric tons in 1990 to 4.65 metric tons in 2022, and countries without an official religion also saw a decrease, from 7.15 metric tons in 1990 to 5.78 metric tons in 2022.

Researchers have explored the connection between religion and climate change, primarily through qualitative studies. As scientific understanding of the relationship between religion and climate change grows, there is an urgent need for quantitative data. To date, substantial quantitative research on the relationship between religion and climate change remains very limited (Jenkins et al.,

Figure 4: Comparison of trade openness and FDI by religion-government relationship (processed from the World Bank, 2022)

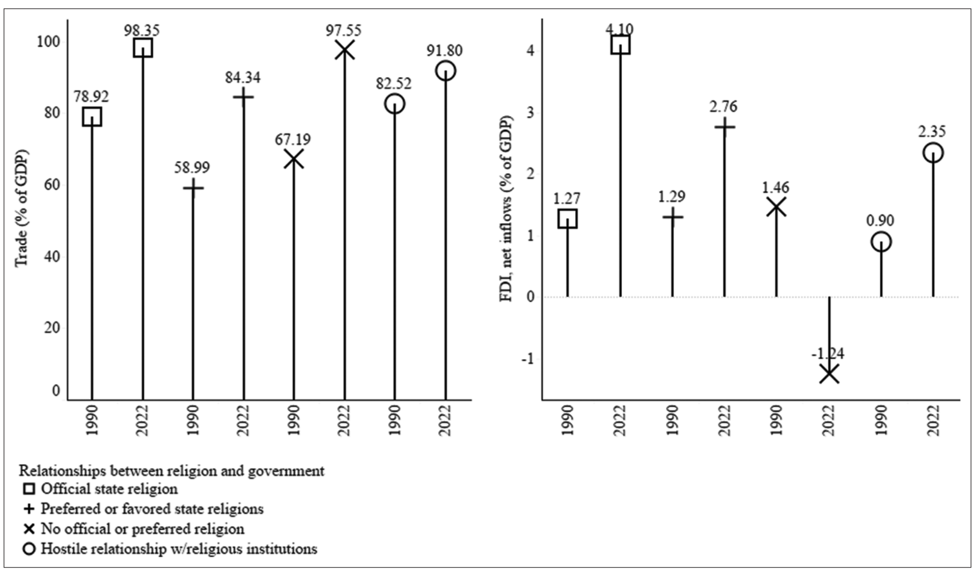
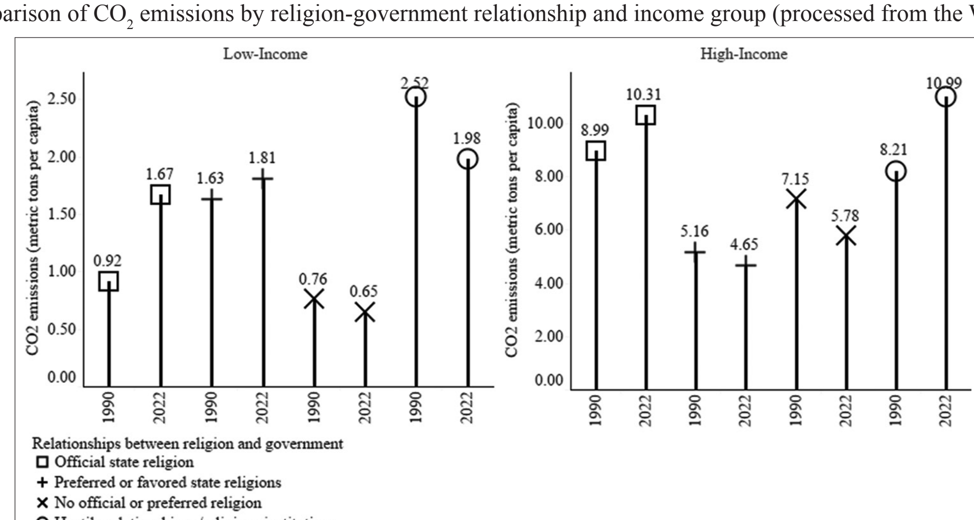


Figure 5: Comparison of CO_2 emissions by religion-government relationship and income group (processed from the World Bank, 2022)



2018). Studies examining the impact of religiosity on climate change are still scarce. Additionally, as outlined in the background of this study, quantitative analyses on the relationship between economics and climate change have been conducted extensively using the EKC and PHH frameworks. However, none of these studies have classified countries based on the relationship between religion and government systems.

Based on this background, the author is interested in conducting a more in-depth investigation into the link between economic development and climate change among countries with an official religion. The findings of this research can serve as a reference for religiously-based governments worldwide in making economic decisions. Such economic decisions would aim to prevent and mitigate climate change, thereby promoting sustainable economic development. Furthermore, it is hoped that individuals and religious institutions can also determine their stance and actions regarding climate change issues.

2. RESEARCH METHODS

This study is quantitative research utilizing secondary data sourced from the World Development Indicators (WDI), Our World in Data (OWD), and the Pew Research Center (PRC). The study employs a combined dataset consisting of time series data over a 33-year period from 1990 to 2022 and cross-sectional data encompassing 29 countries with an official religion. According to Kishi et al. (2017), researchers from the PRC identified 43 countries with an official religion. After considering the variables used in this study, the number of countries was reduced to 29. These countries with an official religion will then be further classified by income group. Countries with high and upper-middle incomes will be categorized as high-income countries (20 countries), while countries with lower-middle and low incomes will be grouped as low-income countries (9 countries).

2.1. Regression Model

The panel data analysis method is employed for empirical analysis with more dynamic data. Panel data is a combination of cross-sectional and time-series data, also known as pooled data. Baltagi (2021) explains that panel data offers several advantages for research. Panel data involves more information-rich data, allowing for more reliable estimates and the testing of more sophisticated behavioral models with fewer restrictive assumptions. Another critical advantage of panel data is the ability to control individual heterogeneity. Failing to account for unobserved individual heterogeneity can lead to biased estimates. Panel data can also better identify and estimate effects that may not be detected with cross-sectional or time-series data alone. Unlike cross-sectional data, panel data is better suited for studying dynamic behavior. For example, with cross-sectional data, one can estimate CO_2 emissions per capita released into the atmosphere at a specific point in time. Repeated cross-sectional data can show how carbon dioxide emissions change over time. By making data available for several thousand units, panel data can minimize biases that might occur if countries are aggregated into broad groups. In summary, panel data can enhance empirical analysis in ways that are not possible when using cross-sectional or time-series data alone.

The standard panel data model can be represented in Equation (1):

$$y_{it} = \alpha_i + \beta' x_{it} + e_{it} \tag{1}$$

Where i represents cross-sectional data and t represents time-series data, with $i = 1, 2, ..., N$, and t= 1, 2,…, T. Here, y_{it} is the dependent variable, x_{it} is a K × 1 vector of regressors, β is a K × 1 parameter vector to be estimated, α_i represents the fixed effect of the cross-sectional data, and e_{it} is the error term.

Equation (1) can be transformed into an autoregressive distributed lag (ARDL) panel model, as shown in Equation (2), as suggested by Pesaran and Shin (1998) and Pesaran et al. (2001). This model can be used when the number of cross-sectional units (N) and time-series observations (T) are large. The PARDL model is suitable for this study, given the 33-year time series and 29 cross-sectional units of countries with an official religion, grouped by income levels—high- and low-income countries.

$$y_{it} = \sum_{j=1}^{p} \delta_i y_{i,t-j} + \sum_{j=0}^{q} \beta'_{ij} x_{i,t-j} + \alpha_i + e_{it} \tag{2}$$

where p is the lag of the dependent variable and q is the lag of the independent variable. The PARDL model is used to examine the long-term effects of the independent variables on the dependent variable. To analyse both long-term and short-term effects, Equation (2) needs to be transformed into an error correction model (ECM), as shown in Equation (3).

$$\Delta y_{it} = \theta_i \left[y_{i,t-1} - \lambda'_i x_{i,t} \right] + \sum_{j=1}^{p-1} \xi_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \beta'_{ij} \Delta x_{i,t-j} + \varphi_i + e_{it} \tag{3}$$

where $\theta_i = -(1-\delta_i)$ represents the adjustment speed coefficient, which measures how quickly the variable returns to long-term equilibrium after a shock. The error correction term (ECT) should have a statistically significant coefficient with a negative sign and be <1 ($\theta_i < 1$). Δ is the first-difference operator, λ'_i is the vector of long-term relationships, $ECT = y_{i,t-1} - \lambda'_i x_{i,t}$ is the error correction model (ECM), and ξ_{ij}, β'_{ij} are the short-term dynamic coefficients.

When the variables in this study are added to the PARDL-ECM model in Equation (3), the equation can be rearranged into Equation (4). In constructing the model in Equation (4), the author follows the influential work of Grossman and Krueger (1991), Panayotou (1993), and Copeland and Taylor (1994). Subsequently, this EKC and PHH model has been studied in numerous research studies worldwide. The use of variables and estimation methods in this study adapts and modifies the model developed by Pata et al. (2022), Ahmed et al. (2022), Yao et al. (2019), Sabir and Gorus (2019), and Li et al. (2016). This model aids in determining the impact of economic variables on climate change in both the long and short term, addressing some of the limitations of prior literature that only examined either short-term or long-term effects.

$$\Delta lnCC_{it} = \theta_i \begin{bmatrix} LCC_{i,t-1} - \lambda_1 LGDPC_{i,t} - \lambda_2 \left(LGDPC\right)^2_{i,t} \\ -\lambda_3 TRADE_{i,t} - \lambda_4 FDI_{i,t} - \lambda_5 IND_{i,t} - \\ \lambda_6 LENERGY_{i,t} - \lambda_7 RENERGY_{i,t} - \lambda_8 LPOL_{i,t} \end{bmatrix} + \sum_{j=1}^{p-1} \xi_{1j} \Delta CC_{i,t-j} + \sum_{j=0}^{q-1} \beta_{1j} \Delta LGDPC_{i,t-j} + \sum_{j=0}^{q-1} \beta_{2j} \Delta \left(LGDPC\right)^2_{i,t-j} + \sum_{j=0}^{q-1} \beta_{3j} \Delta TRADE_{i,t-j} + \sum_{j=0}^{q-1} \beta_{4j} \Delta FDI_{i,t-j} + \sum_{j=0}^{q-1} \beta_{5j} \Delta IND_{i,t-j} + \sum_{j=0}^{q-1} \beta_{6j} \Delta LENERGY_{i,t-j} + \sum_{j=0}^{q-1} \sum_{j=0}^{q-1} \beta_{7j} \Delta RENERGY_{i,t-j} + \sum_{j=0}^{q-1} \beta_{8j} \Delta LPOL_{i,t-j} + \varphi_i + e_{it} \quad (4)$$

Where *CC* is the dependent variable representing climate change, proxied by CO_2 emissions per capita (CO_2C) in metric tons per capita. The independent variables cover economic and political aspects. The economic aspect is represented by GDP per capita at PPP, constant 2017 international dollars (*GDPC*); trade openness (*TRADE*), calculated as exports plus imports divided by GDP and multiplied by 100; foreign direct investment (*FDI*) inflows as a share of GDP; the share of the industrial sector, including construction (*IND*), as a percentage of GDP; energy consumption (*ENERGY*) in kWh per person; and the share of renewable energy (*RENERGY*) as a percentage of total final energy consumption. The political aspect is represented by the political regime variable (*POL*), scaled from 0 for autocracy to 9 for liberal democracy (Lührmann et al., 2018). Variables CO_2C*, GDPC, ENERGY*, and *POL* are expressed in natural logarithmic form. Meanwhile, φ_i captures country fixed effects (due to cross-country differences in economic structure, culture, climate, etc.), and e_{it} is the error term. Based on the dynamic model specification in Equation (4), the EKC hypothesis is supported if $\beta_1>0$ and $\beta_2<0$. The PHH hypothesis is supported if $\beta_3>0$ and $\beta_4>0$. This study also performs robustness testing by substituting CO_2 emissions per capita with ecological footprint per person.

The model in Equation (4) can be estimated using the pooled mean group (PMG), mean group (MG), and dynamic fixed effect (DFE) techniques. The PMG estimator in the PARDL model has advantages in determining dynamic long-term and short-term relationships. The PMG estimator can estimate short-term relationships, including coefficients and adjustment speeds to long-term equilibrium, while allowing the error variance to be heterogeneous. Long-term coefficients are constrained to be homogeneous across countries. This method is suitable because it is more efficient and consistent, especially when a long-term relationship exists. The primary difference between this method and others is that not all series need to be stationary at the same level. The panel ARDL method also provides robust and effective results for small samples (Narayan and Narayan, 2004). The PARDL-PMG approach considers cross-sectional heterogeneity through short-term parameters (Mensah et al., 2019).

The MG estimator, according to Pesaran and Smith (1995), has a less restrictive procedure that can estimate parameter diversity. The MG estimator can also estimate different coefficients for each country. Both MG and PMG estimators require selecting an appropriate lag length using the Schwarz Bayesian Criterion (SBC) or Akaike Information Criterion (AIC). The MG estimator provides consistent long-term averages, though it may be inefficient when assuming homogeneity. With long-term homogeneity, pooled estimators are consistent and efficient.

The DFE estimator is like the PMG estimator. DFE can restrict cointegration coefficients to be consistent across all panels. Additionally, it restricts time adjustment coefficients, resulting in consistent short-term estimates. DFE constrains the integration vector coefficients across all panels. All estimators (PMG, MG, and DFE) can indicate the long-term and short-term effects of each variable. According to Pesaran et al. (1999), this approach is more consistent in producing long-term coefficients regardless of whether the order of integration is I(0) or I(1). This method leverages a large combination of time-series and cross-sectional data.

The Hausman test (1978) is used to choose an efficient and consistent estimator between the PMG or MG estimators and between the PMG or DFE estimators. According to Pirotte (1999), the MG estimator allows independent parameters between groups and does not account for inter-group heterogeneity. However, Pesaran et al. (1999) argue that the PMG estimator is preferable because it provides different short-term variance coefficients across countries, while assuming long-term homogeneity for all countries. In contrast, the MG estimator allows both short-term and long-term coefficients to be heterogeneous across countries. The choice between the PMG and MG estimators depends on the null hypothesis test. If the null hypothesis cannot be rejected, then the PMG estimator is selected because it is more efficient and consistent than the MG estimator. If the null hypothesis is rejected, then the MG estimator is chosen over the PMG. Furthermore, to choose between the PMG and DFE estimators, if the null hypothesis cannot be rejected, the PMG estimator is more efficient and consistent than the DFE estimator.

2.1.1. Pre-Estimation Test

Before estimating the PARDL model, it is necessary to conduct tests for cross-sectional dependence, unit roots, and cointegration. Cross-sectional dependence testing is crucial before selecting first-generation or second-generation unit root tests. If there is dependence between units, first-generation tests like the Augmented Dickey-Fuller (ADF) may result in bias and size distortion, as they do not account for relationships between units (Baltagi and Pesaran, 2007; Chang, 2002). Thus, if cross-sectional dependence is detected, second-generation tests such as the Cross-sectionally Augmented Dickey-Fuller (CADF) and Cross-sectionally Augmented IPS (CIPS) are recommended, as they utilize information from other units and capture common factors in panel data (Pesaran et al., 2013). The unit root test is critical in PARDL modeling. If data contain unit roots, it implies issues with autocorrelation and heteroskedasticity, which may lead to invalid estimators and result in spurious regressions. The initial step in this empirical approach is to identify the order of integration in the data, which is essential for estimating the ARDL model. It must be ensured that the variables in the regression are integrated at order zero, I(0), or at most integrated at order one, I(1). The ARDL approach fails to provide robust results with variables integrated at order two, I(2); thus, I(2) variables should be excluded from the dataset.

A panel cointegration test is conducted to determine if a long-term equilibrium relationship exists among non-stationary variables. The concept of cointegration was introduced by Engle and Granger (1987), suggesting that a linear combination of two or more non-stationary variables can result in a stationary variable. This linear combination, known as the cointegration equation, can be interpreted as a long-term equilibrium relationship among the variables. After confirming the order of integration, the Pedroni (1999; 2004) and Kao (1999) panel cointegration tests are conducted. Other panel cointegration tests, such as Westerlund (2007), are not valid for this study's purpose, as Westerlund himself noted that the test often suffers from distortions when the time series sample size is <100. The Pedroni (1999; 2004) and Kao (1999) tests are based on panel data models for the dependent variable I(1) and test the null hypothesis of no cointegration against the alternative hypothesis of cointegration.

3. RESULTS AND DISCUSSION

3.1. Descriptive Analysis

Table 1 presents descriptive statistics, providing important insights into the characteristics of the main variables analysed in the study. The data reveal significant variation among countries in terms of CO_2 emissions per capita, ecological footprint per person, real GDP per capita, trade openness, and foreign direct investment, reflecting differences in levels of economic development and industrial activity. High variability in variables such as foreign direct investment and energy use suggests that some countries may rely more heavily on international capital flows and intensive energy consumption. Additionally, the wide range in renewable energy usage indicates that the adoption of sustainable energy varies significantly across countries. The inclusion of political variables in this analysis also suggests that policy aspects and political stability are considered potential factors influencing economic and environmental performance.

Figure 6 compares CO_2 emissions between 1990 and 2022 among countries with an official religion. The left map illustrates total CO_2 emissions (in kilotons) and CO_2 emissions per capita (in metric tons per capita) in 1990, while the right map depicts the same data for 2022. In 1990, countries such as the United Kingdom and Norway had relatively high CO_2 emissions, both in total and per capita. However, by 2022, some Middle Eastern countries, particularly Iran, recorded extremely high CO_2 emissions, both total and per capita. This shift indicates a change in the CO_2 emission center from European countries to the Middle Eastern region (Arouri et al., 2012). Figure 6 not only highlights the geographic shift in CO_2 emissions from Europe to the Middle East but also underscores other important trends. In 2022, countries like Iran experienced a significant increase in CO_2 emissions compared to 1990, likely influenced by industrial growth and an oil- and gas-based economy in the region. In contrast, European countries such as the United Kingdom and Norway exhibited stable or slightly declining CO_2 emissions, possibly due to the implementation of clean energy policies and the transition to renewable energy sources (Lisaba and Lopez, 2021). Furthermore, differences in CO_2 emissions per capita between specific regions have become more pronounced, with some Middle Eastern countries showing very high per capita emissions due to high energy consumption for industrial needs and domestic uses, such as air conditioning (Elmarzougui et al., 2016). These differences indicate that countries with an official religion in different regions exhibit diverse economic dynamics and environmental policies, with developed countries tending to be more successful in controlling emissions compared to developing countries experiencing increased energy consumption and industrialization.

This study continues by investigating correlations among variables, as shown in Figure 7 through a correlation heatmap. The correlation results reveal a strong positive correlation between CO_2 emissions per capita and energy use per person, as well as GDP per capita, indicating that higher energy consumption and economic growth tend to be associated with higher emissions. Additionally, there is a negative correlation between renewable energy and CO_2 emissions, suggesting that countries with a higher proportion of renewable energy tend to have lower emissions. However, the negative correlation between renewable energy and GDP per capita implies that adopting renewable energy is not always associated with high economic growth in certain contexts. Some

Table 1: Descriptive statistics

Variable	Symbol	Obs.	Mean	Standard deviation	Min.	Max.
ln CO_2 per capita	LCO2C	957	1.66	0.95	0.10	3.95
ln Ecological footprint per person	LEFP	783	1.41	0.61	0.37	2.86
ln Real GDP per capita	LGDPC	957	2.75	1.09	0.11	4.71
Trade	TRADE	957	88.30	50.26	0.02	333.12
Foreign direct investment	FDI	957	4.92	23.35	-28.31	449.08
Industry	IND	957	32.53	14.91	7.00	85.00
ln Energy use per person	LENERGY	957	9.87	1.45	5.36	12.64
Renewable energy	RENERGY	957	19.89	25.61	0.00	90.32
ln Politic	LPOL	957	1.31	0.85	0.00	2.30

Sample size was 29 countries.

Figure 6: Comparison of CO_2 emissions in 1990 and 2022 for countries with official religions (processed from the World Bank, 2022)

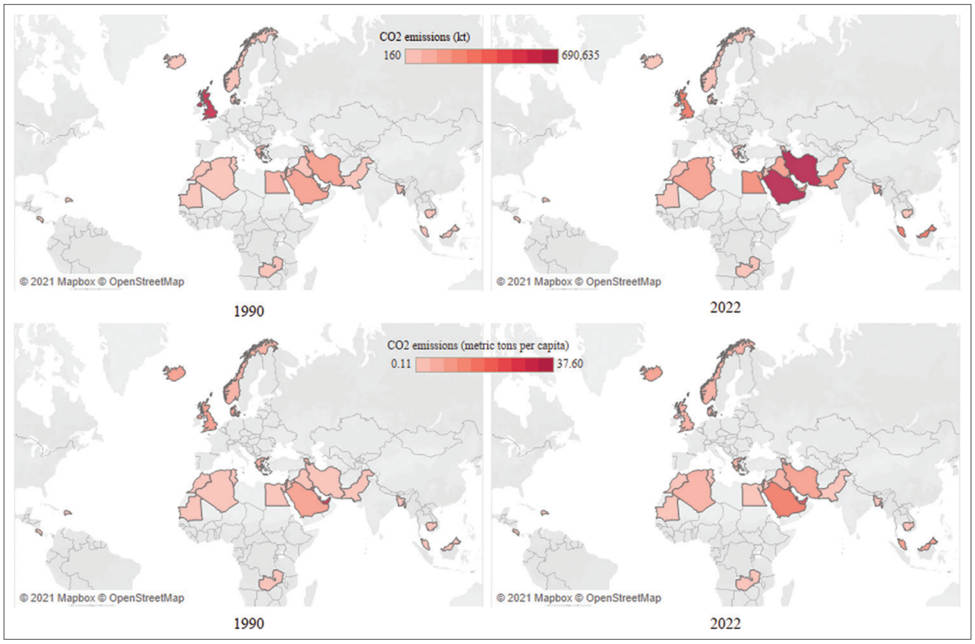
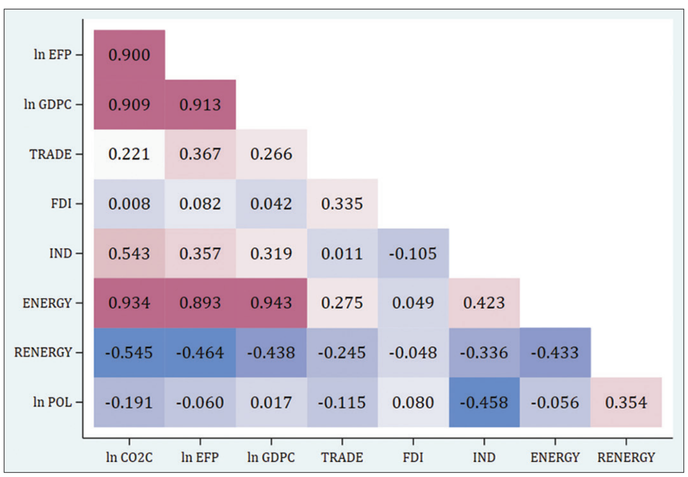


Figure 7: Pairwise correlation heatmap



other variables, such as foreign direct investment, show weak correlations with other variables, suggesting that its relevance in this context may not be highly significant.

3.2. Cross-Sectional Dependence and Unit Root Tests

Before estimating the ARDL model, it is crucial to perform cross-sectional dependence and unit root tests. The cross-sectional dependence test examines whether there is interdependence among units in the panel data. If dependence exists, first-generation unit root tests such as ADF or PP are no longer adequate. In such cases, second-generation unit root tests, such as Pesaran's CADF or CIPS, are used to accommodate cross-sectional dependence (Pesaran, 2021; Barbieri, 2009). Table 2 shows that all variables exhibit cross-sectional dependence, as indicated by most CD values being significant at the 1% level, except for the political variable, which is significant at the 10% level. This finding suggests a correlation among countries in the panel data. To check for stationarity, unit root tests using the CIPS and CADF methods were conducted. The test results indicate that most variables are non-stationary at level (I(0)) but become stationary after first differencing (I(1)), as shown by the rejection of the null hypothesis in the CIPS(1) and CADF(1) columns. This implies that the variables have long-term trends and require differencing to achieve stationarity. These findings emphasize the importance of accounting for cross-sectional dependence in the analysis to ensure the validity of the model and the reliability of the results obtained.

3.3. Optimal Lag Selection

The selection of the optimal lag in the Autoregressive Distributed Lag (ARDL) model aims to identify the most appropriate lag combination. Selecting the optimal lag is crucial, as it directly affects the accuracy and quality of predictions, enabling a more in-depth analysis of the effects of independent variables, both in the current and past periods. Table 3 presents the results of lag selection for the Panel ARDL model based on several criteria: Modified Bayesian Information Criterion (MBIC), Modified Akaike Information Criterion (MAIC), and Modified Quasi Information Criterion (MQIC), as well as the J-statistic test and p-value. In lag selection, information criteria such as MBIC, MAIC, and MQIC are used to evaluate the model by choosing the lowest value as the best indicator, as it represents a balance between model complexity and predictive capability (Katuka et al., 2023; Zhao and Park, 2024). The results indicate that a lag of 1 meets all criteria effectively, as it not only has the lowest information criterion values but is also statistically significant based on the J-statistic. Longer lags, although tested, did not show meaningful improvement and tended to reduce model efficiency. Therefore, a lag of 1 is considered optimal, as it effectively captures the relationships between variables while keeping the model simple and avoiding overfitting.

3.4. Cointegration Test

To test the long-term relationships among variables, this study employs the Pedroni and Kao cointegration tests (Dradra and Abdennadher, 2024; Abdullahi et al., 2024; Ullah et al., 2024).

Table 2: Cross-sectional dependence and unit root tests

Variable	CD	CIPS (0)	CIPS (1)	CADF (0)	CADF (1)
ln CO_2 per capita	8.89***	−1.35	−5.32***	−1.44	−2.93***
ln Ecological footprint per person	16.204***	−2.427***	−5.485***	−2.252***	−2.893***
ln Real GDP per capita	71.91***	−2.51***	−4.20***	−2.06*	−2.55***
Trade	15.63***	−1.83	−4.83***	−1.62	−2.99***
Foreign direct investment	21.49***	−3.46***	−5.96***	−2.03*	−3.81***
Industry	8.31***	−2.03	−5.37***	−1.61	−2.92***
ln Energy use per person	15.12***	−2.18**	−5.10***	−1.98	−3.25***
Renewable energy	3.05***	−0.86	−4.83***	−0.92	−2.77***
ln Politic	82.84*	−1.07	−2.75***	−1.08	−2.08**

CD is cross-sectional dependence, CIPS is Pesaran unit root test and CADF is Augmented Dickey-Fuller test in the presence of cross-sectional dependence. *, **, and *** indicate significance at 10%, ** at 5% and *** at 1%, respectively

Table 3: Criteria for optimal lag selection in PARDL

Lag Lengths	J	P-value	MBIC	MAIC	MQIC
1	389.675	0.005	−1730.451	−250.325	−820.507
2	306.672	0.016	−1389.428	−205.328	−661.473
3	192.174	0.482	−1079.901	−191.826	−533.935
4	129.095	0.456	−718.955	−126.905	−354.978

Table 4: PARDL cointegration test results

Test	Statistic	P-value
Kao		
Modified Dickey-Fuller t	−2.718	0.003
Dickey-Fuller t	−5.383	0.000
Augmented Dickey-Fuller t	−0.547	0.292
Unadjusted modified Dickey	−9.315	0.000
Unadjusted Dickey-Fuller t	−8.364	0.000
Pedroni		
Modified Phillips-Perron t	4.558	0.000
Phillips-Perron t	−3.403	0.000
Augmented Dickey-Fuller t	−3.224	0.001

The results of the Kao test indicate that most statistics, such as the Dickey-Fuller t and Modified Dickey-Fuller t, are significant with P-values below 0.05, suggesting the presence of cointegration or a long-term relationship between variables. However, the Augmented Dickey-Fuller t statistic in the Kao test is not significant, meaning that not all tests yield consistent results. Meanwhile, the Pedroni test reinforces these findings, as all tests, including the Phillips-Perron t and Augmented Dickey-Fuller t, show significance at the 5% level (see Table 4). These results confirm the existence of a long-term relationship among variables. Overall, both tests indicate that the variables in the model move together in the long term, despite short-term fluctuations. This finding supports the validity of using the PARDL model to evaluate long-term relationships.

3.5. The Effect of Economic Development on Climate Change

Table 5 presents the estimation results of the impact of economic and political factors on CO_2 emissions per capita. Based on the Hausman test, the null hypothesis (H□) of homogeneity cannot be rejected in both the MG versus PMG comparison (with a probability value of 0.977) and the MG versus DFE comparison (with a probability value of 1.000). This suggests that the assumption of homogeneity—i.e., that long-term effects of variables are consistent across countries—can be accepted. The model selected as the best is PMG in the first comparison and DFE in the second. However, since both indicate consistent homogeneity, PMG is recommended when short-term heterogeneity across countries is an important consideration. This flexibility makes PMG more realistic in capturing short-term differences between countries while maintaining long-term consistency in estimates (Ahmad et al., 2022; Espoir et al., 2023; Brini, 2021). Therefore, PMG is chosen as the most reliable estimator among the three models tested, providing the best balance between flexibility and accuracy in panel data analysis.

The results are explained in three sections: the error correction term (ECT), long-term effects, and short-term effects. The estimation results show that all models (MG, PMG, and DFE) have a significant and negative ECT. These models are able to adjust back to the long-term equilibrium path after experiencing a shock. The fastest adjustment occurs in the MG model, followed by DFE and PMG. Whenever there is a deviation from equilibrium, the models correct this error to regain stability, though at different speeds (Li and Shao, 2022; Shaari et al., 2020).

In analyzing long-term effects, there is no evidence supporting the existence of the EKC hypothesis in any of the models. In the MG model, economic growth and its square have no significant effect on CO_2 emissions per capita. In the PMG model, economic growth has a negative effect on CO_2 emissions per capita, while the square of economic growth has a significant positive effect. In the DFE model, economic growth significantly affects CO_2 emissions per capita, but the square of economic growth has no significant effect. Based on these results, the EKC hypothesis is not confirmed in the sample of countries with an official religion. This finding is consistent with studies by Djellouli et al. (2022) in Africa, Ochoa-Moreno et al. (2021) in Latin America, and Sadik-Zada and Ferrari (2020) in 26 OECD countries.

The absence of EKC support may be due to several reasons. First, the pattern of emission reduction with economic growth does not consistently occur in all countries, particularly in developing countries where increased real GDP per capita is more

Table 5: Estimation of MG, PMG, and DFE in the PARDL model

Dependent variable=*LCO2C*	MG (1)	PMG (2)	DFE (3)
ECT	−0.578*** (0.066)	−0.184*** (0.048)	−0.219*** (0.020)
Long-run coefficients			
ln Real GDP per capita	−21.940 (23.370)	−0.259*** (0.064)	0.261* (0.153)
(ln Real GDP per capita)^2	2.319 (2.516)	0.054*** (0.014)	−0.042 (0.031)
Trade	−0.000 (0.002)	−0.000 (0.000)	−0.004*** (0.001)
Foreign direct investment	−0.011 (0.009)	0.002** (0.001)	0.001** (0.001)
Industry	−0.011 (0.008)	−0.004*** (0.001)	0.007*** (0.002)
ln Energy use per person	0.088 (0.205)	0.610*** (0.025)	0.237*** (0.050)
Renewable energy	0.218 (0.499)	−0.002** (0.001)	−0.006** (0.003)
ln Politic	0.048 (0.074)	−0.001 (0.016)	0.136*** (0.042)
Short-run coefficients			
Δln Real GDP per capita	−3.410 (4.245)	0.689 (3.407)	0.159** (0.080)
Δ (ln Real GDP per capita)^2	0.519 (0.557)	−0.014 (0.417)	−0.005 (0.0182)
ΔTrade	−0.000 (0.000)	−0.000 (0.001)	−0.002*** (0.000)
ΔForeign direct investment	0.000 (0.002)	−0.000 (0.001)	0.000 (0.000)
ΔIndustry	−0.000 (0.001)	0.001 (0.001)	0.001 (0.001)
Δln Energy use per person	0.224*** (0.056)	0.294*** (0.051)	0.251*** (0.024)
ΔRenewable energy	−0.164** (0.079)	−0.121* (0.063)	−0.014*** (0.002)
Δln Politic	0.060 (0.058)	0.027 (0.043)	0.052*** (0.012)
Constant	0.845 (3.335)	−0.703*** (0.183)	−0.217** (0.101)
No. of observation	928	928	928
No. of countries	29	29	29
Hausman test	-	(1) versus (2)	(1) versus (3)
Chi-square	-	1.65	0
Prob>Chi-square	-	0.977	1.000
Decision	-	The H_0 of homogeneity cannot be rejected	The H_0 of homogeneity cannot be rejected
Which model is Good?	-	PMG	DFE

The dependent variable is LCO_2C in each column. Standard errors in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. The results are reported only three digits after decimal to avoid space consumption

likely accompanied by higher fossil fuel consumption and CO_2 emissions. According to Destek and Sarkodie (2019), the validity of EKC is strongly influenced by policy factors. Only countries with strong environmental policies may experience emission reductions as their economies grow, while countries with less strict regulations tend to maintain or increase emissions. Second, economic structure plays a significant role, as countries reliant on heavy industry or manufacturing find it more difficult to reduce emissions as their economies grow compared to service-based economies, since the industrial sector is generally more energy-intensive and polluting (Acheampong et al., 2020).

Third, in the era of globalization, foreign investment flows to developing countries often relocate polluting industries to these countries, thereby hindering efforts to reduce CO_2 emissions in line with the EKC pattern. This phenomenon, known as carbon leakage, occurs when emissions shift from developed to developing countries with weaker environmental regulations (Misch and Wingender, 2024). Fourth, the increased consumption demand driven by economic growth spurs higher fossil fuel use, which directly raises emissions, challenging emission reductions amid rising incomes. Fifth, green technology adoption or clean energy use does not automatically accompany economic growth, especially in countries with limited technology access, making the EKC pattern inapplicable for CO_2 emission reduction.

In the context of the PHH hypothesis, analysis results indicate that trade openness has a significant effect only in the DFE model, with a negative coefficient. This finding suggests that trade openness does not support the PHH, which posits that countries with lax environmental regulations will attract more polluting trade or production activities. Instead, the negative relationship suggests that increased trade openness may actually contribute to reducing CO_2 emissions per capita, possibly through the adoption of more efficient and environmentally friendly technology or higher environmental standards from global market participation. On the other hand, FDI inflows consistently show a significant positive impact on CO_2 emissions per capita, as evidenced in the PMG and DFE models. This positive coefficient supports the PHH hypothesis, confirming that foreign investment tends to be directed toward high-carbon-intensive sectors in host countries, especially where environmental regulations are lax. Consequently, FDI may worsen the environmental conditions of recipient countries, as increased investment brings negative impacts in the form of increased pollution and carbon emissions, aligning with the notion that foreign companies seek locations with low environmental costs. Studies supporting the PHH include those by Djellouli et al. (2022), Ochoa-Moreno et al. (2021), and Bakirtas and Cetin (2017).

There are several factors behind the increase in CO_2 emissions per capita due to FDI in countries with an official religion. First, most of these countries may have less strict environmental regulations, either due to policy priorities focused on cultural and social values or limited emphasis on environmental issues in domestic policies. This aligns with findings by Shahbaz et al. (2018), which indicate that environmental regulations are weaker in countries with less focus on sustainability, allowing foreign companies to operate with lower environmental standards. Second, FDI inflows often target capital- and energy-intensive industrial sectors that directly contribute to emissions. According to Cole et al. (2017), multinational companies often seek countries with minimal environmental barriers to maximize their profits. Third, some countries may experience socio-political pressure to prioritize investment and employment over strict environmental regulations, as some religious traditions may place greater emphasis on social and economic stability than environmental sustainability, making environmental regulations less of a priority (Clements et al., 2014).

The estimation results show differences in the impact of the industrial sector between the PMG and DFE models. Industrialization has been a double-edged sword in terms of CO_2 emissions per capita. Although industrialization has historically contributed to increased emissions through increased production and energy consumption, recent trends indicate that industrialization also has significant potential to facilitate CO_2 reduction through technological advancements and regulatory frameworks. In the PMG model, the industrial sector has a significant negative effect on CO_2 emissions per capita, suggesting that increased industrial activity is associated with reduced emissions. This may indicate that some countries in this model have successfully integrated eco-friendly technologies and implemented energy efficiency in their industrial processes. Additionally, stringent environmental regulations may already be in place, forcing industries to adapt to low-emission standards. The use of green technologies, such as renewable energy and improved production process efficiency, likely also plays a role in reducing emissions.

Industrialization can reduce CO_2 emissions per capita through increased energy efficiency and clean technology adoption, although this sector remains a major global emitter due to its reliance on fossil fuels, particularly coal, which requires carbon capture and storage (CCS) technology for mitigation (Polyzou, 2023). Studies show that energy efficiency is critical for industrial energy conservation and emissions reduction (Wang et al., 2015), while transitioning to advanced and low-energy consumption technologies is also a key strategy (Wang and Zhang, 2021). Policy interventions such as carbon taxes place economic pressure on industries to reduce emissions and switch to renewable energy (Cox et al., 2022). These taxes encourage low-carbon technological efficiency and innovation, further supported by renewable energy incentives such as solar and wind subsidies, which Kyzym et al. (2023) found effective in encouraging the industrial sector to adopt green practices and achieve significant emission reductions while creating sustainable economic growth opportunities.

Conversely, the DFE model shows a significant positive effect of the industrial sector on CO_2 emissions per capita, indicating that in some countries, industrialization still relies on conventional high-carbon technology (Murad et al., 2018). Dependence on fossil fuels and a lack of investment in clean technology may be primary reasons emissions remain high. Additionally, countries in the early stages of industrialization may focus more on economic growth than environmental sustainability, so emission reduction policies are not yet prioritized. The differing results between these two models reflect heterogeneity in technological progress and environmental policy implementation across countries. The PMG model assumes that, in the long term, all countries in the sample will converge, meaning the industrial impact will become uniform once a certain development level is reached. In contrast, the DFE model captures variations across countries more specifically, where some may still be in transition toward clean technology and adequate environmental regulation.

Energy consumption per capita has a positive and significant effect on CO_2 emissions per capita, as seen in both the PMG and DFE models. This is especially true in countries that still rely on fossil fuels like oil, gas, and coal to support economic growth and daily activities, such as electricity, transportation, and industrial processes (Osobajo et al., 2020; Adeleye et al., 2021; Alam and Paramati, 2015). High energy consumption is indeed linked to improved living standards and industrialization, but without a shift to clean energy, this usage will worsen pollution and accelerate climate change (Rahman et al., 2021). Although both models show a similar effect, the DFE model shows a smaller impact compared to PMG, indicating that in some countries, the impact of energy consumption on emissions has begun to decrease. This may be due to the adoption of renewable energy or the implementation of energy efficiency policies that help curb emissions by reducing the carbon intensity per unit of energy. However, many countries still face challenges in transitioning to clean energy due to high costs, limited technology, and reliance on old energy infrastructure, so conventional energy consumption remains a major challenge for carbon emission reduction efforts (Borenstein and Kellogg, 2021).

Renewable energy use has a significant negative impact on CO_2 emissions per capita in both the PMG and DFE models, indicating that increasing the share of renewable energy in the energy mix effectively reduces carbon emissions. Renewable energy sources such as solar, wind, and hydro play a vital role in reducing reliance on fossil fuels, the primary source of emissions (Kumar, 2020; Kumar et al., 2021; Bölük and Mert, 2014). By replacing conventional energy, renewable energy not only reduces pollution but also supports the transition to a low-carbon economy. Moreover, adopting clean energy allows countries to mitigate environmental impacts without hindering economic growth, especially amid rising global energy demand (Mammadov et al., 2022; Lima et al., 2020). Policies supporting renewable energy development, such as investment incentives, infrastructure financing, and regulations facilitating technological innovation, are crucial in accelerating the energy transition and ensuring environmental sustainability. This is increasingly relevant given the challenges of climate change and the need to reduce emissions in the energy sector, one of the world's largest carbon contributors (Szetela et al., 2022).

The political system variable in the DFE model has a positive and significant coefficient, meaning that higher levels of democracy are associated with increased CO_2 emissions per capita. In liberal democracies, governments often face pressure to prioritize economic growth and meeting citizens' needs. This can lead to increased energy consumption and carbon emissions, especially since democratic societies usually have greater access to energy-intensive goods and services, such as electricity and transportation.

Moreover, government decisions may be more influenced by short-term economic demands than environmental agendas. Conversely, in the PMG model, the political variable coefficient is not significant, suggesting that the impact of the political system on CO_2 emissions per capita may vary by country context. Some democracies may successfully balance economic growth with eco-friendly policies by adopting renewable energy, while in other countries, economic growth remains the primary focus with less emphasis on environmental issues.

The impact of democratization on CO_2 emissions per capita is complex, involving various factors that can produce different influences. On one hand, democratization can increase CO_2 emissions per capita because democratic countries tend to experience faster economic growth, which in turn drives energy consumption and emissions. You et al. (2015) found that the impact of democracy on CO_2 emissions varies by emission levels, with democracies generally having higher emissions due to economic activity and consumption patterns. Policardo (2014) noted that although democratic countries typically have better environmental policies than authoritarian ones, economic activity in democracies can increase emissions. Gök's (2020) study in Turkey supports this view, showing that economic growth facilitated by a democratic system can negatively impact environmental quality, including increased CO_2 emissions.

However, democratization can also reduce emissions due to stronger commitments to sustainable environmental policies. According to Povitkina (2018), democratic countries generally emit less CO_2, although this effectiveness is greatly influenced by low levels of corruption, which allows for effective environmental policy implementation. Findings by Muttakin et al. (2022) support this, indicating that countries with strong democratic institutions have lower carbon emission intensity, suggesting that transparent and effective governance can enhance environmental performance. Research by Iheonu et al. (2023) in Africa also found that higher democracy quality correlates with reduced emissions, thanks to democratic aspects that emphasize transparency and equality.

In the short-term analysis, neither the EKC nor PHH hypotheses are supported by any of the models. This is consistent with recent empirical evidence suggesting that the relationship between economic growth and emission reduction requires time and depends on long-term policies. EKC often only appears after economies reach maturity with clean technology and strict regulation. Meanwhile, the lack of evidence for PHH in the short term reflects that the relocation of polluting industries through trade and FDI takes time and depends on the environmental policies of the host country. Host countries receiving FDI may not yet have implemented strict regulations, but the effects of emission relocation will only be visible in the long term. Additionally, some origin countries with strict regulations may have reduced potential carbon leakage through sustainable trade policies, thereby minimizing pollution exports through FDI and trade. The impact of PHH is more evident in the long term when industrial relocation and environmental regulation enforcement evolve over time. Success in reducing emissions remains heavily reliant on clean energy policies and technological transitions within each country.

Short-term analysis results show that some sectors significantly impact CO_2 emissions per capita, while others do not have a meaningful effect. Energy consumption per capita shows a significant positive effect in all models, indicating that increased energy consumption directly drives carbon emissions. Conversely, renewable energy has a significant negative effect, suggesting that an increase in clean energy immediately reduces emissions. On the other hand, the industrial sector does not have a significant short-term impact. This may be because changes in industrial production and technological shifts take longer to affect emissions. The political system is only significant in the DFE model, indicating that in certain contexts, changes in political dynamics can influence emissions, especially through economic and environmental policies. Overall, energy consumption remains the primary driver of emissions in the short term, while the transition to clean energy provides immediate benefits.

In the PMG analysis conducted across multiple countries, the effects of various economic and political variables on CO_2 emissions per capita in the short term are observed (Table 6). The research variables have varying impacts on CO_2 emissions per capita, indicating that the relationship between these factors and emission levels is not uniform across countries. Instead, it depends on specific economic characteristics, levels of industrialization, and energy policies.

In this analysis, the EKC hypothesis is only valid for certain countries. Among countries with Islam as the official religion, Jordan and Pakistan exhibit an EKC pattern, while among Christian-majority countries, Armenia, Denmark, and the Dominican Republic also support this hypothesis. Additionally, Israel, with Judaism as the official religion, shows a similar pattern. In these countries, real GDP per capita increases to a certain point, followed by a decrease in CO_2 emissions per capita (Adebanjo and Shakiru, 2022; Alkhawaldeh et al., 2023; Shakoor et al., 2023; Almeida et al., 2024; Kar, 2024; Sánchez-Fung, 2017; Cave, 2020). This indicates a link between economic development and increased environmental awareness, as well as the adoption of more eco-friendly technology. On the other hand, most countries in the sample do not exhibit EKC validity. This suggests that economic growth in these countries does not always lead to reduced CO_2 emissions. Factors likely contributing to this include reliance on high-emission conventional energy or a lack of strict environmental policies to support a transition to low-carbon technology.

The analysis also evaluates the validity of the PHH hypothesis, which posits that countries with lax environmental regulations tend to attract high-pollution industries. The results indicate that only some countries in the sample support the PHH hypothesis, meaning that the impact of trade openness and FDI on increased CO_2 emissions per capita is more significant in countries with relatively lax environmental regulations or substantial incentives for investment in high-pollution industries. Countries supporting the PHH hypothesis include Bahrain, Malaysia, Iraq, and Denmark. In these countries, trade openness or incoming FDI tends to contribute to increased CO_2 emissions per capita, likely due to less stringent environmental policies or incentives for carbon-

Table 6: Short-term results for 29 countries with an official religion using the PMG estimator

Country	Religion	ECT	DLGDPC	DLGDPC2	DTRADE	DFDI	DIND	DLENERGY	DRENERGY	DLPOL	EKC	PHH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
United Arab Emirates	Muslim	−0.354**	0.186	−0.018	0.001	0.002	0.000	0.699***	−0.093	0.248***	Invalid	Invalid
		(0.164)	(2.684)	(0.309)	(0.001)	(0.005)	(0.002)	(0.166)	(0.109)	(0.058)		
Bangladesh	Muslim	−0.042***	−0.132	0.011	0.000	0.002	0.001	0.0697**	−0.004***	0.001	Invalid	Invalid
		(0.012)	(0.171)	(0.044)	(0.000)	(0.003)	(0.001)	(0.028)	(0.001)	(0.002)		
Bahrain	Muslim	−0.873***	−60.670***	8.053***	0.000	0.002*	−0.002	0.289**	-	-	Invalid	Valid
		(0.143)	(13.280)	(1.740)	(0.001)	(0.001)	(0.003)	(0.120)	-	-		
Algeria	Muslim	−0.036	−3.411	0.722	−0.000	−0.019***	0.001	0.330***	0.026	0.008	Invalid	Invalid
		(0.056)	(2.196)	(0.490)	(0.001)	(0.006)	(0.001)	(0.093)	(0.044)	(0.012)		
Egypt, Arab Rep.	Muslim	−0.188	−2.763*	0.616*	0.001	0.002	−0.001	0.335***	−0.034***	0.004	Invalid	Invalid
		(0.117)	(1.594)	(0.360)	(0.001)	(0.002)	(0.002)	(0.090)	(0.007)	(0.005)		
Iran, Islamic Rep.	Muslim	−0.081	0.080	−0.016	0.000	−0.015**	0.002	0.470***	−0.006	–	Invalid	Invalid
		(0.085)	(1.460)	(0.284)	(0.001)	(0.007)	(0.001)	(0.094)	(0.016)	-		
Iraq	Muslim	−0.432***	−0.211	0.067	0.001**	−0.004	−0.001	0.552***	0.010	−0.013	Invalid	Valid
		(0.097)	(0.162)	(0.048)	(0.000)	(0.005)	(0.001)	(0.041)	(0.013)	(0.019)		
Jordan	Muslim	−0.498***	4.071*	−0.851*	−0.000	0.001	0.003	0.326***	−0.040***	-	Valid	Invalid
		(0.095)	(2.197)	(0.483)	(0.000)	(0.001)	(0.003)	(0.087)	(0.006)	-		
Kuwait	Muslim	−0.553***	−10.480**	1.292**	−0.010***	−0.001	0.003	0.745***	−0.783**	−0.024	Invalid	Invalid
		(0.083)	(5.005)	(0.610)	(0.002)	(0.006)	(0.002)	(0.101)	(0.330)	(0.025)		
Morocco	Muslim	−0.831***	−1.254***	0.402***	0.000	0.001	−0.005***	0.488***	0.001	-	Invalid	Invalid
		(0.168)	(0.403)	(0.137)	(0.000)	(0.001)	(0.002)	(0.049)	(0.001)	-		
Maldives	Muslim	−0.129**	1.052	−0.159	−0.003*	0.001	0.010	0.168***	−0.190***	0.035	Invalid	Invalid
		(0.052)	(1.963)	(0.354)	(0.002)	(0.003)	(0.007)	(0.044)	(0.021)	(0.034)		
Mauritania	Muslim	0.007	−4.003	1.327	−0.001	0.000	0.000	−0.004	−0.008***	0.019***	Invalid	Invalid
		(0.013)	(2.520)	(0.820)	(0.000)	(0.001)	(0.001)	(0.013)	(0.003)	(0.007)		
Malaysia	Muslim	−0.399***	−1.166	0.219	−0.001	0.006**	0.005	0.242*	−0.002	−0.158	Invalid	Valid
		(0.145)	(1.612)	(0.273)	(0.001)	(0.003)	(0.004)	(0.137)	(0.009)	(0.117)		
Pakistan	Muslim	−0.171**	1.373**	−0.576***	−0.002**	0.012***	−0.001	0.172***	−0.012***	−0.007	Valid	Mixed
		(0.068)	(0.657)	(0.219)	(0.001)	(0.004)	(0.002)	(0.051)	(0.002)	(0.005)		
Qatar	Muslim	−0.142**	72.14	−7.917	0.001	−0.003	−0.002	0.006	−0.417	-	Invalid	Invalid
		(0.063)	(71.740)	(7.947)	(0.002)	(0.007)	(0.004)	(0.099)	(0.358)	-		
Saudi Arabia	Muslim	−0.052	−7.194	0.987	−0.000	0.000	−0.002	0.188	−1.685	-	Invalid	Invalid
		(0.097)	(8.831)	(1.176)	(0.002)	(0.004)	(0.002)	(0.162)	(1.025)	-		
Tunisia	Muslim	−0.049	−0.864	0.291	0.000	0.001	−0.001	0.003	−0.018***	0.016	Invalid	Invalid
		(0.064)	(1.697)	(0.382)	(0.001)	(0.002)	(0.006)	(0.069)	(0.007)	(0.033)		
Armenia	Christian	0.046	1.194**	−0.194	0.003	−0.002	0.010	0.198*	−0.039***	0.246**	Valid	Invalid
		(0.086)	(0.471)	(0.137)	(0.002)	(0.005)	(0.018)	(0.110)	(0.005)	(0.106)		
Costa Rica	Christian	−0.056	0.550	0.085	−0.003*	0.016**	0.008	0.132	−0.007***	-	Invalid	Mixed
		(0.087)	(1.748)	(0.303)	(0.001)	(0.007)	(0.006)	(0.131)	(0.002)	-		
Denmark	Christian	−0.078***	11.420**	−1.555**	0.0027***	−0.000	−0.010*	1.010***	−0.022***	−0.616***	Valid	Valid
		(0.023)	(5.679)	(0.725)	(0.001)	(0.001)	(0.006)	(0.058)	(0.003)	(0.150)		
Dominican Republic	Christian	0.0105	2.167***	−0.366**	−0.001	0.004	0.008*	0.171**	−0.016***	−0.096	Valid	Invalid
		(0.110)	(0.742)	(0.145)	(0.001)	(0.004)	(0.005)	(0.080)	(0.004)	(0.062)		
United Kingdom	Christian	−0.100**	0.857	−0.117	−0.001	−0.001	0.003	0.877***	−0.026**	0.643***	Invalid	Invalid
		(0.040)	(4.194)	(0.560)	(0.001)	(0.001)	(0.006)	(0.172)	(0.011)	(0.229)		
Greece	Christian	0.112***	−2.743	0.428	0.003***	−0.020***	0.012***	0.048	−0.019***	0.157**	Invalid	Mixed
		(0.030)	(2.139)	(0.311)	(0.001)	(0.004)	(0.002)	(0.055)	(0.003)	(0.076)		

(Contd...)

Table 6: (Continued)

Country	Religion	ECT	DLGDPC	DLGDPC2	DTRADE	DFDI	DIND	DLENERGY	DRENERGY	DLPOL	EKC	PHH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Iceland	Christian	0.044	4.933	−0.875	−0.007*	0.002	0.009	−0.071	−0.014	−0.513	Invalid	Invalid
		(0.094)	(11.730)	(1.498)	(0.004)	(0.002)	(0.011)	(0.447)	(0.012)	(0.861)		
Malta	Christian	−0.043	4.615	−0.788	−0.001	0.000	−0.005	0.141	−0.064***	0.377	Invalid	Invalid
		(0.046)	(6.316)	(0.892)	(0.001)	(0.000)	(0.005)	(0.180)	(0.017)	(0.491)		
Norway	Christian	−0.416***	−1.496	0.206	0.004	0.001	−0.005	0.296*	−0.022***	0.35	Invalid	Invalid
		(0.161)	(11.700)	(1.490)	(0.004)	(0.003)	(0.003)	(0.155)	(0.007)	(0.441)		
Zambia	Christian	0.054***	0.081	−0.045	0.000	0.000	−0.001	0.112***	−0.015***	−0.026**	Invalid	Invalid
		(0.017)	(0.171)	(0.089)	(0.000)	(0.001)	(0.001)	(0.029)	(0.001)	(0.013)		
Cambodia	Buddhist	−0.046**	−0.091	0.036	−0.000	0.001	0.002	0.020	−0.006*	0.130	Invalid	Invalid
		(0.019)	(0.073)	(0.086)	(0.001)	(0.002)	(0.003)	(0.022)	(0.003)	(0.110)		
Israel	Jewish	−0.026	11.740**	−1.657**	0.001	0.000	−0.010	0.513***	−0.011**	-	Valid	Invalid
		(0.067)	(5.208)	(0.736)	(0.002)	(0.003)	(0.008)	(0.144)	(0.004)	-		

Standard errors in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

intensive industries (Al-Mulali and Tang, 2013; Ridzuan et al., 2022; Levitt et al., 2015). These findings suggest that, without strong regulations, trade openness and FDI in industrial sectors can add to the environmental burden, confirming the applicability of the PHH hypothesis in some countries in the study sample.

Alongside countries that fully support the PHH hypothesis, there are countries with mixed results. In these countries, trade openness and FDI variables have varying effects on PHH validity, where one variable supports PHH while the other shows pollution reduction. For example, in countries like Pakistan, Costa Rica, and Greece, one of these variables supports PHH, with emissions increasing due to foreign investment or intensive trade activity. However, the other variable shows reduced emissions, which could be due to stricter environmental policies or the use of more efficient technologies to reduce environmental impact. These findings indicate that the validity of the PHH hypothesis does not always uniformly apply across all economic sectors in these countries. The impact of FDI and trade openness on emissions can vary depending on the industrial sectors in development and the regulatory and environmental initiatives specific to each country (Shahbaz et al., 2019).

Most countries in the research sample show that increased per capita energy consumption correlates with higher CO_2 emissions per capita. This data suggests that increased energy consumption, particularly fossil fuel-based, directly contributes to high CO_2 emissions per capita (Nguyen, 2019; Maalej and Cabagnols, 2020). However, there is also evidence that transitioning to renewable energy, as indicated by the renewable energy variable in the model, correlates with lower CO_2 emissions per capita in several countries (Alharthi et al., 2021). This shows that diversifying energy sources toward more environmentally friendly options positively impacts reducing carbon footprints, as countries that have successfully adopted renewable energy show significant emission reductions. These findings underscore the importance of sustainability-oriented energy policies to achieve global emission reductions (Lau, 2023).

The analysis also reveals that the impact of the political system on CO_2 emissions per capita varies across countries (Pickering et al., 2020; Jahanger et al., 2021). In Christian-majority countries like Denmark and Zambia, increased democratization levels are associated with reduced CO_2 emissions per capita. This phenomenon may be due to stricter environmental policies and stronger public support for sustainability, which often emerge in more advanced democratic systems (Chou et al., 2019; Kelleher and Kim, 2014). Conversely, in countries like Greece and the United Kingdom, higher democracy levels correlate with increased CO_2 emissions, likely driven by intensive economic activities and increased energy consumption as part of economic growth. In countries with Islam as the official religion, such as the UAE and Mauritania, increased democratization is also associated with higher CO_2 emissions per capita. This may be due to accelerated economic growth, leading to increased fossil fuel-based energy consumption, ultimately raising emissions. In this context, greater economic freedom often promotes industrial and infrastructure expansion, increasing economic activity but not always balanced by strict environmental policies (Mendoza et al., 2021).

However, most countries in the sample indicate that the political system does not have a significant impact on CO_2 emissions per capita. This suggests that the influence of the political system on emissions is highly contextual and does not apply uniformly across all countries (Bättig and Bernauer, 2009). In most countries, other factors, such as energy policy, economic structure, and reliance on conventional energy, play a more substantial role in influencing CO_2 emissions. These findings suggest that although democratization in some countries correlates with increased emissions, this impact is mainly shaped by specific economic contexts and environmental policies in each country.

This study also evaluates the economic and political impacts on CO_2 emissions per capita in high- and low-income countries, as shown in Table 7. The estimation results from the three estimators—MG, PMG, and DFE—indicate that both high- and low-income country samples have a significant and negative Error Correction Term (ECT). This suggests long-term stability in the relationships among variables concerning CO_2 emissions per capita, where the model can return to equilibrium despite short-term disturbances (Şanlı et al., 2023).

For high-income countries, the Hausman test results indicate that PMG and DFE estimators are more efficient than MG. This can be explained by the homogeneity assumption, which is more appropriate in high-income countries where structural and institutional factors are likely more similar. In contrast, for low-income countries, the DFE estimator shows better efficiency than PMG, as seen from the Hausman test results, which do not reject the null hypothesis of homogeneity for DFE compared to MG. This may be due to low-income countries having more similar economic structures, making DFE's assumption of homogeneity across countries more relevant in this case.

In high-income countries, the PMG and DFE estimations also show differences in detecting the existence of the EKC hypothesis. PMG does not provide evidence of EKC in either the long or short term, while DFE does indicate the presence of EKC. This discrepancy may arise because the PMG estimator allows for homogeneity in the long-term coefficients while enabling variation in short-term coefficients, error correction terms, and intercepts across units. This flexibility allows PMG to effectively capture both a general long-term relationship and individual short-term dynamics (Anoruo et al., 2024; Sulaiman and Abdul□Rahim, 2020). Conversely, DFE, which assumes similar behavior across countries, may highlight an overall EKC pattern. In this case, DFE might imply that at higher income levels, economic growth up to a certain point can reduce emissions, while PMG presents a more nuanced picture. Meanwhile, for low-income countries, the EKC hypothesis is not validated in either the long or short term. This is evident from the insignificant income variable coefficients, indicating that economic growth in low-income countries does not necessarily reduce CO_2 emissions once a certain income level is reached. This could be explained by the limited availability of eco-friendly technologies, weak institutional quality, and an economic structure still reliant on carbon-intensive sectors, making the contribution of economic growth to emission reduction less apparent (Hishan et al., 2019; Masron and Subramanian, 2020).

The PHH hypothesis appears to hold for both high- and low-income countries, where FDI inflows significantly contribute to increasing CO_2 emissions per capita. This aligns with the PHH, which suggests that multinational corporations often relocate less eco-friendly production activities to countries with more lenient environmental regulations, potentially worsening environmental quality in FDI-recipient countries (Raihan, 2023). A similar pattern is observed in high-income countries, although results may vary due to stricter environmental oversight. Developed countries, despite having strong environmental laws, can still attract FDI in high-pollution sectors due to the comparative advantage offered by lower operational costs in these sectors (Shi et al., 2020; Solarin and Al-Mulali, 2018). Conversely, trade openness tends to reduce CO_2 emissions per capita, especially in high-income countries. This effect suggests that market openness allows these countries access to greener technology and production practices, thereby helping to reduce emissions. In contrast, for low-income countries, trade openness does not have a significant impact on CO_2 emissions per capita, likely due to constraints in adopting green technology and a trade orientation that remains focused on carbon-intensive commodity exports (Wang et al., 2024).

Further estimation results show that increased contributions from the industrial sector, particularly in developed countries, may reduce CO_2 emissions per capita. This occurs when industrialization is pursued through the adoption of green technological innovations (Gao et al., 2022). Moreover, increased energy consumption per capita is associated with increased CO_2 emissions per capita in both high- and low-income countries, indicating that energy intensity significantly contributes to carbon emissions across income groups (Nguyen, 2019). On the other hand, renewable energy has a reducing effect on CO_2 emissions per capita, highlighting the importance of transitioning to more sustainable energy sources to mitigate carbon emissions (Guo et al., 2022). Additionally, the level of democratization in the political system has a positive relationship with CO_2 emissions per capita. This may be due to higher energy consumption in democratic societies or political constraints in implementing CO_2 emission reduction policies (Adedoyin and Zakari, 2020).

3.6. Robustness Check

This study conducted a robustness check by substituting CO_2 emissions per capita with ecological footprint per capita as the dependent variable. The use of ecological footprint as a proxy for environmental degradation and climate change is well-established (Xue et al., 2021; Khan et al., 2021; Jena et al., 2022; Nathaniel et al., 2020; Ansari et al., 2020). This approach ensures the consistency of estimation results, making the analysis valid and reliable even with a different environmental indicator. Table 8 presents the estimation results using ecological footprint per capita as the dependent variable, and these results are compared with Tables 5 and 7 from previous estimations.

The Hausman test results in Table 8 indicate that the PMG and DFE estimators are more efficient than MG. This suggests that the PMG and DFE models have advantages in capturing both long-term and short-term relationships among variables within the analyzed sample. Additionally, PMG proves superior to

Table 7: MG, PMG, and DFE estimations in the PARDL model by income group

Dependent variable=*LCO2C*	High-income countries			Low-income countries		
	MG	PMG	DFE	MG	PMG	DFE
	(1)	(2)	(3)	(4)	(5)	(6)
ECT	−0.534*** (0.078)	−0.199*** (0.062)	−0.264*** (0.027)	−0.676*** (0.120)	−0.174** (0.075)	−0.080*** (0.028)
Long-run coefficients						
ln Real GDP per capita	−32.110 (33.900)	−0.147 (0.103)	0.584*** (0.192)	0.680 (0.925)	−0.047 (0.104)	0.321 (0.350)
(ln Real GDP per capita)^2	3.378 (3.650)	0.0350* (0.020)	−0.113*** (0.038)	−0.035 (0.223)	0.117*** (0.031)	0.007 (0.094)
Trade	−0.000 (0.002)	0.000 (0.000)	−0.003*** (0.000)	−0.001 (0.001)	−0.000 (0.000)	0.000 (0.001)
Foreign direct investment	−0.016 (0.013)	0.001 (0.001)	0.001** (0.001)	−0.000 (0.003)	0.013*** (0.003)	0.002 (0.007)
Industry	−0.015 (0.011)	−0.006*** (0.001)	0.007** (0.003)	−0.002 (0.003)	−0.004*** (0.001)	0.007 (0.005)
ln Energy use per person	0.152 (0.290)	0.692*** (0.039)	0.464*** (0.061)	−0.054 (0.163)	−0.050 (0.041)	0.073 (0.077)
Renewable energy	0.324 (0.728)	−0.003 (0.003)	−0.009*** (0.003)	−0.017 (0.011)	−0.005*** (0.001)	−0.002 (0.004)
ln Politic	0.087 (0.101)	−0.049** (0.024)	0.068 (0.052)	−0.039 (0.079)	−0.005 (0.005)	0.021 (0.060)
Short-run coefficients						
Δln Real GDP per capita	−3.817 (6.183)	0.922 (4.928)	0.313*** (0.111)	−2.505** (1.149)	−1.143** (0.530)	−0.058 (0.048)
Δ(ln Real GDP per capita)^2	0.472 (0.804)	−0.091 (0.606)	−0.049** (0.024)	0.624** (0.294)	0.323** (0.157)	0.060*** (0.023)
ΔTrade	−0.000 (0.000)	−0.000 (0.000)	−0.002*** (0.000)	−0.000 (0.000)	−0.000 (0.000)	0.000 (0.000)
ΔForeign direct investment	0.000 (0.002)	−0.000 (0.001)	0.000 (0.000)	0.000 (0.002)	0.000 (0.000)	−0.000 (0.000)
ΔIndustry	0.000 (0.002)	0.002 (0.001)	0.001 (0.001)	−0.001** (0.001)	−0.000 (0.001)	−0.000 (0.001)
Δln Energy use per person	0.266*** (0.080)	0.361*** (0.067)	0.437*** (0.034)	0.132** (0.067)	0.139*** (0.053)	0.026** (0.012)
ΔRenewable energy	−0.233** (0.112)	−0.183* (0.097)	−0.021*** (0.003)	−0.010** (0.004)	−0.009 (0.005)	−0.007*** (0.001)
Δln Politic	0.055 (0.080)	0.030 (0.063)	0.115*** (0.022)	0.073 (0.061)	−0.005 (0.005)	0.008* (0.004)
Constant	1.364 (4.864)	−0.942*** (0.297)	−0.879*** (0.181)	−0.309 (0.570)	0.201** (0.081)	−0.042 (0.049)
No. of observation	640	640	640	288	288	288
No. of countries	20	20	200	9	9	9
Hausman test	-	(1) versus (2)	(1) versus (3)	-	(4) versus (5)	(4) versus (6)
Chi-square	-	1.29	0.00	-	−25.63	0.00
Prob>Chi-square	-	0.989	1.000	-	Fail to meet the asymptotic assumptions of the Hausman test	1.000
Decision	-	The H_0 of homogeneity cannot be rejected	The H_0 of homogeneity cannot be rejected	-	Inconclusive	The H_0 of homogeneity cannot be rejected
Which model is Good?	-	PMG	DFE	-	Inconclusive	DFE

Standard errors in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

Table 8: MG, PMG, and DFE estimations in the PARDL model for ecological footprint per person

Dependent variable=*LEFP*	Full sample			High-income countries			Low-income countries		
	MG	PMG	DFE	MG	PMG	DFE	MG	PMG	DFE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ECT	−0.915***	−0.333***	−0.160***	−0.923***	−0.307***	−0.167***	−0.900***	−0.520***	−0.313***
	(0.081)	(0.057)	(0.018)	(0.096)	(0.069)	(0.023)	(0.157)	(0.138)	(0.049)
Long-run coefficients									
ln Real GDP per capita	1.749	−0.689***	0.17	−6.793	−2.618***	0.308	18.830	0.064	0.019
	(7.517)	(0.067)	(0.182)	(6.281)	(0.351)	(0.268)	(18.120)	(0.040)	(0.118)
(ln Real GDP per capita)^2	−0.902	0.133***	−0.010	0.796	0.392***	−0.050	−4.298	0.076***	0.095***
	(1.480)	(0.015)	(0.037)	(0.777)	(0.051)	(0.054)	(4.078)	(0.013)	(0.031)
Trade	−0.002	−0.000	−0.004***	0.001	0.001	−0.004***	−0.007	−0.0004**	0.000
	(0.003)	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)	(0.007)	(0.000)	(0.001)
Foreign direct investment	0.006	0.004***	0.000	−0.009	0.002	0.000	0.035	0.000	−0.001
	(0.015)	(0.001)	(0.001)	(0.016)	(0.002)	(0.001)	(0.029)	(0.001)	(0.003)
Industry	0.006	0.009***	0.008***	0.005	0.007***	0.007*	0.007	−0.003***	0.001
	(0.005)	(0.001)	(0.003)	(0.006)	(0.001)	(0.004)	(0.009)	(0.001)	(0.002)
ln Energy use per person	0.323*	0.325***	0.192***	0.240	0.769***	0.363***	0.487	0.000	−0.000
	(0.179)	(0.038)	(0.067)	(0.196)	(0.062)	(0.110)	(0.381)	(0.012)	(0.032)
Renewable energy	0.317	−0.005***	0.001	0.441	−0.007***	0.003	0.069	−0.002**	0.001
	(0.208)	(0.001)	(0.004)	(0.308)	(0.002)	(0.007)	(0.079)	(0.001)	(0.002)
ln Politic	0.189	−0.021***	−0.010	0.271	−0.792***	−0.149	0.025	−0.017	0.011
	(0.216)	(0.004)	(0.057)	(0.325)	(0.280)	(0.106)	(0.036)	(0.012)	(0.024)
Short-run coefficients									
Δln Real GDP per capita	−5.481	10.990	0.090	−9.332	15.660	0.108	2.219*	0.478	−0.085
	(7.892)	(7.262)	(0.067)	(11.830)	(11.550)	(0.100)	(1.255)	(0.467)	(0.076)
Δ (ln Real GDP per capita)^2	0.751	−1.191	0.022	1.436	−1.740	0.013	−0.618	0.021	0.175***
	(1.034)	(0.835)	(0.017)	(1.525)	(1.320)	(0.023)	(0.435)	(0.123)	(0.043)
ΔTrade	0.002*	0.001	−0.000	0.003**	0.002*	0.000	−0.001*	−0.001***	−0.001**
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
ΔForeign direct investment	0.000	0.000	−0.000	−0.000	0.000	−0.000	0.001	−0.001	0.002*
	(0.002)	(0.001)	(0.000)	(0.003)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)
ΔIndustry	0.001	0.000	0.000	0.002	0.001	0.001	−0.000	0.000	−0.001
	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
Δln Energy use per person	0.166*	0.129**	0.044**	0.187	0.163*	0.084**	0.124	0.093	0.000
	(0.087)	(0.065)	(0.021)	(0.122)	(0.093)	(0.035)	(0.100)	(0.074)	(0.018)
ΔRenewable energy	0.114	0.084	−0.004**	0.169	0.136	−0.004*	0.004	−0.000	−0.001
	(0.099)	(0.071)	(0.002)	(0.148)	(0.116)	(0.003)	(0.014)	(0.006)	(0.002)
Δln Politic	0.111	0.105**	−0.008	0.18	0.095	−0.035	−0.028	−0.017	0.002
	(0.083)	(0.053)	(0.010)	(0.120)	(0.058)	(0.023)	(0.050)	(0.049)	(0.007)
Constant	0.783	−0.392***	−0.127	1.864	−0.353***	−0.382*	−1.379	0.395***	0.156*
	(5.178)	(0.069)	(0.105)	(7.809)	(0.116)	(0.212)	(1.181)	(0.115)	(0.086)
No. of observation	756	756	756	504	504	504	252	252	252
No. of countries	27	27	27	18	18	18	9	9	9

(Contd...)

Table 8: *(Continued)*

Dependent variable=*LEFP*	Full sample			High-income countries			Low-income countries		
	MG	**PMG**	**DFE**	**MG**	**PMG**	**DFE**	**MG**	**PMG**	**DFE**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Hausman test	-	(1) versus (2)	(1) versus (3)	-	(4) versus (5)	(4) versus (6)	-	(7) versus (8)	(7) versus (9)
Chi-square	-	2.97	0.00	-	7.42	0.00	-	5.03	0.00
Prob>Chi-square	-	0.936	1.000	-	0.492	1.000	-	0.539	1.000
Decision	-	The H0 of homogeneity cannot be rejected	The H0 of homogeneity cannot be rejected	-	The H0 of homogeneity cannot be rejected	The H0 of homogeneity cannot be rejected	-	The H0 of homogeneity cannot be rejected	The H0 of homogeneity cannot be rejected
Which model is Good?	-	PMG	DFE	-	PMG	DFE	-	PMG	DFE

The dependent variable is LEFP in each column. Using time series data from 1990-2018 on 29 countries. Standard errors in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

DFE as it can balance long-term homogeneity across countries while accommodating short-term variations. Thus, PMG is the optimal choice to ensure more stable and reliable estimation results (Espoir et al., 2023). The estimation results also show that the ECT value remains consistently negative and significant for all estimators. This indicates a consistent adjustment back to long-term equilibrium after short-term deviations, reinforcing the model's reliability in demonstrating the relationship between independent variables and ecological footprint.

In the context of the EKC hypothesis, the idea that economic growth will eventually reduce environmental impact is not supported in the long term for the entire sample, including both high- and low-income countries. This result suggests that income growth does not automatically lead to a reduction in ecological footprint per capita, and the EKC cannot be universally applied. In the short term, the EKC hypothesis is also generally invalid, except for low-income countries when using the DFE estimator. This suggests that, under certain conditions, low-income countries may exhibit an EKC pattern in the short term, but this cannot be generalized to other groups or the long term. These findings are consistent with Ansari et al. (2020) for Gulf Cooperation Council (GCC) countries.

In this analysis, the PHH hypothesis is tested to examine the effects of trade openness and FDI on ecological footprint per capita. Based on the results in Table 8, trade openness does not have a significant positive effect on ecological footprint per capita. This indicates that trade openness is not a factor that directly increases ecological footprint per capita in this sample. However, when using FDI as a variable representing the PHH hypothesis, the results show support for the hypothesis across the entire sample. This means that FDI inflows are associated with an increased ecological footprint per capita, supporting the argument that foreign investment can add to the environmental burden in recipient countries (Sabir and Gorus, 2019). Overall, FDI appears to have a more significant impact on ecological footprint than trade openness; thus, in this context, PHH is only valid with FDI presence, not trade openness.

3.7. Faith-Driven Climate Economics

Countries with official religions face unique challenges in balancing spiritual responsibilities with economic and ecological needs. An economic approach that integrates religious values with sustainability efforts is increasingly relevant in addressing the climate crisis. This study proposes four practical ideas for implementation. First, enhancing participation in global climate forums is essential for strengthening these countries' positions as key actors in shaping global policies aimed at balancing economic development with environmental conservation (Agusalim and Karim, 2024a). Increased involvement of religious nations in climate forums is important because it brings moral authority that can deepen climate change discourse by emphasizing the ethical and moral dimensions of this environmental crisis. Religious organizations often motivate sustainability actions through values that resonate with the public, as evidenced by Agusalim and Karim (2014b), who found that religious beliefs can influence attitudes and behaviors related to climate change. The involvement of religious nations also enriches global climate policy with diverse cultural perspectives, as reflected in Jenkins et al. (2018). Furthermore, the history of religious engagement in climate advocacy, including interfaith collaboration among leaders of different faiths, strengthens their role as critical stakeholders in the global climate dialogue.

Second, the formation of faith-based organizations (FBOs) that are directly involved in environmental management is crucial (Tarpeh and Hustedde, 2021; Salter and Wilkinson, 2024). FBOs can act as driving forces in environmental stewardship through activities such as fundraising for nature conservation, levying special charges to support preservation programs, and promoting green technologies. These activities demonstrate a synergy between religious responsibilities and environmental care. FBOs can also contribute to educational programs to raise public awareness about waste management and renewable energy use.

Third, faith-driven economics offers an economic framework rooted in sustainable moral principles, focusing on responsible resource management and the awareness that humans are obligated to protect the Earth. This approach encourages both communities and nations to prioritize ecological balance and social justice, aligning with religious teachings that emphasize humanity's role as stewards of nature. While the Sustainable Development Goals (SDGs) focus on the holistic management of economic, social, and environmental dimensions, religion's role in sustainability is often under-recognized (Haustein and Tomalin, 2021). The SDGs tend to adopt a secular perspective that emphasizes scientific and technical approaches to environmental challenges. However, religious teachings provide strong moral guidance for addressing environmental issues in a more inclusive way, urging believers to care for nature as part of their spiritual responsibility. In this context, a faith-driven economy not only enriches sustainability discourse but also provides a moral foundation that can support the SDGs, particularly in fostering sustainable consumption and production patterns, reducing dependency on non-renewable resources, and promoting green economic innovation. By incorporating religious perspectives, sustainability policies can more effectively resonate with communities and encourage more collective action to combat climate change.

Fourth, faith-based investing is an investment approach that integrates religious values and moral beliefs into investment decisions. This approach emphasizes selecting investments that align with religious principles, often avoiding "sin stocks," which are stocks from companies or industries that are considered to be contrary to religious teachings, such as the alcohol and gambling industries. Faith-based investing also promotes ethical business practices that prioritize social responsibility and sustainability, supporting companies that operate with regard for community and environmental welfare. Faith-based investing often aligns with socially responsible investing (SRI) and environmental, social, and governance (ESG) investing. Both approaches consider environmental, social, and corporate governance factors as key criteria in investment evaluations. For instance, in SRI and ESG investing, investors consider not only financial returns but also evaluate how companies impact society, employees, and the environment (Yi, 2023).

4. CONCLUSION

This study finds that the EKC hypothesis does not hold in most countries with official religions, particularly among low-income countries that still heavily rely on fossil fuels. Although economic growth is occurring, income increases in these countries have not yet led to a significant reduction in CO_2 emissions per capita, indicating that the transition to cleaner energy sources is not yet optimal. Conversely, the PHH proves relevant in the long term, especially with the inflow of FDI linked to increased CO_2 emissions per capita in countries with weaker environmental regulations. Energy consumption and the industrial sector contribute significantly to emissions, while renewable energy adoption consistently aids in reducing CO_2 per capita.

From a policy perspective, this research suggests implementing a faith-driven economy approach, which integrates spiritual values into green economic policies, as an option for countries with official religions. Additionally, faith-based investing is proposed to encourage more ethical and environmentally conscious business practices, thereby contributing more meaningfully to mitigating climate change impacts. This approach aims to help these countries achieve a better balance between economic growth and environmental conservation, strengthening their commitment to long-term sustainability while meeting the socio-economic needs of their populations.

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REFERENCES

Abdullahi, N.M., Danlami, M., Kakar, S.K., Bah, A.S. (2024), Modeling the dynamic nexus between climate change, ICT, and agriculture in sub-Saharan Africa: A panel quantile ARDL. GeoJournal, 89(5), 203.

Acheampong, A.O., Adams, S., Boateng, E. (2019), Do globalization and renewable energy contribute to carbon emissions mitigation in Sub-Saharan Africa? Science of the Total Environment, 677, 436-446.

Adebanjo, S.A., Shakiru, T.H. (2022), Dynamic relationship between air pollution and economic growth in Jordan: An empirical analysis. Journal of Environmental Science and Economics, 1(2), 30-43.

Adedoyin, F., Zakari, A. (2020), Energy consumption, economic expansion, and CO_2 emission in the UK: The role of economic policy uncertainty. The Science of the Total Environment, 738, 140014.

Adeleye, B.N., Osabohien, R., Lawal, A.I., De Alwis, T. (2021), Energy use and the role of per capita income on carbon emissions in African countries. PLoS One, 16(11), e0259488.

Adger, W., Huq, S., Conway, D., Hulme, M. (2003), Adaptation to climate change in the developing world. Progress in Development Studies, 3(3), 179-195.

Agusalim, L., Karim M. (2023), Transformasi Ajaran Agama Melawan Krisis Iklim. Bogor: PT. IPB Press.

Agusalim, L., Karim, M. (2024a), Religiosity and climate change: An eco-religious approach. Environmental and Socio-economic Studies, 12(1), 35-50.

Agusalim, L., Karim, M. (2024b), How religiosity affect climate change?

A cross-country analysis. International Journal of Energy Economics and Policy, 14(1), 150-164.
Ahmad, S., Khan, D., Magda, R. (2022), Assessing the influence of financial inclusion on environmental degradation in the ASEAN region through the panel PMG-ARDL approach. Sustainability, 14(12), 7058.
Ahmed, B., Alam, S., Ahmed, I., Sammonds, P. (2023), The anthropogenic aggravation of landslide disasters in Bangladesh: Key informants' perspectives. In: Progress in Landslide Research and Technology. Vol. 1. Cham: Springer International Publishing. p385-401.
Ahmed, F., Ali, I., Kousar, S., Ahmed, S. (2022), The environmental impact of industrialization and foreign direct investment: Empirical evidence from the Asia-Pacific region. Environmental Science and Pollution Research, 29(20), 29778-29792.
Alam, M.S., Paramati, S.R. (2015), Do oil consumption and economic growth intensify environmental degradation? Evidence from developing economies. Applied Economics, 47(48), 5186-5203.
Alharthi, M., Doğan, E., Taşkın, D. (2021), Analysis of CO_2 emissions and energy consumption by sources in MENA countries: Evidence from quantile regressions. Environmental Science and Pollution Research, 28(29), 38901-38908.
Alifu, H., Hirabayashi, Y., Imada, Y., Shiogama, H. (2022), Enhancement of river flooding due to global warming. Scientific Reports, 12(1), 20687.
Alkhawaldeh, B.Y.S., Alhawamdeh, H., Almarshad, M., Fraihat, B.A.M., Abu-Alhija, S.M.M., Alhawamdeh, A.M., Ismaeel, B. (2023), The effect of macroeconomic policy uncertainty on environmental quality in Jordan: Evidence from the novel dynamic simulations approach. Jordan Journal of Economic Sciences, 10(2), 116-131.
Almeida, D., Carvalho, L., Ferreira, P., Dionísio, A., Haq, I.U. (2024), Global dynamics of environmental Kuznets curve: A cross-correlation analysis of income and CO_2 emissions. Sustainability, 16(20), 9089.
Al-Mulali, U., Tang, C.F. (2013), Investigating the validity of pollution haven hypothesis in the Gulf Cooperation Council (GCC) countries. Energy Policy, 60, 813-819.
Anoruo, E., Nwala, K., Afolabi, F. (2024), Asymmetric impact of real effective exchange rate shocks on economic growth in Africa: Evidence from symmetric and asymmetric panel ARDL-PMG model. Journal of Applied Business and Economics, 26(2), 150-162.
Ansari, M.A., Ahmad, M.R., Siddique, S., Mansoor, K. (2020), An environment Kuznets curve for ecological footprint: Evidence from GCC countries. Carbon Management, 11(4), 355-368.
Anwar, M.A., Zhang, Q., Asmi, F., Hussain, N., Plantinga, A., Zafar, M.W., Sinha, A. (2022), Global perspectives on environmental Kuznets curve: A bibliometric review. Gondwana Research, 103, 135-145.
Apergis, N., Pinar, M., Unlu, E. (2022), How do foreign direct investment flows affect carbon emissions in BRICS countries? Revisiting the pollution haven hypothesis using bilateral FDI flows from OECD to BRICS countries. Environmental Science and Pollution Research, 30, 14680-14692.
Arouri, M. E. H., Youssef, A. B., M'henni, H., Rault, C. (2012), Energy consumption, economic growth and CO2 emissions in Middle East and North African countries. Energy Policy, 45, 342-349.
Ayitehgiza, M.A. (2020), Urbanization, economic growth and industrial structure on carbon dioxide emissions: Empirical evidence from Ethiopia. International Journal of Scientific and Research Publications, 10(8), 947-954.
Bakirtas, I., Cetin, M.A. (2017), Revisiting the environmental Kuznets curve and pollution haven hypotheses: MIKTA sample. Environmental Science and Pollution Research, 24(22), 18273-18283.
Baltagi, B., Pesaran, M. (2007), Heterogeneity and cross section dependence in panel data models: Theory and applications introduction. Journal of Applied Econometrics, 22(2), 229-232.
Baltagi, B.H. (2021), Econometrics (Classroom Companion: Economics). 6th ed. Cham: Springer Nature Switzerland AG.
Barbieri, L. (2009), Panel unit root tests under cross-sectional dependence: An overview. Journal of Statistics: Advances in Theory and Applications, 1(2), 117-158.
Barro, R.J., McCleary, R.M. (2019), The wealth of religions. In: The Wealth of Religions. United States: Princeton University Press.
Bättig, M.B., Bernauer, T. (2009), National institutions and global public goods: Are democracies more cooperative in climate change policy? International Organization, 63(2), 281-308.
Becker, S.O., Rubin, J., Woessmann, L. (2021), Religion in economic history: A survey. In: The Handbook of Historical Economics. Cambridge: Academic Press. p585-639.
Bergmann, S. (2005), Creation Set Free: The Spirit as Liberator of Nature. Grand Rapids: Eerdmans Publishing.
Bergmann, S., Gerten, D. (2010), Religion and Dangerous Environmental Change: Transdisciplinary Perspectives on the Ethics of Climate and Sustainability. Vol. 2. Münster: LIT Verlag.
Bilgili, F., Koçak, E., Bulut, U. (2016), The dynamic impact of renewable energy consumption on CO_2 emissions: A revisited environmental Kuznets curve approach. Renewable and Sustainable Energy Reviews, 54, 838-845.
Bölük, G., Mert, M. (2014), Fossil and renewable energy consumption, GHGs (greenhouse gases) and economic growth: Evidence from a panel of EU (European Union) countries. Energy, 74, 439-446.
Borenstein, S., Kellogg, R. (2021), Challenges of a clean energy transition and implications for energy infrastructure policy. In: Rebuilding the Post-Pandemic Economy. Washington, DC: Aspen Institute Press.
Brini, R. (2021), Renewable and non-renewable electricity consumption, economic growth and climate change: Evidence from a panel of selected African countries. Energy, 223, 120064.
Bulus, G.C., Koc, S. (2021), The effects of FDI and government expenditures on environmental pollution in Korea: The pollution haven hypothesis revisited. Environmental Science and Pollution Research, 28(28), 38238-38253.
Carlton, J., Perry-Hill, R., Huber, M., Prokopy, L. (2015), The climate change consensus extends beyond climate scientists. Environmental Research Letters, 10(9), 094025.
Cave, L.A. (2020), The Environmental Kuznets Curve and Israel. In: Walden University Research Conference. Walden University.
Chang, Y. (2002), Nonlinear IV unit root tests in panels with cross-sectional dependency. Journal of Econometrics, 110(2), 261-292.
Chou, L., Zhang, W., Wang, M., Yang, F. (2019), The influence of democracy on emissions and energy efficiency in America: New evidence from quantile regression analysis. Energy and Environment, 31(8), 1318-1334.
Clements, J.M., Xiao, C., McCright, A.M. (2014), An examination of the "greening of Christianity" thesis among Americans, 1993-2010. Journal for the Scientific Study of Religion, 53(2), 373-391.
Cole, M.A., Elliott, R.J., Zhang, L. (2017), Foreign direct investment and the environment. Annual Review of Environment and Resources, 42(1), 465-487.
Cook, J., Oreskes, N., Doran, P.T., Anderegg, W.R., Verheggen, B., Maibach, E.W., Carlton, J.S., Lewandowsky, S., Skuce, A.G., Green, S.A., Nuccitelli, D., Jacobs, P., Richardson, M., Winkler, B., Painting, R., Rice, K. (2016), Consensus on consensus: A synthesis of consensus estimates on human-caused global warming. Environmental Research Letters, 11(4), 048002.
Copeland, B.R., Taylor, M.S. (1994), North-South trade and the environment. The Quarterly Journal of Economics, 109(3), 755-787.

Cox, B., Innis, S., Kunz, N., Steen, J. (2022), The mining industry as a net beneficiary of a global tax on carbon emissions. Communications Earth and Environment, 3, 17.

Destek, M.A., Sarkodie, S.A. (2019), Investigation of environmental Kuznets curve for ecological footprint: The role of energy and financial development. Science of the Total Environment, 650, 2483-2489.

Djellouli, N., Abdelli, L., Elheddad, M., Ahmed, R., Mahmood, H. (2022), The effects of non-renewable energy, renewable energy, economic growth, and foreign direct investment on the sustainability of African countries. Renewable Energy, 183, 676-686.

Dokulil, M. (2017), Recent trends in global climate warming with a focus on Europe. Oceanography and Fisheries Open Access Journal, 2(1), 555576.

Dradra, Z., Abdennadher, C. (2024), Modeling the contribution of energy consumption to climate change: A panel cointegration analysis for mediterranean countries. Journal of the Knowledge Economy, 15(1), 1142-1158.

Druckman, J.N., McGrath, M.C. (2019), The evidence for motivated reasoning in climate change preference formation. Nature Climate Change, 9(2), 111-119.

Elmarzougui, E., Larue, B., Tamini, L. (2016), Trade openness, domestic and foreign investments, and the environment. Modern Economy, 7(5), 591-605.

Engle, R.F., Granger, C.W. (1987), Co-integration and error correction: Representation, estimation, and testing. Econometrica: Journal of the Econometric Society, 55, 251-276.

Eom, K., Tok, T.Q.H., Saad, C.S., Kim, H.S. (2021), Religion, environmental guilt, and pro-environmental support: The opposing pathways of stewardship belief and belief in a controlling god. Journal of Environmental Psychology, 78, 101717.

Espoir, D.K., Sunge, R., Bannor, F. (2023), Exploring the dynamic effect of economic growth on carbon dioxide emissions in Africa: Evidence from panel PMG estimator. Environmental Science and Pollution Research, 30(52), 112959-112976.

Eyring, V., Gillett, N.P., Rao, K.M.A., Barimalala, R., Parrillo, M.B., Bellouin, M., Cassou, C., Durack, P.J., Kosaka, Y., McGregor, S., Min, S., Morgenstern, O., Sun, Y. (2021), Human influence on the climate system. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. United Kingdom: Cambridge University Press. p423-552.

Farooq, S., Ozturk, I., Majeed, M.T., Akram, R. (2022), Globalization and CO_2 emissions in the presence of EKC: A global panel data analysis. Gondwana Research, 106, 367-378.

Forster, P.M., Smith, C., Walsh, T., Lamb, W.F., Lamboll, R., Hall, B., Hauser, M., Ribes, A., Rosen, D., Gillett, N.P., Palmer, M.D., Rogelj, J., von Schuckmann, K., Trewin, B., Allen, M., & Zhai, P. (2024), Indicators of global climate change 2023: Annual update of key indicators of the state of the climate system and human influence. Earth System Science Data, 16(6), 2625-2658.

Gao, P., Wang, Y., Zeng, Y., Su, X., Che, X., Yang, X. (2022), Green technology innovation and carbon emissions nexus in China: Does industrial structure upgrading matter? Frontiers in Psychology, 13, 951172.

Gerten, D., Bergmann, S. (2012), Facing the human faces of climate change. In: Religion in Environmental and Climate Change: Suffering, Values, Lifestyles. London: Continuum. p50-69.

Gök, A. (2020), Freedom to pollute. Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 29(3), 334-350.

Grim, B. (2016), The Role of Faith in Systemic Global Challenges. Cologny, Switzerland: World Economic Forum.

Grodzicki, T., Jankiewicz, M. (2022), The impact of renewable energy and urbanization on CO_2 emissions in Europe-spatio-temporal approach. Environmental Development, 4, 100755.

Grossman, G.M., Krueger, A.B. (1991), Environmental Impacts of a North American Free Trade Agreement. NBER Working Papers, No. 3914. National Bureau of Economic Research.

Guo, X., Huang, K., Li, L., Wang, X. (2022), Renewable energy for balancing carbon emissions and reducing carbon transfer under global value chains: A way forward. Sustainability, 15(1), 234.

Guzel, A.E., Okumus, I. (2020), Revisiting the pollution haven hypothesis in ASEAN-5 countries: New insights from panel data analysis. Environmental Science and Pollution Research, 27(15), 18157-18167.

Hartter, J., Hamilton, L.C., Boag, A.E., Stevens, F.R., Ducey, M.J., Christoffersen, N.D., Oester, P.T., Palace, M.W. (2018), Does it matter if people think climate change is human caused? Climate Services, 10, 53-62.

Hausman, J.A. (1978), Specification tests in econometrics. Econometrica: Journal of the Econometric Society, 46(6), 1251-1271.

Haustein, J., Tomalin, E. (2021), Religion, populism, and the politics of the sustainable development goals. Social Policy and Society, 20(2), 296-309.

Hishan, S., Khan, A., Ahmad, J., Hassan, Z., Zaman, K., Qureshi, M. (2019), Access to clean technologies, energy, finance, and food: Environmental sustainability agenda and its implications on Sub-Saharan African countries. Environmental Science and Pollution Research, 26(16), 16503-16518.

Hovelsrud, G.K., Smit, B. (2010), Community Adaptation and Vulnerability in Arctic Regions. Dordrecht: Springer.

Hulme, M. (2009), Why We Disagree about Climate Change: Understanding Controversy, Inaction and Opportunity. United Kingdom: Cambridge University Press.

Hulme, M. (2017), Climate change and the significance of religion. Economic and Political Weekly, 52(28), 14-17.

Iheonu, C., Muoneke, O., Agbutun, S. (2023), Investigating the democracy and environmental sustainability nexus in 52 African countries: Evidence from two□stage least squares and quantile regression. Social Science Quarterly, 104(5), 1006-1019.

Jahanger, A., Usman, M., Balsalobre□Lorente, D. (2022), Autocracy, democracy, globalization, and environmental pollution in developing world: Fresh evidence from STIRPAT model. Journal of Public Affairs, 22(4), e2753.

Jena, P.K., Mujtaba, A., Joshi, D.P.P., Satrovic, E., Adeleye, B.N. (2022), Exploring the nature of EKC hypothesis in Asia's top emitters: Role of human capital, renewable and non-renewable energy consumption. Environmental Science and Pollution Research, 29, 88557-88576.

Jenkins, W., Berry, E., Kreider, L.B. (2018), Religion and climate change. Annual Review of Environment and Resources, 43(1), 85-108.

Jones, R.P., Cox, D., Navarro-Rivera, J. (2014), Believers, Sympathizers, and Skeptics: Why Americans are Conflicted about Climate Change, Environmental Policy, and Science. Public Religion Research Institute. Available from: https://www.prri.org/wp-content/uploads/2014/11/2014-climate-change-final1-1.pdf

Kaika, D., Zervas, E. (2013), The environment Kuznets curve (EKC) theory-Part A: Concept, causes and the CO_2 emissions case. Energy Policy, 62(5), 1392-1402.

Kao, C. (1999), Spurious regression and residual-based tests for cointegration in panel data. Journal of Econometrics, 90(1), 1-44.

Kar, A.K. (2024), Investigating the environmental Kuznets curve hypothesis for CO_2 emissions in Nordic countries. International Journal of Environmental Studies, 81(4), 1637-1652.

Karaçuka, M. (2018), Religion and economic development in history: Institutions and the role of religious networks. Journal of Economic Issues, 52(1), 57-79.

Katuka, B., Mudzingiri, C., Vengesai, E. (2023), The effects of non-

performing loans on bank stability and economic performance in Zimbabwe. Asian Economic and Financial Review, 6(13), 393-405.
Kelleher, D., Kim, G. (2014), Environmental policy performance and political development: Do democracies outperform authoritarian regimes? International Studies Review, 15(1), 27-59.
Khan, A., Chenggang, Y., Xue Yi, W., Hussain, J., Sicen, L., Bano, S. (2021), Examining the pollution haven, and environmental kuznets hypothesis for ecological footprints: An econometric analysis of China, India, and Pakistan. Journal of the Asia Pacific Economy, 26(3), 462-482.
Kishi, K., Cooperman, A., Smith, G.A., Majumdar, S., Ochoa, J.C.E., Alper, B.A., Evans, J. (2017), Many Countries Favor Specific Religions, Officially or Unofficially. Pew Research Center. Available from: https://www.pewresearch.org/religion/2017/10/03/many-countries-favor-specific-religions-officially-or-unofficially
Kumar, A., Yu, Z.G., Klemeš, J.J., Bokhari, A. (2021), A state-of-the-art review of greenhouse gas emissions from Indian hydropower reservoirs. Journal of Cleaner Production, 320, 128806.
Kumar, M. (2020), Social, economic, and environmental impacts of renewable energy resources. In: Wind Solar Hybrid Renewable Energy System. London: IntechOpen.
Kuznets, S. (1955), Economic growth and income inequality. The American Economic Review, 45(1), 1-28.
Kyzym, M., Khaustova, V., Horal, L., Shpilevskiy, V., Zinchenko, V. (2023), Structural changes in Ukraine's electricity generation and their impact on the reduction of CO_2 emissions. IOP Conference Series Earth and Environmental Science, 1150(1), 012018.
Lau, H. (2023), Global decarbonization: Current status and what it will take to achieve net zero by 2050. Energies, 16(23), 7800.
Leichenko, R., O'Brien, K. (2019), Climate and Society: Transforming the Future. Hoboken: John Wiley and Sons.
Levitt, C.J., Pedersen, M.S., Sørensen, A. (2015), Examining the efforts of a small, open economy to reduce carbon emissions: The case of Denmark. Ecological Economics, 119, 94-106.
Li, S., Shao, Q. (2022), Greening the finance for climate mitigation: An ARDL-ECM approach. Renewable Energy, 199, 1469-1481.
Li, T., Wang, Y., Zhao, D. (2016), Environmental Kuznets curve in China: New evidence from dynamic panel analysis. Energy Policy, 91, 138-147.
Lima, M.A., Mendes, L.F.R., Mothé, G.A., Linhares, F.G., De Castro, M.P.P., Da Silva, M.G., Sthel, M.S. (2020), Renewable energy in reducing greenhouse gas emissions: Reaching the goals of the Paris agreement in Brazil. Environmental Development, 33, 100504.
Lisaba, E.B.F. Jr., Lopez, N.S.A. (2021), Spatiotemporal comparison of drivers to CO_2 emissions in ASEAN: A decomposition study. Sustainability, 13(11), 6183.
Lührmann, A., Tannenberg, M., Lindberg, S. I. (2018), Regimes of the world (RoW): Opening new avenues for the comparative study of political regimes. Politics and Governance, 6(1), 60-77.
Maalej, A., Cabagnols, A. (2020), Energy consumption, CO_2 emissions and economic growth in MENA countries. Environmental Economics, 11(1), 133-150.
Mammadov, N.S., Ganiyeva, N.A., Aliyeva, G.A. (2022), Role of renewable energy sources in the world. Journal of Renewable Energy, Electrical, and Computer Engineering, 2(2), 63-67.
Masron, T.A., Subramanian, Y. (2020), Threshold effect of institutional quality and the validity of environmental Kuznets curve. Malaysian Journal of Economic Studies, 57, 81-112.
Matewos, T. (2019), Climate change-induced impacts on smallholder farmers in selected districts of Sidama, Southern Ethiopia. Climate, 7(5), 70.
Mayoral, L., Esteban, J. (2019), Religiosity and economic performance: The role of personal liberties. In: Advances in the Economics of Religion. Cham: Palgrave Macmillan. p405-422.
McLennan, M. (2024), The Global Risks Report 2024. 19th ed. Cologny, Switzerland: World Economic Forum.
Mendoza, A., Reyes, K., Soriano, P., Cabauatan, R. (2021), The impact of CO_2 emissions on the GDP per capita, employment rate and energy consumption of China, Korea and Japan. Malaysian Journal of Social Sciences and Humanities, 6(11), 315-333.
Mensah, I. A., Sun, M., Gao, C., Omari-Sasu, A. Y., Zhu, D., Ampimah, B. C., Quarcoo, A. (2019), Analysis on the nexus of economic growth, fossil fuel energy consumption, CO2 emissions and oil price in Africa based on a PMG panel ARDL approach. Journal of Cleaner Production, 228, 161-174.
Misch, F., Wingender, P. (2024), Revisiting carbon leakage. Energy Economics, 140, 107786.
Müller, T. (2021), People of faith are allies to stall climate change. Nature, 592(7852), 9.
Murad, W., Alam, M., Islam, M. (2018), Dynamics of Japan's industrial production and carbon emissions: Causality, long-term trend and implications. Letters in Spatial and Resource Sciences, 11(2), 127-139.
Murthy, K.V., Gambhir, S. (2018), Analyzing environmental Kuznets curve and pollution haven hypothesis in India in the context of domestic and global policy change. Australasian Accounting, Business and Finance Journal, 12(2), 134-156.
Muttakin, M., Rana, T., Mihret, D. (2022), Democracy, national culture and greenhouse gas emissions: An international study. Business Strategy and the Environment, 31(7), 2978-2991.
Nagle, J.C. (2008), The evangelical debate over climate change. University of St. Thomas Law Journal, 5(1), 53-86.
Narayan, S., Narayan, P. K. (2004), Determinants of demand for Fiji's exports: An empirical investigation. The Developing Economies, 42(1), 95-112.
Nathaniel, S., Aguegboh, E., Iheonu, C., Sharma, G., Shah, M. (2020), Energy consumption, FDI, and urbanization linkage in coastal Mediterranean countries: Re-assessing the pollution haven hypothesis. Environmental Science and Pollution Research, 27(28), 35474-35487.
Nelson, R.H. (2014), Bringing religion into economic policy analysis. Regulation, 37, 52-57.
Nguyen, A. (2019), Carbon dioxide emissions and implications for environmental policy: Evidence in Southeast Asia. Journal of Asian Energy Studies, 3(1), 8-24.
Niamir-Fuller, M., Özdemir, I., Brinkman, F.J. (2016), Environment, Religion, and Culture in the Context of the 2030 Agenda for Sustainable Development. Nairobi, Kenya: United Nations Environment Programme.
Noland, M. (2005), Religion and economic performance. World Development, 33(8), 1215-1232.
Ochoa-Moreno, W.S., Quito, B.A., Moreno-Hurtado, C.A. (2021), Foreign direct investment and environmental quality: Revisiting the EKC in Latin American countries. Sustainability, 13(22), 12651.
Osobajo, O.A., Otitoju, A., Otitoju, M.A., Oke, A. (2020), The impact of energy consumption and economic growth on carbon dioxide emissions. Sustainability, 12(19), 7965.
Panayotou, T. (1993), Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development. (WEP. 2-22/WP. 238). International Labour Organization.
Pata, U.K., Dam, M.M., Kaya, F. (2022), How effective are renewable energy, tourism, trade openness, and foreign direct investment on CO_2 emissions? An EKC analysis for ASEAN countries. Environmental Science and Pollution Research, 30, 14821-14837.
Pedroni, P. (1999), Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxford Bulletin of Economics and

Statistics, 61(S1), 653-670.
Pedroni, P. (2004), Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Econometric Theory, 20(3), 597-625.
Pesaran, H. H., Shin, Y. (1998), Generalized impulse response analysis in linear multivariate models. Economics Letters, 58(1), 17-29.
Pesaran, M.H, Smith, L., Yamagata, T. (2013), Panel unit root tests in the presence of a multifactor error structure. Journal of Econometrics, 175(2), 94-115.
Pesaran, M.H. (2021), General diagnostic tests for cross-sectional dependence in panels. Empirical Economics, 60(1), 13-50.
Pesaran, M. H., Shin, Y., Smith, R. J. (2001), Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289-326
Pesaran, M.H., Shin, Y., Smith, R.P. (1999), Pooled mean group estimation of dynamic heterogeneous panels. Journal of the American Statistical Association, 94(446), 621-634.
Pesaran, M.H., Smith, R. (1995), Estimating long-run relationships from dynamic heterogeneous panels. Journal of Econometrics, 68(1), 79-113.
Pickering, J., Bäckstrand, K., Schlosberg, D. (2020), Between environmental and ecological democracy: Theory and practice at the democracy-environment nexus. Journal of Environmental Policy and Planning, 22(1), 1-15.
Pirotte, A. (1999), Convergence of the static estimation toward the long run effects of dynamic panel data models. Economics Letters, 63(2), 151-158.
Policardo, L. (2014), Is democracy good for the environment? Quasi-experimental evidence from regime transitions. Environmental and Resource Economics, 64(2), 275-300.
Polyzou, O. (2023), Analysis of the legislative and regulatory framework of Co_2 capture, transport and storage systems in targeted European countries. IOP Conference Series Earth and Environmental Science, 1196(1), 012042.
Pörtner, H.O., Roberts, D.C., Adams, H., Adelekan, I., Adler, C., Adrian, R., Aldunce, P., Ali, E., Ara Begum, R., Bednar-Friedl, B., Bezner Kerr, R., Biesbroek, R., Birkmann, J., Bowen, K., Caretta, M.A.,… & Zaiton Ibrahim, Z. (2022), Climate Change 2022: Impacts, Adaptation, and Vulnerability. IPCC Sixth Assessment Report. Cambridge: Cambridge University Press.
Povitkina, M. (2018), The limits of democracy in tackling climate change. Environmental Politics, 27(3), 411-432.
Proctor, J.D., Berry, E. (2005), Social science on religion and nature. In: Taylor, B., editor. Encyclopedia of Religion and Nature. Vol. 2. London: Continuum.
Rahman, M.M., Nepal, R., Alam, K. (2021), Impacts of human capital, exports, economic growth and energy consumption on CO_2 emissions of a cross-sectionally dependent panel: Evidence from the newly industrialized countries (NICs). Environmental Science and Policy, 121, 24-36.
Rahman, Z.U., Chongbo, W., Ahmad, M. (2019), An (a)symmetric analysis of the pollution haven hypothesis in the context of Pakistan: A non-linear approach. Carbon Management, 10(3), 227-239.
Raihan, A. (2023), Exploring environmental Kuznets curve and pollution haven hypothesis in Bangladesh: The impact of foreign direct investment. Journal of Environmental Science and Economics, 2(1), 25-36.
Ridzuan, A.R., Kumaran, V.V., Fianto, B.A., Shaari, M.S., Esquivias, M.A., Albani, A. (2022), Reinvestigating the presence of environmental Kuznets curve in Malaysia: The role of foreign direct investment. International Journal of Energy Economics and Policy, 12(5), 217-225.
Ritchie, H., Rosado, P., Roser, M. (2022), CO_2 and greenhouse gas emissions. Our World in Data. Available from https://ourworldindata.org/co2-and-greenhouse-gas-emissions.
Romer, D. (2019), Advanced Macroeconomics. 5th ed. New York: McGraw-Hill/Irwin.
Sabir, S., Gorus, M.S. (2019), The impact of globalization on ecological footprint: Empirical evidence from the South Asian countries. Environmental Science and Pollution Research, 26(32), 33387-33398.
Sadik-Zada, E.R., Ferrari, M. (2020), Environmental policy stringency, technical progress and pollution haven hypothesis. Sustainability, 12(9), 3880.
Salter, J., Wilkinson, O. (2024), Faith framing climate: A review of faith actors' definitions and usage of climate change. Climate and Development, 16(2), 97-108.
Sánchez-Fung, J.R. (2017), Modelling the Link between Aggregate Income and Carbon Dioxide Emissions in Developing Countries: The Case of the Dominican Republic. MPRA Paper, No. 68958.
Şanlı, D., Muratoğlu, Y., Songur, M., Uğurlu, E. (2023), The asymmetric effect of renewable and non-renewable energy on carbon emissions in OECD: New evidence from non-linear panel ARDL model. Frontiers in Environmental Science, 11, 1228296.
Schuman, S., Dokken, J.V., Van Niekerk, D., Loubser, R.A. (2018), Religious beliefs and climate change adaptation: A study of three rural South African communities. Jàmbá: Journal of Disaster Risk Studies, 10(1), 509.
Shaari, M.S., Abdul Karim, Z., Zainol Abidin, N. (2020), The effects of energy consumption and national output on CO_2 emissions: New evidence from OIC countries using a panel ARDL analysis. Sustainability, 12(8), 3312.
Shahbaz, M., Gözgör, G., Adom, P., Hammoudeh, S. (2019), The technical decomposition of carbon emissions and the concerns about FDI and trade openness effects in the United States. International Economics, 159, 56-73.
Shahbaz, M., Nasir, M.A., Roubaud, D. (2018), Environmental degradation in France: The effects of FDI, financial development, and energy innovations. Energy Economics, 74, 843-857.
Shahbaz, M., Sinha, A. (2019), Environmental Kuznets curve for CO_2 emissions: A literature survey. Journal of Economic Studies, 46(1), 106-168.
Shakoor, A., Ahmed, R., Ahmed, Z., Khan, U. (2023), Impact of subsectors of agriculture and economic growth on CO_2 emissions in Pakistan: Evidence from environmental Kuznets curve. Environmental Science and Pollution Research, 30(10), 25728-25739.
Shi, W., Wu, H., Sun, Q. (2020), The impact of foreign direct investment on environmental pollution in China: Corruption matters. International Journal of Environmental Research and Public Health, 17(18), 6477.
Smith, N., Leiserowitz, A. (2013), American evangelicals and global warming. Global Environmental Change, 23, 1009-1017.
Solarin, S., Al□Mulali, U. (2018), Influence of foreign direct investment on indicators of environmental degradation. Environmental Science and Pollution Research, 25(25), 24845-24859.
Spolaore, E., Wacziarg, R. (2013), How deep are the roots of economic development? Journal of Economic Literature, 51(2), 325-369.
Steffen, W., Sanderson, R.A., Tyson, P.D., Jäger, J., Matson, P.A., Moore, B., Oldfield, F., Richardson, K., John Schellnhuber, H., Turner, B.L., Wasson, R.J. (2006), Global Change and the Earth System: A Planet Under Pressure. Berlin: Springer Science and Business Media.
Sulaiman, C., Abdul□Rahim, A. (2020), The impact of wood fuel energy on economic growth in Sub-Saharan Africa: Dynamic macro-panel approach. Sustainability, 12(8), 3280.
Szetela, B., Majewska, A., Jamróz, P., Djalilov, B., Salahodjaev, R. (2022), Renewable energy and CO_2 emissions in top natural resource rents depending countries: The role of governance. Frontiers in Energy Research, 10, 872941.

Tarpeh, S., Hustedde, R. (2021), How faith-based organizations perceive their role in community development: An exploratory study. Community Development, 52(1), 61-76.

Taylor, B. (2006a), Encyclopedia of Religion and Nature. Vol. 2. London: Continuum.

Taylor, B. (2016b), The greening of religion hypothesis (part one): From Lynn White, Jr and claims that religions can promote environmentally destructive attitudes and behaviors to assertions they are becoming environmentally friendly. Journal for the Study of Religion, Nature and Culture, 10(3), 268-305.

Thio, E., Tan, M., Li, L., Salman, M., Long, X., Sun, H., Zhu, B. (2022), The estimation of influencing factors for carbon emissions based on EKC hypothesis and STIRPAT model: Evidence from top 10 countries. Environment, Development and Sustainability, 24(9), 11226-11259.

Ullah, S., Arif, M., Hussain, S., Al-Faryan, M.A.S. (2024), Climate change, governance, and economic growth in Asia: A panel cointegration analysis. Cogent Economics and Finance, 12(1), 2299125.

Wang, G., Chen, X., Zhang, Z., Niu, C. (2015), Influencing factors of energy-related CO_2 emissions in China: A decomposition analysis. Sustainability, 7(10), 14408-14426.

Wang, H., Zhang, X. (2021), Examining the driving factors of industrial CO_2 emissions in Chinese cities using geographically weighted regression model. Clean Technologies and Environmental Policy, 23(6), 1873-1887.

Wang, Q., Zhang, F., Li, R. (2024), Free trade and carbon emissions revisited: The asymmetric impacts of trade diversification and trade openness. Sustainable Development, 32(1), 876-901.

Weber, M. (1905), The Protestant Ethic and the Spirit of Capitalism. Crows Nest: Unwin University Books.

Wen, Y., Haseeb, M., Safdar, N., Yasmin, F., Timsal, S., Li, Z. (2022), Does degree of stringency matter? Revisiting the pollution haven hypothesis in BRICS countries. Frontiers in Environmental Science, 10, 949007.

Westerlund, J. (2007), Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics, 69(6), 709-748.

Xue, L., Haseeb, M., Mahmood, H., Alkhateeb, T.T.Y., Murshed, M. (2021), Renewable energy use and ecological footprints mitigation: Evidence from selected South Asian economies. Sustainability, 13(4), 1613.

Yao, S., Zhang, S., Zhang, X. (2019), Renewable energy, carbon emission and economic growth: A revised environmental Kuznets Curve perspective. Journal of Cleaner Production, 235, 1338-1352.

Yi, P. (2023), Faith-based investing, stewardship, and sustainability: A comparative analysis. Erasmus Law Review, 16(3), 114-127.

You, W., Zhu, H., Yu, K., Cheng, P. (2015), Democracy, financial openness, and global carbon dioxide emissions: Heterogeneity across existing emission levels. World Development, 66, 189-207.

Zhao, M., Park, H. (2024), Research on the dynamic interrelationship between economic policy uncertainty and stock market returns. Journal of Risk and Financial Management, 17(8), 347.