International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2024, 14(1), 150-164.

How Religiosity Affect Climate Change? A Cross-Country Analysis

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Received: 11 July 2023 **Accepted:** 13 December 2023 **DOI:** https://doi.org/10.32479/ijeep.15166

ABSTRACT

Climate change demands a collective response, including from religious perspectives, but it presents a dualistic challenge. On one hand, some believers see it as a divine, immutable law (theocentric), urging humans not to defy it. Conversely, others attribute climate change to human actions that exploit nature (anthropocentric). This study scrutinizes the relationship between religiosity and climate change, using per capita CO_2 emissions as a proxy. It employs cross-country regression analysis, along with robustness and sensitivity tests. The findings highlight religiosity's substantial role in curbing per capita CO_2 emissions growth. This underscores religion's potential as a societal force in overcoming environmental problems, global climate issues, safeguarding natural resources and ecosystems, and ensuring a comfortable, secure existence on Earth.

Keywords: Religiosity, Climate Change, Environment, Emission
JEL Classifications: Z12, Q54, Q57

1. INTRODUCTION

In 2020, "The Global Risks" report was issued by the World Economic Forum (WEF), highlighting that half of the top ten most severe global risks anticipated over the coming decade are associated with environmental concerns. These include failures in climate action, extreme weather events, biodiversity loss, harm to the human environment, and crises concerning natural resources (McLennan, 2022). One year later, the Swiss Re Institute released a publication outlining that climate change represents the most significant long-term threat to the global economy. It is estimated that by 2050, the world's economy could suffer losses of up to 18% of GDP due to climate change if no action is taken (Swiss Re Institute., 2021). During that time, it is projected that global temperatures could rise by more than 3°C. The institute conducted stress tests to assess how 48 world economies (representing 90% of the global economy) would be impacted by the sustained effects of climate change under four different temperature increase scenarios. As global warming intensifies the severity of weather-related natural disasters, it could result in substantial income and productivity losses over time (Liu et al., 2023; Orlov et al., 2020; Zander et al., 2015).

The 2021 Intergovernmental Panel on Climate Change (IPCC) report asserts that humans are the primary drivers of global climate change (Eyring et al., 2021). Additionally, in 2022, the IPCC emphasized that effective climate governance requires meaningful and sustained engagement from all segments of society, ranging from local to global levels. These stakeholders encompass individuals and households, communities, governments at all tiers, the private sector, non-governmental organizations, indigenous communities, and religious groups (Pörtner et al., 2022).

As widely recognized, religion exerts a significant influence on human existence, shaping an individual's viewpoints, cognitions, and interactions within the world. All faiths provide frameworks

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for managing the relationships between humanity, the natural world, and the divine. It was stated that it would be unexpected if issues related to climate change were not addressed by religions (Hulme, 2017). In 2016, the World Economic Forum (WEF) released a report that specifically delved into the role of beliefs and religion in promoting economic equity and addressing climate change. Religion was recognized as having an adaptable and progressive role in galvanizing communities. Consequently, WEF consistently involves religious leaders in collaborative initiatives aimed at addressing global challenges, especially climate change (Grim, 2016). Alongside WEF, the United Nations Environment Programme (UNEP) has also issued reports on the environment, religion, and culture within the framework of the 2030 agenda for sustainable development. These publications contribute to the exploration of how religion and culture can play a part in safeguarding and conserving the natural environment (Niamir-Fuller et al., 2016).

The examination of the interplay between religion and climate change necessitates a meticulous and rigorous investigation (Taylor, 2016a). Scholars consider religion as a promising analytical framework and a cultural microcosm worthy of emulation when delving into the intricate dimensions of human cognition and behavior, encompassing worldviews, moral paradigms, practices, aesthetics, ethics, lifestyles, expectations, and anxieties, all within the context of global transformations, notably climate change (Bergmann and Gerten, 2010). Religious construal's of climate change emanate from a multitude of traditions elucidating how climate change functions within specific communities or traditions. Frequently, public perceptions of climate change draw upon religious terminology. As climate change is inexorably linked with human existence, encompassing both its origins and repercussions, individuals are influenced by the multifaceted ways in which religion shapes and inspires human conduct. Consequently, an all-encompassing comprehension of climate change necessitates not only an appreciation of its economic, social, and political facets but also a nuanced understanding of the religious dimensions, particularly how religion intersects with human experiences and responses to climate change (Jenkins et al., 2018). Religion constitutes a complex system encompassing diverse beliefs that may yield divergent consequences for environmental behaviors. Considering the extensive global population adhering to various religions, grasping the intricacies of this relationship is imperative in addressing contemporary global environmental challenges (Eom et al., 2021).

There is a widespread consensus within the global scientific community affirming that human activities exert a discernible influence on the overarching dynamics of the Earth's climate system (Cook et al., 2016). This assertion has been previously articulated by (Steffen et al., 2005) who identified human activities as the primary driver of global emissions. Scientific findings linking human activities to the climate system have played a pivotal role in identifying the issue of climate change and justifying measures to mitigate it. Scientific evidence strongly supports the assertion that global warming is a result of increased greenhouse gas (GHG) emissions from human activities (Leichenko and O'Brien, 2019). Furthermore, empirical indications of climate change also emanate from meticulous observations conducted by individual actors, including agriculturists, horticulturists, ornithologists, and other stakeholders (Hovelsrud and Smit, 2010). In recent research, Eyring et al. (2021) emphasized that humans have been the primary cause of climate change over the past decade. This conclusion is based on a synthesis of information from various sources, including recent direct observations of Earth's climate changes, analyses of tree rings, ice cores, and other long-term records documenting past climate variations, and computer simulations based on fundamental physics governing the climate system.

Despite the evolving consensus regarding climate change, there exists significant variability in beliefs concerning its causal factors among the general populace. Current research underscores that these causal beliefs are profoundly influenced by cultural, political, and identity perspectives (Hartter et al., 2018). In modern society, there is a prevailing tendency to attribute climate change primarily to human activities (anthropogenic), whereas individuals with conservative inclinations are notably less inclined to endorse this perspective (theocentric). For those subscribing to the notion that human activities are the cause of climate change, this belief has implications for the perceived importance of state policy support in addressing climate change. Socialization through religious institutions can impact people's perceptions of the world, including their perspectives on environmental issues like climate change. However, communities harboring climate change skepticism tend to reject new information that contradicts their pre-existing beliefs. Those skeptical of climate change often dismiss scientific information that appears credible because it contradicts their beliefs (Druckman and McGrath, 2019; Nagle, 2008). One of the reasons a subset of religious adherents may disagree on climate change relates to differing convictions regarding their roles toward others, nature, and God (Hulme, 2009).

Numerous climate change surveys reveal conspicuous discrepancies among individuals affiliated with diverse religious backgrounds (Jones et al., 2014; Smith and Leiserowitz, 2013). These disparities prompt inquiries into their root causes, whether they align with specific theological commitments, and whether they reflect religious-based reservations about modes of scientific knowledge. This necessitates further investigation. Within this context, the impact of religion is regarded as highly equivocal, capable of yielding both positive and negative outcomes (Bergmann, 2005; Proctor and Berry, 2005). On one side, there is a discernible inclination among religious entities and individuals toward the adoption of environmentally conscientious behaviors. They frame their religious traditions as moral imperatives for addressing climate change and demonstrating reverence for the broader natural environment (Taylor, 2016b). Conversely, another faction dismisses these notions.

The interplay of religion with the intricate challenges posed by climate change and environmental issues unfolds as a multifaceted narrative, marked by a simultaneous coexistence of progressive and regressive dynamics. This intricate landscape necessitates a comprehensive and meticulous examination, prompting the call for expansive interdisciplinary research endeavors. These

research initiatives should transcend disciplinary boundaries and embrace a cross-faith and cross-cultural perspective, providing a nuanced understanding of the multifarious roles that religion and culture assume in the broader context of global climate change. In undertaking these studies, the primary objective is to conduct a thorough assessment of the merits and demerits inherent in religious responses to climate change, a focal point consistently underscored by Gerten and Bergmann (Gerten and Bergmann, 2012). However, it is imperative to acknowledge that religious beliefs wield considerable influence over the comprehension and experiences of climate change among their adherents. This realization highlights the profound importance of integrating such insights into the realm of climate change education, a proposition firmly articulated by Schuman et al. (2018).

Amidst the ongoing discourse and often complex discourse involving scientists, religious groups, and interfaith dialogues, Müller (2021) assertion that individuals of faith can be valuable allies in the collective effort to combat climate change holds profound significance. It is within the realm of collaborative endeavors that the latent synergy between religious communities and the scientific community emerges as a potent force, capable of effecting tangible change in the ongoing struggle to preserve a hospitable planet. As he insightfully suggests, the heart of these collaborative efforts lies in the facilitation of meaningful discussions, ones that revolve around shared concerns that transcend religious and scientific boundaries. Central to these discussions is the overarching consideration of the Earth's well-being, and the world that future generations are destined to inherit. It is within this crucible of dialogue and cooperation that the true strength of the alliance between these two seemingly disparate groups becomes manifest. If harnessed effectively, this alliance has the potential to inscribe a new and transformative chapter in the annals of human history, one that is dedicated to safeguarding the environment and ensuring the flourishing of all life on Earth.

Morrison et al. (2015) noted that there has been a scarcity of research specifically dedicated to exploring the relationship between religion and people's attitudes and behaviors regarding climate change. Previous research in this field predominantly focused on specific religious groups and secular viewpoints. However, in recent years, there has been a noticeable surge in research endeavors delving into the intricate interplay between religious perspectives and the multifaceted issues of climate change (Allison, 2015; Clingerman and O'Brien, 2017; Edenhofer et al., 2015; Haluza-DeLay, 2014; Hulme, 2017; Jenkins et al., 2018; Kilburn, 2014; Murphy et al., 2016; Smith and Leiserowitz, 2013). This increase in research depth and breadth has placed a particular emphasis on cultural and value-related aspects. Consequently, it has spurred researchers to scrutinize the role of religion in comprehending the intricate cultural dynamics intertwined with the phenomenon of climate change (Abson et al., 2017; Adger et al., 2013; Christie et al., 2019; Hulme, 2016; Ives et al., 2020; Ives and Kidwell, 2019; Jenkins et al., 2018; O'Brien, 2018; Otto et al., 2020).

The shifting research landscape has predominantly favored qualitative inquiries to explore the multifaceted relationship between religion and climate change. Despite the growing recognition of the importance of religion in shaping attitudes and behaviors toward climate change, the quantitative research addressing this intersection remains relatively underdeveloped. Jenkins et al. (2018) have highlighted this notable gap in literature. They noted that while qualitative research has provided rich narratives and qualitative descriptions of the role of religion in climate change perceptions and responses, quantitative studies are essential for providing a broader, data-driven perspective.

Considering the context outlined above, the authors are motivated to undertake a more comprehensive examination of the role of religion in addressing climate change, with a specific emphasis on employing quantitative methodologies. The findings generated through this research endeavor have the capacity to provide valuable support to followers, communities, and religious leaders actively participating in global initiatives aimed at adapting and mitigating climate change.

2. METHODS AND DATA

2.1. Regression Model

This study adopts an adapted cross-country regression model from several relevant studies (Mentel et al., 2022; Sharma et al., 2021; Squalli, 2019; York and McGee, 2017). The empirical representation of this model is presented in Eq. (1).

$$LCO2C_i = \alpha + \beta Religiosity_i + \gamma' CV_i + e_i \quad (1)$$

Where *LCO2C* is the dependent variable for climate change which is proxied using CO_2 per capita (log) in country *i*. Religiosity is an independent variable which is a measure in country *i*. *CV* is a set of control variables consisting of the variables economic growth, foreign direct investment, population growth, industry, electricity consumption, globalization index, quality of institutions, democracy index and region dummy. β is a parameter of the religiosity index variable which is expected to have a negative sign. γ control variable parameter vector. α is the intercept, and *e* is the error term. By including all control variables, 95 country observations are obtained (Table A1).

2.2. Dependent Variable

The dependent variable employed in this study is the per capita CO_2 emissions transformed into natural logarithmic form. CO_2 is a commonly utilized indicator due to its significant contribution to greenhouse gas (GHG) emissions, which constitute the primary source of climate change (Thio et al., 2022). This variable utilizes data from the year 2020, sourced from the World Bank.

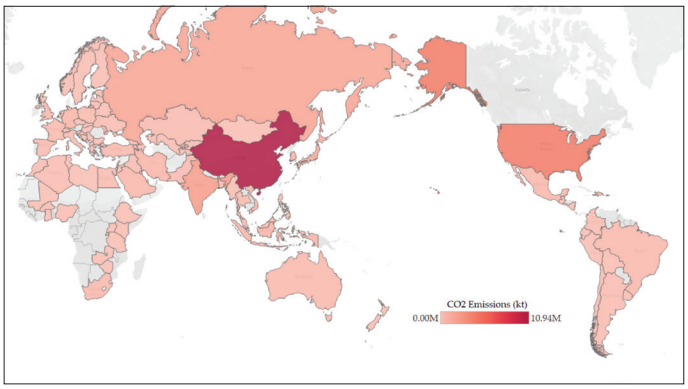
Visually, the spatial distribution of carbon dioxide (CO_2) emissions can be observed in Figure 1. Based on data published by the World Bank, it is evident that in 2020, among the 95 countries examined, the top ten emitters of CO_2 were China, the United States, India, Russia, Japan, Iran, Germany, South Korea, Indonesia, and Saudi Arabia. These ten countries collectively accounted for approximately 74.98% of global CO_2 emissions. China contributed 30.63% of the world's CO_2 emissions, attributed to its rapid industrialization, substantial population, and status as

the largest global consumer of coal, accounting for 53% of the total global coal consumption. Conversely, the countries with the lowest CO_2 emissions were Rwanda, Montenegro, and Haiti. When considering emissions per capita, the leading contributors were Qatar, Kuwait, Australia, Saudi Arabia, the United States, Kazakhstan, and Russia. The distribution map of CO_2 emissions per capita can be observed in Figure 2.

The world's largest emitting are predominantly countries characterized by expansive geographic territories, often engaging in extensive deforestation for agricultural expansion and fuel sources, exemplified by nations like China, the United States, and Russia (The Lancet Planetary Health, 2021). The concentration of carbon dioxide (CO_2) in the atmosphere has experienced a 50% increase since the inception of the industrial era in 1750. This surge in CO_2 levels is primarily attributable to human activities, including deforestation and the combustion of fossil fuels. Such an increase has the potential to elevate Earth's surface temperatures, thereby triggering climatic alterations, natural disasters, and consequential disruptions to economic activities (Lindsey, 2023).

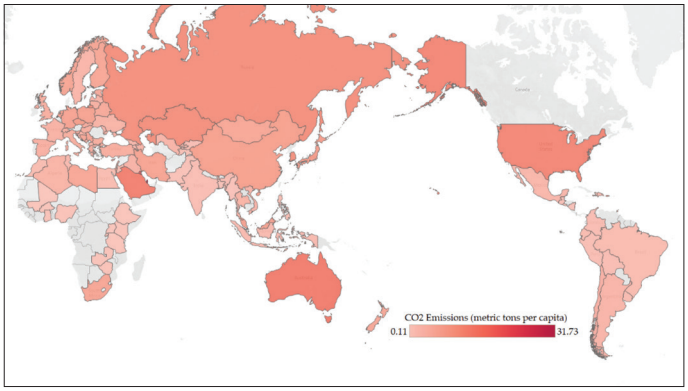
The escalation in carbon dioxide concentration primarily results from humanity's reliance on fossil fuels for energy production. Fossil fuels, exemplified by coal and oil, encompass carbon that was initially sequestered from the atmosphere through photosynthesis by plants over millions of years. Remarkably, humans are now reintroducing this carbon into the atmosphere within a mere span of centuries. Since the mid-20th century, the annual emissions stemming from the combustion of fossil fuels have exhibited a consistent upward trajectory, with levels surging from approximately 11 billion tons of CO_2 per annum during the 1960s to an estimated 36.6 billion tons in 2022 (Friedlingstein et al., 2022).

Figure 1: Spatial distribution of CO_2 emissions



Higher values represented by darker red areas

Figure 2: Spatial distribution of CO_2 emissions per capita



Higher values represented by darker red areas

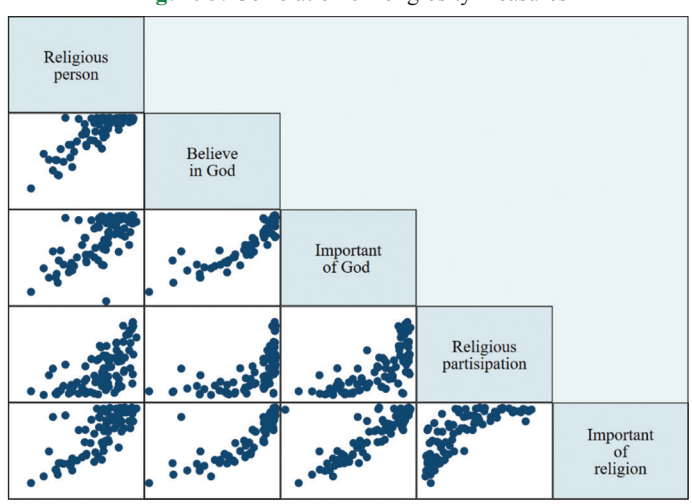
2.3. Independent Variable

2.3.1. Religiosity index

To measure religiosity, this research adheres to the approach employed by Sharma et al. (2021) and Bénabou et al. (2015), which centers on five crucial facets of an individual's religious orientation, namely: (i) The proportion of individuals who consider themselves religious, believe in God, affirm the importance of religion in their lives, regularly attend religious activities (weekly or more), and assert that God is important in their lives. Data were sourced from the World Values Survey (WVS). This study utilizes pooled data covering seven waves of data (wave 1-7), which were averaged for all available waves, spanning approximately four decades (1981-2022). During wave 1 (1981-1984), data on religiosity were available for 11 countries. In wave 2 (1989-1993), data were available for 21 countries. Wave 3 (1994-1998) included data from 55 countries, while wave 4 (1999-2004) encompassed data from 41 countries. Wave 5 (2005-2009) featured data from 58 countries, wave 6 (2010-2014) had data from 60 countries, and wave 7 (2017-2022) encompassed data from 57 countries. Each WVS wave retains some countries surveyed in the previous wave, while a few new countries are added. By employing a pooled data approach, a sample of 106 countries was obtained. This sample size reduces to 95 countries after incorporating control variables (Table A1). The five religiosity measures exhibit strong correlations (Figure 3).

This study also conducted a principal component analysis (Labrin and Urdinez, 2020), which helps identify the most representative combination of data for measuring the targeted concept. The analysis demonstrated that the first principal component explained 82.34% of the total variance and established a reliable overarching religiosity scale (Cronbach's alpha = 0.94). In this research, a comprehensive index was constructed by averaging the combined scores of the five religiosity measures. The resulting religiosity

Figure 3: Correlation of religiosity measures



index ranged between zero and one, where higher values indicated greater religiosity.

The sample used in this study encompassed 410,086 participants from 95 different countries. Approximately 85.06% of these individuals professed their belief in God. Furthermore, 73.11% regarded God as significant in their lives, and 72.40% considered religion to be an essential aspect of their daily existence. Notably, 70.60% self-identified as religious, regardless of their attendance at religious gatherings or events. Additionally, 34.03% of respondents engaged in religious activities at least once a week (Figure 4). These findings demonstrate that at least eight out of ten individuals worldwide hold a belief in God, with seven out of ten identifying themselves as religious and valuing religion and God as important aspects of their lives.

Figure 5 provides a visual representation of the global variations in religiosity. Out of the 95 countries included in the analysis, China emerges as the least religious nation, achieving a mere 0.11 on the religiosity index, while Qatar stands as the most religious country, scoring notably higher at 0.97 on the religiosity index. On the lower end of the religiosity spectrum, we find countries such as the Czech Republic, Japan, Sweden, Estonia, Vietnam, the Netherlands, Norway, France, South Korea, Germany, and the United Kingdom, all displaying relatively low religiosity scores. In coexhibits nations like Nigeria, Tanzania, Ghana, Zimbabwe, Uganda, Ethiopia, Kenya, Pakistan, Bangladesh, Rwanda, and Mali exhibit significantly higher religiosity scores. Notably, high-income countries such as the United States, Israel, Trinidad and Tobago, Poland, and Greece register relatively elevated religiosity scores, exceeding 0.70 on the index.

Religiosity levels have remained relatively stable in most of these countries throughout the sampled period. For instance, the

Figure 4: Indicators for measuring religiosity

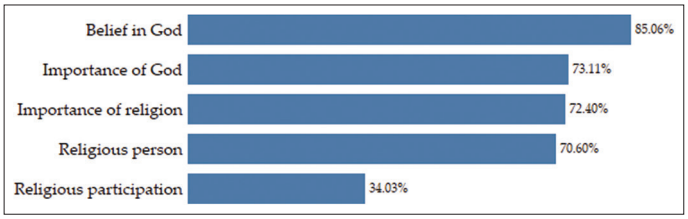
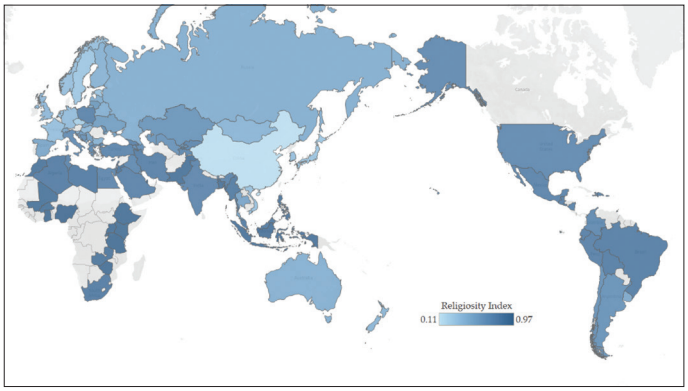


Figure 5: Spatial variations in religiosity



The religiosity index ranges from zero to one. High values (represented by darker blue areas) indicate higher religiosity

religiosity index for South Korea (spanning all WVS waves) ranged from 0.35 in 1982 to 0.29 in 2018. Within the scope of this study, the method of calculating a country's religiosity index by averaging across various survey waves appears to be an acceptable approach.

Figure 6 presents an array of religiosity variations categorized by region (panel a), the dominant religion among a country's populace (panel b), income groups (panel c), and the interplay between religion and the state (panel d). When examining regions, Sub-Saharan African nations emerge as the most religious, with countries like Nigeria, Tanzania, and Ghana standing out. Conversely, countries in the East Asia and Pacific region tend to be among the least religious, encompassing nations such as China, Japan, and Vietnam. In terms of the majority religion within a population, countries with a predominantly Islamic populace tend to exhibit the highest religiosity levels (e.g., Qatar, Nigeria, and Pakistan), followed by nations with a majority Jewish (Israel), Hindu (India), or Christian (Tanzania, Ghana, and Zimbabwe) population.

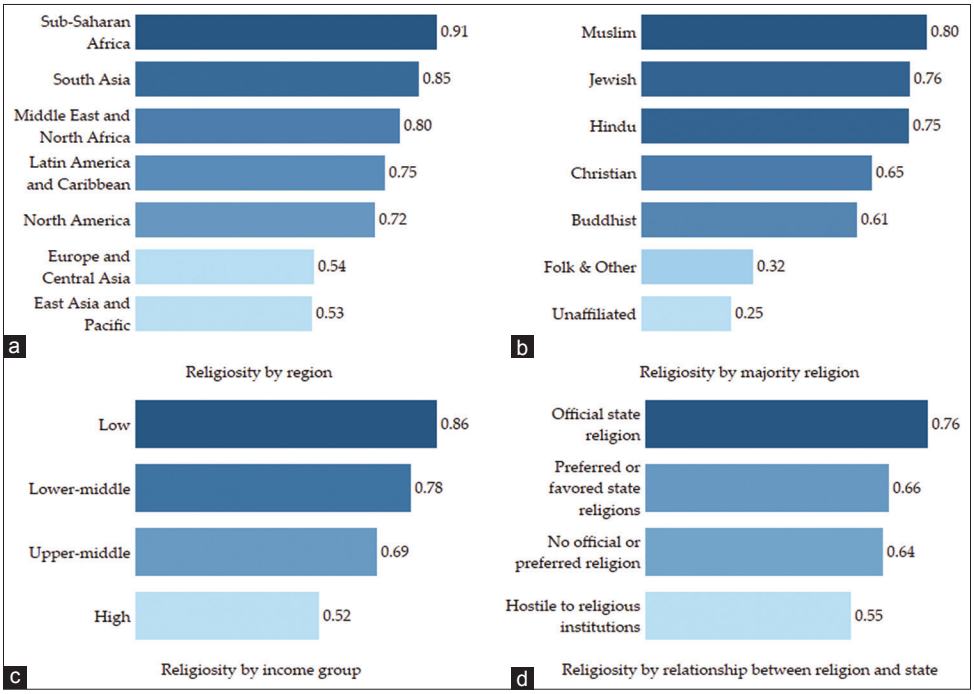
When categorized by income, it becomes evident that, on average, high-income countries tend to exhibit lower levels of religiosity (e.g., Czech Republic, Japan, and Sweden), while low-income countries tend to display higher levels of religiosity (e.g., Uganda, Ethiopia, and Rwanda). In the final panel (panel d), it is observed that countries with an official religion tend to be the most religious (e.g., Qatar, Pakistan, and Bangladesh), whereas nations embroiled in conflicts and exhibiting hostility towards specific religious institutions tend to have the lowest levels of religiosity (e.g., China, Vietnam, and Kazakhstan).

2.3.2. Control variables

This study incorporates control variables encompassing economic, demographic, institutional, and political aspects to enhance the validity of the model estimates. All control variables utilize data from the year 2020. First, it includes economic growth, represented as the logarithm of GDP per capita, PPP (constant 2017 international $). Second, foreign direct investment, net inflows (% of GDP). Third, population growth is accounted for using the logarithm of total population. Fourth, industry (including construction) value added (% of GDP) is included in the analysis. These data sources are obtained from the World Bank. Fifth, per capita electricity generation from fossil fuels (kWh) (log) is included, and this data is sourced from Our World in Data (OWD).

Sixth, the KOF globalization index is utilized to measure openness in economic (trade and economic globalization), social, and political dimensions on a scale ranging from 1 to 100 (Gygli et al., 2019). A higher index value indicates a higher level of globalization occurring in a country. Seventh, institutional quality is derived from the average of political stability and control of corruption, with a scale from −2.5 to 2.5 (Kaufmann et al., 2011). Higher index values represent higher institutional quality. Seventh, the democracy index assesses the extent to which citizens can select their political leaders through free and fair elections, enjoy civil liberties, prefer democracy as a political system, participate in politics, and have an effective government working on their behalf (Economist Intelligence Unit, 2023). It ranges from 0 to 10, with

Figure 6: (a-d) Categorization of religiosity



The religiosity index ranges from zero to one. High values indicate higher religiosity

higher values indicating a higher level of democracy. Last, region dummies are established based on the World Bank's classification.

3. RESULTS

Table 1 provides a statistical summary of the variables used in this research in the form of average values, standard deviation, minimum and maximum values. Focusing on the variables of interest, the religiosity index ranges between a low of 0.12 in China and a high of 0.97 in Qatar. The average value of the religiosity index is 0.66. The countries whose religiosity index values are at the overall average value are Singapore, Chile, Bosnia and Herzegovina and Moldova. Because they are not transformed into natural logarithms, foreign direct investment, KOF globalization index, and industry have high standard deviations. The minimum value of the foreign direct and institutional investment variables is negative, while the other variables are positive.

The impact of religiosity on per capita CO_2 emission growth is estimated using multiple regression analysis with robust standard errors. Table 2 presents the regression results for Eq. (1). All model specifications include regional dummies. Column (1) reports the ordinary least squares estimates without control variables. Economic growth, foreign direct investment, population growth, per capita fossil fuel electricity consumption, globalization index, institutional quality, and democracy index are included in column (2). The R-squared value increases from 0.65 in column (1) to 0.94 in column (2). Thus, the model in the main specification explains 94% of the variability in per capita CO_2 emission growth.

This study identifies a significant negative relationship between the religiosity index and per capita CO_2 emissions in both

Table 1: Descriptive statistics

Variable	Mean	Std. dev.	Min	Max
CO_2 per capita (log)	1.03	1.18	−2.25	3.46
Religiosity index	0.66	0.21	0.12	0.97
Real GDP per capita (log)	9.64	0.96	7.60	11.46
Foreign direct investment	1.56	16.36	−104.06	106.59
Population (log)	16.79	1.54	13.34	21.07
Industry	26.68	7.68	6.64	52.33
Electricity per capita (log)	6.92	1.79	−2.46	9.69
Globalization	68.47	12.32	41.27	90.61
Institutional quality	−0.11	0.88	−2.01	1.82
Democracy	5.77	2.06	1.94	9.81

Sample size is 95

columns (1) and (2). An increase of one point in the religiosity index is associated with a 0.61% reduction in per capita CO_2 emissions. Standardized estimates in column (2) indicate that a one standard deviation increase in the religiosity index is linked to approximately a one-tenth standard deviation decrease in per capita CO_2 emissions. Figure 7 presents a partial regression plot using the estimates reported in column (2) of Table 2. Overall, the estimations of the influence of religiosity on per capita CO_2 emissions reported in this section support the research hypothesis.

3.1. Robustness and Sensitivity Checks

In this section, an examination of the robustness and sensitivity of the estimation results to (i) unavailable religiosity data, (ii) alternative measures of religiosity, and (iii) religious affiliation and income group is conducted. Each of these examinations is discussed in detail in this research.

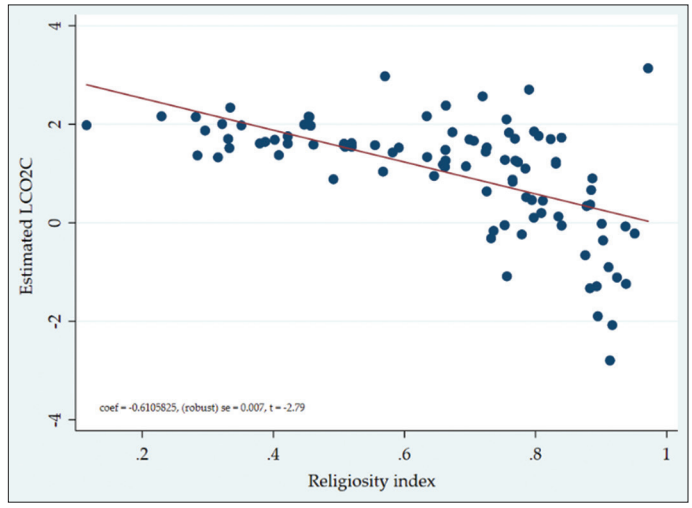
3.1.1. Missing religiosity values

Survey questions related to several measures of religiosity, particularly "belief in God," were not asked in some countries

(approximately 8.42% of the sample countries). This poses a potential concern. For instance, questions related to "belief in God" were not asked in Italy. In the fundamental approach of this research, religiosity indices for these countries were constructed using all other available measures of religiosity (four in the case of Italy). While this represents a pragmatic approach in cross-sectional analysis, aiming to retain as many observations as possible, the resulting religiosity indices are likely not accurate for countries lacking information on several religiosity measures.

This research re-estimates the main model (Table 2, column (2)) to incorporate missing religiosity values using a stochastic multiple imputation algorithm. This is an improved version of deterministic imputation. In deterministic imputation, a regression model is estimated to predict the values of observations for a variable based on other variables with complete and incomplete information (Little and Rubin, 2019). The missing values are then accounted for using the corresponding values from the regression model. Stochastic multiple imputation extends the procedure in two ways: First, residuals are added to the predicted values to manage missing variability. Second, instead of using a single imputed value, missing values are drawn multiple times from the distribution, and each set of data is analyzed separately. Regression results are then consolidated using the average coefficients of separate regressions (Enders, 2022).

Figure 7: Effect of religiosity on CO2 emissions per capita



This figure shows the influence of religiosity on CO_2 per capita (log), after partially excluding the influence of the control variables used in column (2), Table 2

Table 2: The effect of religiosity on per capita CO_2 emissions

Dependent variable=LCO_2C	(1)	(2)
	Basic specification	Main specification (Baseline model)
Religiosity index	−1.77*** (−3.49)	−0.61*** (−2.79)
Economic growth		−1.55 (−1.42)
Economic growth^2		23.32** (2.17)
Foreign direct investment		−0.00 (−0.32)
Population growth		−0.03 (−1.03)
Industry		0.01*** (2.85)
Electricity per capita		0.222*** (2.91)
Globalization		−0.01 (−1.26)
Institutional quality		−0.138 (−1.41)
Democracy		−0.02 (−0.74)
Standardized coefficient of religiosity index	−0.31***	−0.11***
Region dummy	Yes	Yes
R-squared	0.65	0.94
No. of observations	95	95

The religiosity index measures the strength of overall religiosity and varies from zero to one. Region dummy variables are East Asia and the Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, North America, South Asia, and Sub-Saharan Africa. Robust standard errors are used. t-statistics are reported in parentheses. *, ** and *** indicate significance at the level of 10%, 5% and 1%, respectively. Intercept estimates are not shown

Table 3: Estimation results based on imputed values of religiosity

Dependent variable=LCO_2C	(1)	(2)	(3)	(4)	(5)	(6)
Religious person	−0.63*** (−2.74)					
Belief in God		−0.41* (−1.66)				
Importance of God			−0.34* (−1.74)			
Religious participation				−0.68** (−2.38)		
Importance of religion					−0.55** (−2.52)	
Religiosity index						−0.61** (−2.34)
Baseline control	Yes	Yes	Yes	Yes	Yes	Yes
Region dummy	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.94	0.94	0.94	0.94	0.94	0.94
No. of observations	95	95	95	95	95	95

The reported results are estimated while considering the missing values of religiosity measures. Imputation is performed ten times, yielding ten sets of imputed values. The belief in God variable is utilized to impute the values of the missing measures. Multiple imputation regressions are reported for the other measures in columns (1)-(5). In constructing the religiosity index in column (6), missing religiosity measures are replaced with the average of the ten different imputed values. Control variables and region dummy variables are included in the model

Table 3 reports regression estimates based on imputed values. Columns (1) through (5) present the results of individual religiosity measurements, while column (6) indicates the overall religiosity index results. All column outcomes are consistent with the main findings reported in Table 2.

3.1.2. Alternative sample and measures of religiosity

In this section, an inquiry is conducted to investigate whether the religiosity measure used in this study, which is constructed by averaging data from several waves of the WVS survey (1-7), leads to biased coefficient estimates. There are at least five approaches to examine the reliability of the method used to construct this measure of religiosity.

First, the construction of religiosity indices for each country was carried out using data from each available wave separately, and their correlations were examined. The results in Table 4 demonstrate that all religiosity indices (constructed from different waves) exhibit high correlations. These values are also highly correlated with the overall religiosity index created using the collected data, which is the fundamental measure of this study. This suggests that the findings of this research are unlikely to be affected by aggregation bias, instilling confidence in the overall utility of our religiosity index.

Second, this study conducted a robustness check using religiosity indices specific to each wave. However, a sharp drop in the number of observations in some waves posed a constraint in this practice. For instance, estimating Equation (1) using data from the first wave resulted in only 10 observations. Therefore, testing was carried out using the latest wave (Wave 7, 2017-2022) to construct wave-specific religiosity indices that encompassed a relatively larger number of countries. Estimates using these alternative religiosity measures can be observed in column (1) of Table 5. Wave 7 surveys provided data for 57 countries, while column (1) contained only 54 observations due to the unavailability of data for other variables. The results align with the baseline estimation of this study.

Third, the most recent wave of the World Values Survey (WVS) containing religiosity data was utilized for each country. This implies that if religiosity measurements were not available for wave seven, then wave six was utilized, followed by wave five, and so forth. Additionally, it's important to note that the estimation results presented in column (2) of Table 5 align consistently with the baseline model findings in Table 2.

Fourth, this study assesses the sensitivity of its findings by constructing a religiosity measure based on the framework introduced by Squalli (2019), which refers to the publication from the Pew Research Center (PRC) (Lipka and Wormald, 2016). The composite index encompasses four indicators, comprising the importance of religion, frequency of prayer, attendance at places of worship, and belief in God. This research constructs this religiosity index using the WVS data collected. The results are in alignment with and consistent with the baseline model of this study, as evident in column (3) of Table 5.

Fifth, this study constructs an alternative measure of religiosity based on the framework developed by Inglehart and Norris (2003). They measure six crucial aspects of societal religious orientation, namely the importance of God, comfort and strength from God, belief in God, being a religious person, belief in life after death,

Table 4: Correlation between waves of religiosity indices

Religiosity indices	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7	Pooled data
Religiosity index: Wave 1	1.00							
Religiosity index: Wave 2	0.97***	1.00						
Religiosity index: Wave 3	0.95***	0.91***	1.00					
Religiosity index: Wave 4	0.98***	0.98***	0.96***	1.00				
Religiosity index: Wave 5	0.92***	0.92***	0.86***	0.94***	1.00			
Religiosity index: Wave 6	0.91***	0.91***	0.90***	0.89***	0.90***	1.00		
Religiosity index: Wave 7	0.90**	0.89***	0.91***	0.92***	0.93***	0.9***	1.00	
Religiosity index: Pooled data	0.96***	0.97***	0.96***	0.98***	0.97***	0.96***	0.97***	1.00

*, ** and *** indicate significance at the 10%, 5% and 1% levels respectively

Table 5: Estimation results based on alternative sample and measures of religiosity

Dependent variable=LCO_2C	(1)	(2)	(3)	(4)
Religiosity index: Wave 7	−1.02***			
	(−2.94)			
Religiosity index: the most recent wave		−0.48**		
		(−2.30)		
Religiosity index: Squalli			−0.58**	
			(−2.46)	
Religiosity index: Inglehart				−0.56***
				(−2.71)
Baseline control	Yes	Yes	Yes	Yes
Region dummy	Yes	Yes	Yes	Yes
R-squared	0.936	0.941	0.942	0.942
No. of observations	54	95	94	95

Control variables and region dummies are included in the model. Robust standard errors are used. t-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Intercept estimates are not displayed

and religious participation. Using these indicators, a religiosity index is compiled using the WVS data collected. Column (4) in Table 5 reports results that closely resemble the baseline estimates in the main specification of this research.

In brief, regardless of the alternative measures of religiosity employed, the influence of religiosity on per capita CO_2 emissions remains statistically significant, and the coefficient values and their levels of significance remain stable.

3.1.3. Religious affiliation and income groups

In this section, the model's sensitivity analysis is conducted concerning the influence of religious affiliation and income groups. The study re-estimates Eq. (1) while controlling for the relationship between religion and the country, as well as the different religious compositions of the population and income groups.

Kishi et al. (2017) have successfully mapped out the relationship between religion and the state. Working alongside a team of programmers, they examined the constitutions or fundamental laws of each country, along with their policies and official actions towards religious groups, to classify the relationship between religion and the state into one of four categories. The first category comprises countries where an official religion is granted a formal status in their constitution or fundamental laws. The second category includes countries that exhibit a preference for a specific religion, with clear government policies or actions that favor one (or in some cases, more than one) religion over others, usually resulting in legal, financial, or practical advantages. The third category consists of secular states that do not have an official religion or show a preference for any religion. They attempt to avoid granting significant benefits to one religious group over another (though they may provide benefits to multiple religious groups). The fourth category involves states with hostile relationships with religion. These states exercise a high level of control over religious institutions within their borders or actively adopt an aggressive stance against religion in general. In this study, the classification of the sample is accomplished using dummy variables, with the fourth group serving as the omitted group.

Furthermore, the categorization of the religious affiliation of the majority population refers to the publication by Hackett et al. (2015) in conjunction with the Pew Research Center on religion and public life. They estimated that in 2020, there were 6.52 billion individuals, both adults and children, worldwide who identified with a religious affiliation, representing 84.45% of the world's population. Following their approach, this study utilizes seven categories and calculates the percentage of the total population within each category, including Christians, Muslims, Hindus, Buddhists, Jews, adherents of Folk or Traditional religions, and those unaffiliated with any religion. To classify the sample, this research employs dummy variables, designating the majority population unaffiliated with any religion being designated as the omitted group.

Additionally, a sensitivity analysis of the model is conducted to examine the effects of income groups. In this study, the income groupings for each country are drawn from the 2020 World Bank data. These income groups are categorized into four tiers: high income, upper-middle income, lower-middle income, and low income. To categorize our sample, this research employs dummy variables, with the low-income group serving as omitted group.

Columns (1), (4), and (5) in Table 6 present findings that incorporate the relationship between religion and the state. Column (1) adding a dummy variable for the religion-state relationship. Column (4) excludes secular countries from the sample, while column (5) excludes the state with a hostile relationship toward religion religious institutions. The results of the main specification of this study remain robust in all three cases, with religiosity consistently exerting a significant negative influence on per capita CO_2 emissions. However, the relationship between religion and the state does not show a significant effect, as observed in column (1).

Columns (2) and (6) in Table 6 report results that incorporate the effects of the majority population's religion. Column (2) adding a dummy variable representing the religion of the majority population. Meanwhile, Column (6) excluding the countries where the majority population is unaffiliated with any religion. The significance of the impact of religiosity on per capita CO_2 emissions remains consistent in both cases.

Column (3) and (7) in Table 6 report estimation results by controlling the income group. Column (3) adds income group as dummy variables, while Column (7) excluding the low-income and lower-middle-income countries from the sample. The religiosity index still exhibits a statistically significant negative impact on per capita CO_2 emissions in both cases.

4. DISCUSSION

This research discovers a significant negative relationship between the religiosity index and per capita CO_2 emissions. As the religiosity index increases, per capita CO_2 emissions decrease. This information aligns with Chaplin (2016) statement, which suggests that religious institutions have inspired various movements to enhance ecological awareness over the past 30 years. Similar observations were made by Haluza-DeLay (2014), indicating that religious-based actors and organized religious groups have issued numerous statements about climate change in recent years.

The presence of religious environmentalism has seen an increase (Koehrsen et al., 2022). Major world religions have developed "green" theology, launched environmental protection projects, issued public statements on climate change, and attempted to raise awareness among their members about more environmentally friendly lifestyles. Examples of these environmental activities span a wide range, from recycling initiatives in Buddhist communities (Lee and Han, 2015; Mohamad et al., 2012) to eco-friendly pilgrimage guidelines for Muslim Hajj travelers to Mecca (Koehrsen, 2021; Mangunjaya et al., 2015), the ecological vision of Patriarch Bartholomew of Constantinople (Bartholomew, 2012; Theokritoff, 2017), and interfaith events addressing climate change (Robra, 2010).

Religiosity can have a significant impact on climate change, influencing both individual and community attitudes and actions.

Table 6: Sensitivity to religious affiliation and income group

Dependent variable=LCO_2C	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Religiosity index	−0.48*	−0.67**	−0.59***	−0.57**	−0.62**	−0.62**	−0.34*
	(−1.96)	(−2.13)	(−2.65)	(−2.16)	(−2.31)	(−2.34)	(−1.75)
Relationship between religion and state (ref. state with a hostile relationship toward religion)							
Official state religion	−0.37						
	(−1.64)						
Preferred or favored state religions	−0.28						
	(−1.43)						
No official or preferred religion	−0.23						
	(−1.12)						
Majority religion (ref. unaffiliated)							
Muslim		0.08					
		(0.45)					
Christian		0.14					
		(1.12)					
Buddhist		−0.23					
		(−0.84)					
Hindu		0.91**					
		(2.48)					
Folk and other		−0.06					
		(−0.47)					
Jewish		−0.20					
		(−0.95)					
Income group (ref. low)							
High			−0.27				
			(−0.68)				
Upper-middle			−0.20				
			(−0.57)				
Lower-middle			−0.16				
			(−0.54)				
Baseline control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.96	0.95	0.94	0.95	0.95	0.94	0.91
No. of observations	95	95	95	48	88	90	64

Column (1) adds a dummy variable for the religion-country relationship, (2) adds a dummy variable for the religion of the majority population, (3) adds income group dummy variables, (4) excludes secular countries, (5) excludes countries with a hostile relationship toward specific religious institutions, (6) excludes countries where the majority population is unaffiliated with any religion, and (7) excludes low-income and lower-middle-income countries. Control variables and region dummy are included in the model. Robust standard errors are used. t-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Intercept estimates are not displayed

The extent of this influence may vary depending on the level of religiosity, religious beliefs, and interpretations of religious teachings. Here are some of the ways religiosity can affect climate change: First, it can shape attitudes related to morals and ethics. Highly religious individuals may tend to hold higher environmental moral and ethical values. They perceive climate change as a moral issue requiring ethical action to protect the natural environment (Haluza-DeLay, 2014; Posas, 2007). Second, it can raise awareness of responsibility. Religiosity can increase an individual's awareness of their responsibility toward nature. They may feel that caring for the Earth is part of their moral and spiritual calling (Jenkins et al., 2018). Third, it can encourage climate action. Highly religious individuals may be more inclined to take active steps in addressing climate change, such as reducing their carbon footprint, supporting renewable energy, and participating in environmental projects (Koehrsen, 2021; Tomalin et al., 2019; Veldman et al., 2013). Fourth, it can influence environmental policy support. Religiosity can also affect views on climate policies. Highly religious individuals may be more likely to support sustainable environmental policies and urge governments to act (Allison, 2007; Whitney and Whitney, 2012).

Fifth, it can affect perceptions of human's role in climate change. Sometimes, specific religious beliefs can influence an individual's perspective on the role of humans in climate change. Some religions teach that humans are stewards of the Earth, while others see the possibility of climate change as part of divine plans (Hulme, 2017). Sixthly, it can be influenced by religious leaders. Religious leaders and spiritual figures can play a crucial role in influencing the attitudes and actions of their communities regarding climate change. If religious leaders support climate action, it can motivate their followers to act as well (Bean, 2016; Cartlidge, 2015; Haluza-DeLay, 2017; Schaefer, 2016; Shuttleworth and Wylie, 2019; Taylor, 2020). Seventh, it can involve environmental practices in worship. Some religions incorporate environmental practices into their worship, such as prayers for nature or ritual actions aimed at achieving ecosystem balance. This can enhance awareness and responsibility towards the environment (Drew, 2013; Hulme, 2017; Murphy et al., 2016). Eighth, it can promote interfaith collaboration. Many interfaith initiatives focus on climate change. Religiosity can motivate individuals to participate in these efforts to achieve common goals (Allison, 2007; Berry, 2019; Chitando, 2022; Fahy and Haynes, 2018; McKim, 2023; Schaefer, 2016).

Involvement of religion in addressing climate change may be influenced by various barriers and challenges. These obstacles may vary depending on religious traditions, regions, and specific communities, but some common barriers include: First, theological differences. Theological disagreements within and among religious denominations can hinder collective action on climate change (Druckman and McGrath, 2019; Nagle, 2008). Some religious groups may interpret their sacred texts or doctrines differently, leading to conflicting views on environmental management and responsibility (Hulme, 2009). Second, lack of awareness. Some religious leaders and communities may not fully understand the science and urgency of climate change, which can hinder their involvement (Wolf and Moser, 2011). Raising awareness and providing education about climate science and its implications is crucial.

Third, resistance to change (Pennycook et al., 2020). Resistance to change, both within religious communities and among individuals, can hinder efforts to address climate change. Societies may resist changing traditional practices or adopting new environmentally friendly behaviors. Fourth, communication challenges. Effective communication about climate change can be challenging, especially when dealing with diverse religious groups with varying levels of scientific literacy (Koehrsen, 2021). Religious leaders and communicators may struggle to convey the urgency of the issue and the need for action.

Fifth, cultural and regional factors. Cultural norms and regional attitudes toward the environment can influence the involvement of religious communities in addressing climate change (Antwi-Agyei et al., 2015). In some regions, ecological issues may receive less priority. Sixth, conservative attitudes. Some religious communities may hold conservative social and political views that are skeptical of climate science or resistant to climate action, potentially leading to inaction or barriers (Druckman and McGrath, 2019).

Despite these challenges, many religious communities and leaders are actively working to address climate change. Overcoming these obstacles often requires education, dialogue, collaboration, and a commitment to finding common ground among different groups with shared environmental values and responsibilities (Agusalim and Karim, 2023).

The estimation results in Table 2, Column (2), also report the impact of control variables on per capita CO_2 emissions. The Environmental Kuznets Curve (EKC) hypothesis is not supported in this study. The EKC hypothesis does not consistently hold (Anwar et al., 2022; Naveed et al., 2022; Pincheira and Zuniga, 2021; Shahbaz and Sinha, 2019), as empirically found in several studies (Aini and Hartono, 2022; Djellouli et al., 2022; Ochoa-Moreno et al., 2021). Several factors might explain why this hypothesis does not always hold; for instance, the EKC hypothesis cannot universally apply to all types of pollution or countries (Ben Jebli et al., 2022; Stern, 2004). Pollution levels and environmental impacts can be influenced by various contextual factors other than economic growth, such as available natural resources, environmental policies, changes in economic structure, and technology use. Therefore, it is not possible to generalize the EKC relationship to all situations.

Furthermore, the Pollution Haven/Halo hypothesis is not supported, as evidenced by the lack of a significant impact of foreign direct investment variables on the growth of per capita CO_2 emissions. These results support several other studies This result aligns with the findings of Albulescu et al. (2019), Bulut (2021), Mahmood (2022), and Nadeem et al. (2020). This result does not always align with the theory, which may be due to aggregation bias (Ahmad et al., 2021). Although this hypothesis has some theoretical support, there are several reasons why it may not always prove or be complex in practice; for instance, business decisions to relocate production or investments to other countries are not solely based on environmental regulations. Factors such as labor costs, logistics costs, market access, and infrastructure also play a crucial role in these decisions. Therefore, the shift in industrial activities is not always directly related to differences in environmental regulations.

Population growth does not always have a direct impact on the growth of per capita CO_2 emissions, as seen in the estimation results of this study. This can occur because global resource consumption is primarily driven by increased prosperity rather than by population. This is particularly true for high to upper-middle-income countries, which contribute 78% of material consumption, even though their population growth rates are slower than in other parts of the world (Oberle et al., 2019).

The industrial sector and per capita fossil fuel-based electricity consumption partially have a significant positive impact on per capita CO_2 emissions. This result aligns with expectations (Aslam et al., 2021; Bento and Moutinho, 2016; Mentel et al., 2022; York and McGee, 2017). In the early stages of economic development, industrialization is associated with increased energy demand and changes in energy consumption patterns, leading to increased CO_2 emissions (Li and Lin, 2015). The globalization variable, institutional quality, and democracy index do not partially have a significant impact on per capita CO_2 emissions. This result is in line with the findings of You and Lv (2018), who found that globalization does not have a direct effect on the growth of CO_2 emissions. Institutional quality has a significant influence when interacting with energy consumption on the growth of CO_2 emissions (Haldar and Sethi, 2021).

5. CONCLUSION

Climate change has become a global issue and agenda in society. Religious perspectives on climate change remain dualistic. On one hand, religious believers consider climate change as a natural law originating from God, and thus, they believe there is no need to challenge God's law, a perspective known as theocentric. On the other hand, some religious individuals view climate change because of human actions and behaviors that harm and exploit nature, known as anthropocentric. This anthropocentric view is prevalent in the global community regardless of any specific religion, making efforts to prevent and address the impacts of climate change through adaptation and mitigation a shared agenda and consensus within the global community.

This research's findings emphasize the significant impact of religiosity in reducing per capita CO_2 emissions. It illustrates

how the principles and values intrinsic to religious doctrines can shape religion into a potent social institution adept at effectively tackling global climate change challenges. Strengthening the role of religion in addressing climate change involves the promotion of environmental awareness and the cultivation of moral obligations toward the natural world as integral components of religious teachings and practices.

Religion can function as a conduit for environmental education, motivating its adherents to take concrete steps toward environmental preservation, advocating for sustainable environmental policies, and fostering collaborative endeavors with diverse communities and organizations dedicated to environmental protection. Collaborative efforts involving interfaith cooperation among heterogeneous religious groups can further fortify religion's contribution to climate change mitigation. Furthermore, religion can utilize its influential platform to endorse prudent consumption patterns and nurture a collective acknowledgment that environmental preservation constitutes a shared moral duty.

6. ACKNOWLEDGEMENTS

The authors would like to acknowledge the Ministry of Education, Culture, Research, and Technology of Indonesia for funding this research under grant number 0536/E5/PG.02.00/2023.

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APPENDIX

Table A1: 95 sample countries

Algeria, Argentina, Armenia, Australia, Azerbaijan, Bangladesh, Belarus, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Burkina Faso, Chile, China, Colombia, Croatia, Cyprus, Czech, Ecuador, Dominican Republic, Egypt, El Salvador, Estonia, Ethiopia, Finland, France, Germany, Georgia, Ghana, Greece, Guatemala, Haiti, Hungary, India, Indonesia, Iraq, Iran, Israel, Italy, Japan, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Kuwait Latvia, Lebanon, Libya Lithuania, Malaysia, Mali, Morocco, Mexico, Moldova, Mongolia, Montenegro, Myanmar, Netherlands, New Zealand, Nicaragua, Nigeria, North Macedonia, Norway, Pakistan, Peru, Philippines, Poland, Qatar, Russia, Rwanda, Serbia, Singapore, Saudi Arabia, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Tajikistan, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Kingdom, United States, Uruguay, Uzbekistan, Vietnam, Zambia, and Zimbabwe.