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ECONOMIC GROWTH, RELIGIOSITY, AND THE ENVIRONMENT. A COMPARATIVE STUDY BASED ON THE ENVIRONMENTAL KUZNETS CURVE

ABSTRACT

Recent years have seen a growing number of studies that focus on the link between human economic activity and environmental degradation. However, very few studies have explored this relationship considering cultural aspects, such as religiosity. This research aims to address this gap by examining and comparing the relationship between environmental degradation, GDP per capita, trade openness, and urbanization in five groups of countries, categorized based on weekly worship attendance, for the years 1970-2018. The study uses Pedroni and Westerlund tests to check for cointegration and panel FMOLS to estimate coefficients. The results confirm the inverted U-shaped environmental Kuznest curve and indicate that GDP per capita significantly affect CO_2 emissions in almost all panels. Urbanization has a strong negative influence on CO_2 emissions in low and middle-low weekly attendance panels. Trade openness has the most significant impact on CO_2 emissions in less developed countries, particularly those with high weekly worship attendance. The study suggests that religious institutions in these countries could play an active role in improving the environment. They can promote sustainable practices, raise awareness, and advocate for government policies that support environmental protection. Overall, this research sheds light on the importance of cultural factors in environmental degradation and calls for the engagement of religious institutions in promoting a sustainable future.

Keywords: economic growth; environmental Kuznets curve; religion**;** religiosity; urbanization; trade openness.

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INTRODUCTION

Recent years have seen a growing number of studies and publications in many disciplines that concern environmental degradation caused by human economic activity. These studies often focus on the relationships between greenhouse gas emissions, or carbon dioxide emissions, and the gross domestic product, energy consumption (including consumption of renewable energies), trade openness and urbanization. They are part of the research trend that is represented, among others, by numerous empirical articles that deal with the so-called environmental Kuznets curve hypothesis. Recently, a comprehensive overview of the literature in this area has been included in several publications, e.g., by Shahbaz and Sinha [1], Koondhar et al. [2], Pincheira and Zuniga [3]. However, only a few authors analyse these relations taking into account the variables that describe cultural aspects, such as religiosity. In this area, one may find studies that refer primarily to human capital (e.g., Mahmood et al. [4], Majeed and Mazhar [5], Hanif et al. [6], or Ahmad et al. [7]). Our article aims to fill this research gap. We examine the relationship between environmental degradation, economic growth, and religiosity, and our analysis combines two research trends. The first trend of research on a relationship between economic growth and religiosity was started by Barro [8] in the mid 1990s. At the same time, Grossman and Krueger [9] published their works, thereby starting the other research trend devoted to the environmental Kuznets curve hypothesis which explains a relationship between environmental degradation and economic growth. Combining these two trends, our study differs from existing literature on environmental degradation and human economic activity by specifically analyzing the relationship between these factors and religiosity.

The main goal of the article is to examine and compare the long-run relationship between environmental degradation and GDP per capita in five groups of countries, which have been classified based on weekly worship attendance: low, middle-low, middle, middle-high and high weekly worship attendance. Furthermore, the variables of urbanization and trade openness were included in the model. However, the complexity of the research problem is acknowledged. Therefore, it is emphasized that the research is aimed primarily at identifying these relationships, and not at determining the causal connection between them. It is not determined whether religiosity has an impact on the state of the environment, but it is assumed that attitudes shaped by religion can affect attitudes towards the natural environment.

The research model is examined by utilizing data on carbon dioxide emissions, GDP per capita, trade openness and urbanization for the years 1970-2018 from the World Bank database. Data on weekly worship attendance is obtained from various surveys conducted by the Pew Research Centre between 2008 and 2017. The stationarity of variables is initially examined through the use of the Pesaran cross-sectionally augmented Dickey-Fuller (CADF) and cross-sectionally augmented Im, Pesaran, and Shin (CIPS) unit root tests. The next step involves examination of cointegration through the Pedroni and Westerlund tests. Lastly, the long-term parameters are estimated using the Fully Modified Ordinary Least Squars (FMOLS) method. The results of the estimated parameters are then compared for five groups of countries.

The research findings show that there is a long-run relationship (cointegration) between variables in the panels, with the exception of the low weekly attendance panel. The results indicated that GDP per capita and squared GDP per capita had a weighty impact on CO_2 emissions in almost all panels at a significance level of 1%. Urbanization had a strong negative influence on CO_2 emissions in the low and middle low weekly attendance panels at a significance level of 1%. The results regarding the influence of trade openness were significant in all panels. Furthermore, trade openness was found to have the most significant impact on CO_2 emissions in less developed countries, particularly those with high weekly worship attendance, such as Niger, Guinea-Bissau, Mali, Rwanda, among others. Moreover, in countries with high weekly worship attendance, i.e., countries with low GDP per capita, one may observe significant scale effects with a growth in production. In many cases, this may be caused by the internationalization of economies and growing trade openness. Hence, it is important to shape environmental attitudes and provide effective support for pro-ecological investment projects, especially in those countries that cannot afford to implement such projects.

THE OUTLINE OF THE CONTRIBUTION OF SOCIOLOGISTS TO THE DEVELOPMENT OF KNOWLEDGE CONCERNING SOCIAL CHANGES

It is worth emphasizing that the "fathers of social sciences" showed great research and intellectual acumen as well as foresight in trying to explain the impact of political, economic, social and technological changes (PEST) on the development and dynamics of changes in social structures. The continuators

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of their great scientific work are still trying to adapt the achievements of social sciences to the challenges of modern times. However, too often they forget that that they shouldn't only be observers, but also initiators and creators of influence on the authorities, so that the high social costs of introduced changes can also be taken into account. A modern man is often reduced to the pawn, subjected to processes of commercialization, consumerism, multi-professionalism and multitasking, unable to see the difference between the truth and a lie, or between democracy and democrature. In a sense, this is consistent with the principles of the change formulated by A. Touraine, who states that "the lower the level of development of a society, the more its reproduction prevails over production and this type of change turns out to be the most important" [1]. Another issue is that the more directly the political forces reproduce qualitative and quantitative changes in social strata, the less important are the changes of political origin introduced to established political system and the decisions taken within[2]. According to Polish sociologists W. Sitek[3] and F. Bylok[4], societies are most severely affected by the crisis in the domestic economy, where fear, risks and threats overshadow the danger of limiting the pillars of democracy and the awakening of authoritarianism[5].

This extremely important observation indicates that most of the changes are made for socio-economic reasons. Individuals seek to better understand their identity and needs, while at the same time trying to make changes by overcoming risk, anxiety and fear, which enables them to transcend their previous cognitive, social, axiological and practical achievements.

The SARS-CoV-2 pandemic has confirmed that, on one hand, as individuals, communities and a society we can apply different strategies in situations of anxiety and fear, but on the other hand if we are convinced that something is true that manifests itself in our actions. What is more we will try to be expansive, creative, free, responsible and able to perform transgressive actions in order to realize our life plans. According to J. Kozielecki,[6] only people who think independently and those who are able to keep their distance from universal concord

1 Touraine A., Samotworzenie się społeczeństwa, Zakład Wyd. NOMOS, Kraków 2010, p. 372.
2 Tamże, p. 373.
3 Sitek W., Między rynkiem a civil society. Konteksty badań socjologicznych, Wyd. Naukowe Scholar, Warszawa, p. 10.
4 Bylok F.,. Wybrane aspekty socjologii rynku , Wyd. Wydział Zarządzania Politechniki Częstochowskiej, Częstochowa 2005
5 Sitek W., Między rynkiem ….. op. … cit., p. 278
6 Kozielecki J., Koncepcja transgresyjna człowieka, Biblioteka Psychologii Współczesnej, Wyd. PWN,

can consider themselves truly free. Freedom to fulfill a chosen purpose, while taking into account objective limitations is the basic category of the person and his function . [7]Therefore, whoever undertakes actions aimed at punishing or corrupting people for, the truth spoken, violates the freedom guaranteed by the Constitution of the Republic of Poland[8].

It is worth emphasizing that a man is characterized by both constancy and variability, in such a way that he feels them both in his own psychological structure and in symbolic interactions in the social, economic and cultural space. However they cannot liberate themselves from being an organism, a part of nature and above all a part of the social environment .[9] All that thanks to the education and socialization, as well as cognitive schemes built on that basis, thanks to their knowledge and individual ideas about the politics, economy, culture, society, environment and all these things that tend to have such a strong influence on them. Modern technology should not be a tool for subjugating nature, but an extension of its essence. That means to serve in assessment of social, cultural, ethical and biological changes taking place, including those carried out by genetic engineering, artificial intelligence, in accordance with the principles of ethics and applicable law. The same is true in economics, which is profit-oriented, inherently selfish, barren and expansive, but at the same time oriented towards productivity, innovation and creative activities for sustainable development and the good of the individuals.

The continuous task of theoreticians and practitioners in the field of social sciences to search for good conditions for socio-economic development, so that citizens performing roles, employers and employees had an impact on their actions in their immediate and distant environment. It is worth emphasizing that rationality at the individual level does not always correspond to the one representing large organizations. Hence, networks of cooperation and co-management in socio-economic structures and public administration are characterized by various types of rationality, asymmetry, divergences, expectations and conflicting interests. One of the reasons is that only a limited area of social sciences

Warszawa 1987, p.10.

7 Bartnik Cz., Personalizm, Wyd. „O.K" Tomasz Wiater, Warszawa 2000, p. 311.

8 Konstytucja Rzeczypospolitej Polskiej, Zakłady Graficzne "Dom Słowa Polskiego", Warszawa 1997, pp. 7-11.

9 Grabińska T., Zagrożenia bezpieczeństwa społecznego w ideologii transhumanizmu, Kultura Bezpieczeństwa. Nauka-Praktyka- Refleksje 18 (2015), s. 52-54.

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is designated to unravel the complex processes of interaction and institutionalization in comparison to the improvement of organizational methods and management techniques. The current changes perceived in the historical dimension in this area are closely related to the changes in cultural and social conditions that took place in the second half of the twentieth century and have left their mark on visions of societies, institutions, organizations and management.

Society is, in a sense, a reflection of the achievements of individuals, groups and social movements as agents of change, an emanation of their strife for continuous learning and improvement of intellect, instincts and creative abilities for the realization of will of free citizens.

2. LITERATURE REVIEW

2.1. Subsection Relationship between religiosity and economic growth

There are many publications that demonstrate a relationship between religiosity and economic growth, on the one hand, and a relationship between religiosity and the state of the environment, on the other hand. The former was first discussed and analysed in the 1900s in Max Weber's seminal book, *Protestant Ethics and the Spirit of Capitalism*. However, it is the article by Barro that is considered to have opened a new chapter in the research into the influence of human capital, including religiosity, on economic growth [8]. The results of research conducted in 98 countries in the period 1960-1985 indicated that the growth rate of real per capita GDP was positively related to initial human capital (proxied by 1960 school-enrolment rates) and negatively related to the initial (1960) level of real per capita GDP. Additionally, countries with higher human capital had lower fertility rates and higher ratios of physical investment to GDP.

Other important concepts supported by empirical research were introduced in ground-breaking research by Barro and McCleary [10], the results of which supported the thesis that religiosity affected economic growth. Barro and McCleary used international survey data on religiosity for a broad panel of countries to investigate the effects of church attendance and religious beliefs on economic growth. They emphasised that although religiosity tended to decline overall with economic development, the partial relations depended on the specific dimensions of development. For example, the measures of religiosity were positively related to education, negatively related to urbanization, and posi-

tively related to the presence of children. Their results show that, for given religious beliefs, increases in church attendance tend to reduce economic growth. They claim that higher church attendance depresses growth because it signifies a larger use of resources by the religion sector, with the main output of this sector (religious beliefs) remaining constant.

Other works by these authors also fit in a similar context [11-13]. Particularly noteworthy is *The Wealth of Religions: The Political Economy of Believing and Belonging* [14] which is based on articles published by Barro and McCleary over the course of sixteen years of their joint work. They discuss the connection between religion and economic behaviour by looking at a two-way causation: the effect of economic growth on religion and vice versa. The authors base their framework on Adam Smith's approach to competition described in his *Wealth of Nations* and on Max Weber's views on beliefs and character traits that he expressed in his *Protestant Ethic and the Spirit of Capitalism*.

The studies of Sala-i-Martin et al. [15], which use the data set of 68 variables for 88 countries (including the annualized growth rate of GDP per capita between 1960 and 1996), confirm that the Muslim and Buddhist populations have a positive association with economic growth. Slightly different results were obtained by Durlauf et al. [16], who used a balanced panel dataset for a total of 31 countries from different regions over four periods 1965-74, 1975-84, 1985-94, 1995-99. Their results suggest that while religiosity variables such as belief in hell, belief in heaven, and monthly church attendance are potentially relevant to growth, there is no evidence to suggest that they are either quantitatively significant or important. According to Farmer and Schelnast [17], there is substantial evidence demonstrating that religion has a significantly positive impact on human capital and economic growth, for example on children's educational attainment and their future earnings. Many religions, in particular the Judeo-Christian religions, emphasise hard work, honesty, seriousness, and responsibility, all of which enhance children's acquisition of cognitive and non-cognitive skills.

Other studies include an article by Qayyum et al. [18], where religion is considered the most important non-economic factor that constructs a society's basic institutional infrastructure. This study explores the indirect channels through which religion can influence economic growth, such as ethics, poverty alleviation, political participation, social capital and mental health. It also intends to investigate the association between religiosity and economic develop-

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ment at a continental level and examine the role of religion in developing countries' economic growth in developing countries' cross-sectional data of 110 countries. The results indicate that religion has a positive and statistically significant direct effect on economic development and also on the shadow economy. In Asia and Europe, the religious impact is positive and highly significant. However, Africa shows somewhat positive but insignificant results, and in the case of South and North America, the linkage between religion and economic development is not robust. Developing countries show the positive impact of religion on economic development, but these results are not robust. However, in developed countries, the effect of religiosity on economic development is positive and robust.

2.2. Relationship between environment and economic growth

Studies on the relationship between economic development and the state of the environment have been carried out for many years. Most often they refer to the environmental Kuznets curve hypothesis, which describes the relationship between GDP per capita and the level of environmental degradation, measured, among others, by carbon dioxide emissions. The environmental Kuznets curve was first described by Grossman and Krueger [9]. The concept of the environmental Kuznets curve is based on the research of S. Kuznets [19], who stated that income inequality first increases, then reaches a turning point, and then declines during a transition from a low-income to a high-income economy.

The EKC literature has suggested three different channels (effects) through which economic growth may affect environmental welfare: the scale effects, the composition effects and the technique (technological) effects [20]. The scale effects indicate that growth in the scale of the economy would result in a growth in the environmental degradation, usually during the early stages of economic growth when raising the level of income is the primary concern for citizens and policymakers – even at the cost of environment [21,22]. In developing countries, the scale effect resulting from foreign direct investment may increase CO_2 emissions via influence on economic activity as a result of economic liberalization [21], including trade liberalization and the pollution haven phenomenon [23,24]. Hence and Sarkodie [25] and Ouédraogo et al. [26] argue that the scale effect is still more powerful in some African countries than technique and composition effects.

The composition effects have an inverted U-shaped relationship with income level, indicating sectoral structural changes [27]. In low-income coun-

tries, the dominant shift is from agriculture to industry, increasing pollution intensity. In contrast, the dominant shift in high-income countries is from industry to service sector, which is less polluting [28]. Research in this area was conducted, among others, by Akbostanci et al. [29], Hu et al. [30] and Carvalho [31]. The gradual shift from scale effect to composition and technique effects can be seen mainly in terms of energy consumption and energy use patterns [1]. This economic progress often results from increasing urbanization. For example, Zhang [32] points out that the negative long-term elasticity of urbanization on environmental degradation implies that the composition effect exceeds the scale effect through the development of urbanization in China. This means that as a result of emission reduction policies and technological innovations, the positive impact in urban areas outweighs the negative effect of intense industrial concentration and congestion.

The technique effects can be observed also in the post-industrial economies, and they refer to the change in resource and emission intensity of production because of technological modernization [33]. In recent years, there has been an increasing amount of literature on innovations which decrease environmental degradation, for example on new energy resources. A lot of empirical findings support the decisive role of renewable energy consumption in reducing carbon dioxide emissions, e.g.: in developing countries Shahbaz et al. [34]; in BRICS countries Sharma et al. [35]; in South Asia region Murshed et al. [36]; in OECD Erdogan et al. [37]; or the importance of biomass energy Magazzino et al. [38], Alsaleh et al. [39] or Wang et al. [40].

The coefficient on GDP per capita is positive in the inverted U-shaped EKC quadratic function because of a scale effect. As the scale of economic activity rises, usually in the early stages of economic development, CO_2 per capita emissions and environmental degradation tend to increase. In the following stages of development, newer technologies become less harmful to the environment. Conversely, the square ratio of GDP per capita is expected to be negative as emissions decline from a certain point onwards due to the compositional effect. Therefore, the EKC hypothesis assumes an inverted U-shaped model, with a turning point after which a further increase in GDP per capita leads to lower CO_2 emissions [41].

2.3. Relationship between religiosity and environment

Studies on the relationship between religiosity and the quality of environment include primarily qualitative analyses and concern mainly the relations between religious ideas and ethics, social justice, and economic development.

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For example, these issues are examined in the excellent series *Religions of the World and Ecology* published mainly by Harvard University Press. A collection of eleven books considers among others main religious traditions: Buddhism [42], Confucianism [43], Christianity [44], Hinduism [45], Judaism [46], and Islam [47].

There are very few publications that provide a quantitative analysis of the relationship between religiosity and environment. For example, the research by Greeley [48] conducted in Tulsa (Oklahoma) confirmed that low levels of environmental concern correlated with a biblical literalism. They also correlated with being Christian and with confidence in the existence of God. On the other hand, as Greeley writes, "support for environmental spending correlates positively with a gracious image of God and with being Catholic. However, explanatory models suggest that it is not biblical literalism as such which relates to lack of environmental concern, but rather a rigid political and religious "story.""

A more recent study pointing to the important role of religion in shaping attitudes to natural environment was published by Murphy et al. [49]. The authors used two case studies of rural communities in Malawi (Bolero) and Zambia (Monze). They explored how Christianity and Traditional beliefs co-existed and assessed if, and how, holding multiple belief systems affected climate-sensitive livelihood practices of food production. The results indicate that in both communities the elders expressed their concerns on how changing beliefs affected adherence to Traditional Ecological Knowledge management practices. It should be noted that based on these two case studies, the authors confirmed the research findings that religion can be positive for adaptive capacity in building social capital and institutional connections [50]; that churches have an institutional presence at a local level that governments often do not have [51]; and finally that religion (broadly conceived) has an important effect on attitudes and behaviour and it is an important social influence [52]. It should be pointed out that the effect of the ageing population, which attends worship more often, on CO 2emissions shows that, currently, older people improve the air quality positively [53]. However, this association becomes inverse in the future.

A very interesting study on the attitudes towards the Nature of future decision-makers in the Pacific Islands and their concern about climate change was published by Nunn et al. [54]. Their results show that most participants have spiritual feelings of connectedness to Nature, which may account for high levels of pessimism about the current state of the global and Pacific environment. The

authors conclude optimistically that "messages that stress environmental conservation and stewardship, particularly if communicated within familiar and respected religious contexts, are likely to be more successful than secular ones."

Nowadays, Pope Francis' activity is a representative example of how religious institutions can influence attitudes towards sustainable development and the natural environment. His encyclical letter *Laudato si. On Care for our Common Home* [55] is an eloquent voice of the leader who believes that religion can be a remedy for the devastated environment. In his latest encyclical, *Fratelli tutti. On Fraternity and Social Friendship* [56], he calls for building a fairer and more fraternal world where the economy and the environment play an important role [57]. It should be underlined that Pope Francis' proposals combine three essential elements: problem description, problem evaluation from a scientific and religious perspective, and guidelines and actions.

Finally, we would like to draw attention to the model put forward by Gruszecki, Jóźwik, et al. [58] that shows the relationships between faith, economic growth and the degree of environmental degradation. According to this model, higher attendance at worship services, with the belief in heaven and hell remaining constant, reduces the care for the environment. These results are based on the models that make use of the environmental Kuznets curve and on the studies published by Barro and McCleary [10], which show the relationship between religiosity and economic growth. In this theoretical model, religiosity and per capita income, which reflects the economic growth of a given economy, are independent variables, while the degree of environmental degradation is a dependent variable. It should be remembered that this variable may assume values related to various aspects of degradation. In many publications, it is assumed that the variables that reflect environmental degradation include either carbon dioxide emissions or greenhouse gas emissions. The model mentioned above assumes, among others, that the relationships between per capita income and church attendance (weekly or monthly) are linear with a negative slope, as suggested by the results obtained by Barro and McCleary [10]. Therefore, given that the degree of environmental degradation is correlated with the income per capita (according to EKC), we obtain the relationship between two variables: church attendance and environmental degradation. This relationship is examined in the next part of the article.

In summary, the literature review discusses various publications demonstrating a relationship between religiosity, economic growth and environmental degradation. The relationship was first discussed and analyzed in Max Weber's

seminal book, Protestant Ethics and the Spirit of Capitalism. However, the article by Barro is considered to have opened a new chapter in the research into the influence of human capital, including religiosity, on economic growth. Our study differs from the existing literature because it combines the research trends described in the literature review section. It refers to the concept described in the article by Gruszecki, Jóźwik et al. [58]. The authors developed a theoretical model that explores the connection between religiosity, economic development, and environmental degradation. The model suggests that increased participation in religious worship services while maintaining the belief in heaven and hell leads to decreased environmental conservation efforts.

3. Data and methods

The paper examines and compares the long-run relationship between environmental degradation, GDP per capita, trade openness and urban population in five groups (panels) of countries, which are classified based on the weekly worship attendance. As mentioned above, a large and growing body of literature has studied the association between income and environmental degradation using the non-linear relationship between GDP per capita and CO_2 emissions (based on the environmental Kuznets curve concept). The inverted U-shaped EKC hypothesis with these variables has been confirmed in a number of studies, for example those recently published by: Wolde-Rufael and Mulat-Weldemeskel [59], Ahmad et al. [60], Polloni-Silva et al. [61], Ketenci [62] and Tachega et al. [63]. In our research, the model is defined as follows:

$$\ln C_{it} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 (\ln Y_{it})^2 + \beta_3 \ln TR_{it} + \beta_4 \ln URB_{it} + \varepsilon_{it} \quad (1)$$

where β_0, β_1, β_2, β_3 and β_4 represent the regression coefficients, Y_{it} denotes gross domestic product (GDP) per capita of the country i in the year t, TR_{it} trade openness as a share of GDP, URB_{it} urban population as a share of total population, ε_{it} denotes error correction term. The squared term of GDP per capita was added in Eq. (1) to determine the U-shaped curve. When the sign of β_2 is negative we observe the inversion of the U-shaped non-linear relationship between variables.

The current studies usually use carbon dioxide emissions per capita (in metric tons) to measure environmental degradation, for example those recently published by Polloni-Silva et al. [61], Shahbaz et al. [64], Zhou et al. [65], Ma et al. [66], or Hussain and Day [67]. This paper's data is sourced from the World

Bank database. The data on carbon dioxide emissions (kt) are defined as emissions that are produced as a result of burning of fossil fuels and the manufacture of cement. These emissions also include carbon dioxide produced during the consumption of solid, liquid, and gas fuels and gas flaring. Data on the Gross Domestic Product (GDP) per capita (in constant 2010 US$) is a gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for the depreciation of fabricated assets or for the depletion and degradation of natural resources. Trade openness is the sum of exports and imports of goods and services, representing a share of the gross domestic product. Urban population refers to people who reside in urban areas as defined by national statistical offices. The data for this metric is collected and smoothed by the United Nations Population Division. The calculations utilised the GDP per capita data from 1970 to 2018, before the beginning of the COVID-19 pandemic. Data about weekly worship attendance comes from various surveys carried out between 2008 and 2017 by the Pew Research Centre [68], a non-partisan fact tank that informs the public about the issues, attitudes and trends shaping the world. The report contains complete data for 99 countries. Figures on various measures of religious commitment published in this report come from a variety of surveys carried out by the Pew Research Center between 2008 and 2017. These surveys use consistent wording in questionnaires to measure religious commitment across years and geographical areas. For our analysis, we have chosen 56 countries for which the time series started in 1970. These countries are listed in Table A1. in the appendix.

Table 1 shows descriptive statistics of those variables for the global panel and for five panels of countries with different level of religiosity. We separated countries into five panels according to their level of weekly worship attendance, performing a K-means clustering analysis (Table A1). Clustering countries into groups based on their level of weekly worship attendance can provide valuable insights. By clustering countries based on their level of weekly worship attendance, we can compare their religious and cultural patterns to other variables in the dataset. This could help us identify any relationships between these other variables, providing valuable insights into different world regions' broader social and cultural contexts. For example, in our research, we can compare the level of weekly worship attendance to measures of economic development and environmental degradation.

Table 1. Descriptive statistics.

Panel/ Variables	NOBS	Mean	Std. dev.	Min.	Max.	Skew.	Kurt.
global panel (56 countries)							
CO_2 pc	2744	3.94	4.31	0.01	22.51	1.49	5.09
GDP pc	2744	12872.67	16806.94	219.53	91964.26	1.74	5.83
TR	2744	58.26	31.86	0.02	227.73	1.63	6.89
URB	2744	57.06	21.99	3.19	98.00	-0.37	2.29
high weekly attendance panel (11 countries)							
CO_2 pc	539	0.35	0.37	0.01	2.17	2.00	7.72
GDP pc	539	1123.35	768.73	219.53	4284.75	1.37	4.41
TR	539	47.58	15.99	6.32	126.35	0.85	5.42
URB	539	28.41	13.31	3.19	56.37	0.24	1.99
middle-high weekly attendance panel (17 countries)							
CO_2 pc	833	1.99	1.91	0.05	9.92	2.08	7.15
GDP pc	833	3977.86	2818.31	322.33	12131.71	0.79	2.73
TR	833	63.65	36.83	10.99	220.40	1.38	5.33
URB	833	53.50	15.61	7.59	86.56	-0.27	2.82
middle weekly attendance panel (9 countries)							
CO_2 pc	441	4.73	5.69	0.25	22.51	1.83	5.19
GDP pc	441	9063.70	11804.42	1288.94	54953.62	2.30	7.44
TR	441	49.29	24.47	0.02	154.23	0.92	4.37
URB	441	62.66	12.10	37.06	82.25	-0.33	2.15
middle-low weekly attendance panel (12 countries)							
CO_2 pc	588	6.77	3.78	1.04	18.50	0.97	3.88
GDP pc	588	25062.52	14225.85	3856.03	76489.92	0.51	2.60
TR	588	60.48	36.04	10.33	227.73	1.77	6.72
URB	588	73.34	12.50	38.80	95.33	-0.41	2.54
low weekly attendance panel (7 countries)							
CO_2 pc	343	8.45	3.07	0.94	14.25	-0.70	2.90
GDP pc	343	36937.92	21293.43	228.51	91964.26	0.33	3.30
TR	343	69.71	30.71	4.92	166.49	0.83	4.30
URB	343	75.63	19.60	17.18	98.00	-1.69	5.21

Notes: CO_2 pc is the carbon dioxide emissions per capita (in metric tons); GDP pc is the Gross Domestic Product per capita (in constant 2010 US$); TR is the trade openness (% of GDP), URB is the urban population (% of the total population).

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In the first part of the analysis, cross-sectional dependence in panel variables was tested using the Pesaran CD test, which measures correlation coefficients between the time series for each panel member [69]. The sample of countries and periods covered (1970-2018) may experience this type of correlation due to globally common shocks with varying impacts across countries or local spillover effects between countries or regions. Stationarity was then checked using second-generation panel unit root tests: the Pesaran cross-sectionally augmented Dickey-Fuller (CADF) [70-71] and cross-sectionally augmented Im, Pesaran, and Shin (CIPS) [72-73] tests.

In the second part of the analysis, cointegration was examined to study the existence of a long-term relationship between variables. Cointegration is tested because it implies that the I(1) series are in long-run equilibrium, indicating a long-term relationship between variables. The Pedroni [74-75] and Westerlund [76] tests were used to examine cointegration.

Because these tests do not provide long-term parameter estimates, we used the Fully Modified Ordinary Least Square (FMOLS) method for estimating parameters [77]. These test can accommodate considerable heterogeneity across individual members of the panel. One important advantage of working with this type of co-integrated panel approach is that it allows to selectively pool the long-run information contained in the panel while permitting the short-run dynamics and fixed effects to be heterogeneous among different panel members. Additionally, researchers can infer common long-run relationships asymptotically invariant to the considerable degree of short-run heterogeneity prevalent in the dynamics typically associated with panels composed of aggregate national data.

4. Results and discussion

In the beginning, we will check the relationships directly related to the environmental Kuznets curve. The dispersion of points representing CO_2 emissions per capita and GDP per capita in all panels is compared on the scatter plots (Fig 2). The natural logarithm of CO_2 emissions per capita is shown on the vertical axes, while the natural logarithm of GDP per capita is shown on the horizontal axes.

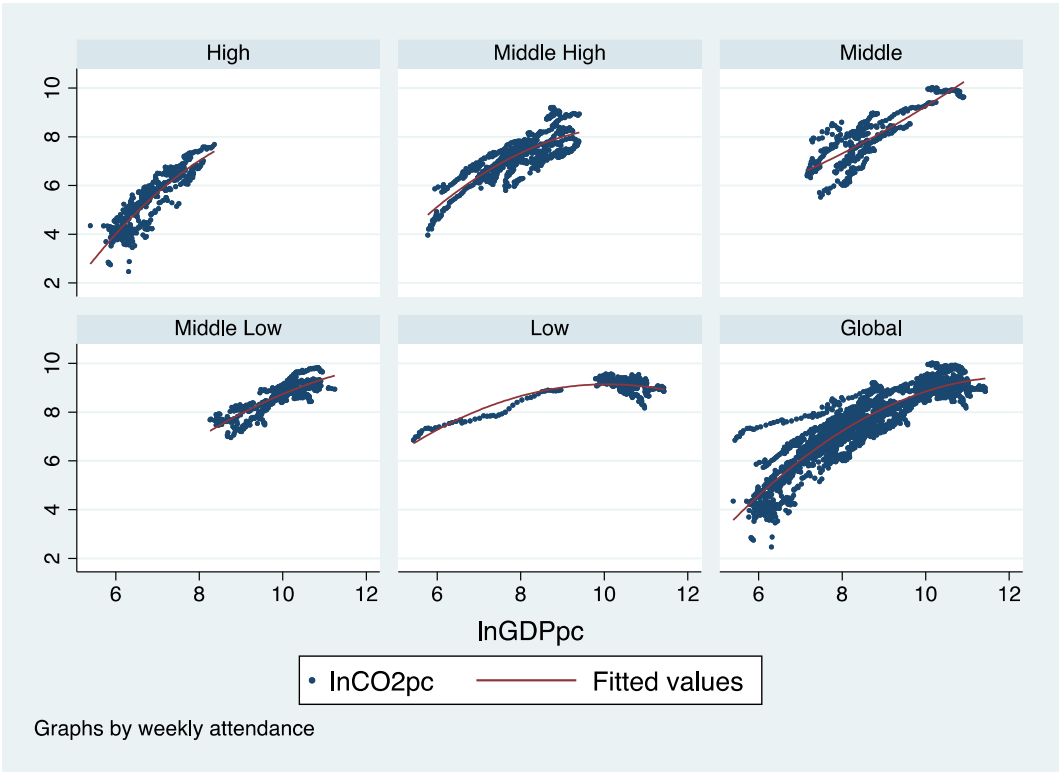

Figure 2. The scatter plots of ln CO_2 emissions per capita and ln GDP per capita

In the first step, an examination was conducted to determine if the panel variables contained cross-sectional dependence using the Pesaran CD test, which follows an N(0,1) distribution (under the null hypothesis of cross-section independence CD ~ N(0,1)). The results of the test indicated that the null hypothesis was rejected at the 1% level of significance for all variables (Table 2). Therefore, it was determined that each of the series contained cross-sectional dependence.

Table 2. The Pesaran test for cross-section dependence and tests for averaged and absolute correlation results.

value	**corr**	**abs(corr)**	**CD-test**	**p-value**	**corr**	**abs(corr)**
			high weekly attendance panel			
000	0.195	0.492	11.06***	0.000	0.213	0.350
000	0.659	0.730	18.12***	0.000	0.349	0.491
000	0.662	0.732	18.35***	0.000	0.353	0.494
000	0.412	0.476	6.25***	0.000	0.120	0.274
000	0.819	0.893	48.39***	0.000	0.932	0.932
ekly attendance panel			middle weekly attendance panel			
000	0.541	0.578	13.67***	0.000	0.325	0.622
000	0.721	0.769	24.86***	0.000	0.592	0.668
000	0.725	0.772	25.11***	0.000	0.598	0.673

0.000	0.383	0.399	15.97***	0.000	0.380	0.435
0.000	0.844	0.885	39.30***	0.000	0.936	0.936
w weekly attendance panel			low weekly attendance panel			
0.000	0.205	0.470	6.06***	0.000	0.189	0.559
0.000	0.897	0.897	31.46***	0.000	0.981	0.981
0.000	0.897	0.897	31.36***	0.000	0.978	0.978
0.000	0.823	0.823	15.59***	0.000	0.486	0.656
0.000	0.551	0.834	29.36***	0.000	0.915	0.915

Notes: $lnCO_2\ pc$ is the natural logarithm of carbon dioxide emissions per capita (in metric tons); $lnGDP\ pc$ is the natural logarithm of Gross Domestic Product per capita (in constant 2010 US$); TR is the trade openness (% of GDP); URB is the urban population (% of the total population). Under the null hypothesis of cross-section independence CD ~ N(0,1). *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Since all variables were found to be affected by cross-sectional dependence, second-generation panel unit root tests, including the Pesaran cross-sectionally augmented Dickey-Fuller (CADF) and cross-sectionally augmented Im, Pesaran, and Shin (CIPS) tests were implemented. Table 3 displays the results for all variables. The panel unit root tests were conducted with intercept and intercept and trend at the level and the first difference. While the results of the Pesaran cross-sectionally augmented Dickey-Fuller test varied, the results of the cross-sectionally augmented Im, Pesaran, and Shin (CIPS) test indicated that all variables were stationary in their first differences.

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Table 3. The Pesaran cross-sectionally augmented Dickey-Fuller (CADF) and cross-sectionally augmented Im,Pesaran, and Shin (CIPS) tests results.

Panel/ variable	**CADF**				**CIPS**		
	at level		at 1st difference		at level		a
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	I
	global panel				global panel		
$lnCO_2\ pc$	1.718	7.799	-0.418	1.901	-1.961	-2.140	-
$lnGDP\ pc$	2.424	0.294	-2.457***	-1.901	-1.670	-2.320	-
$(lnGDP\ pc)^2$	2.457	1.166	-2.183**	-1.031	-1.575	-2.272	-
lnTR	-2.246**	0.114	-5.618***	-2.827***	-2.191**	-2.599**	-
lnURB	-4.486***	-1.976**	-1.111	4.989	-2.396***	-2.794***	-
	high weekly attendance panel				high weekly attendance pa		
$lnCO_2\ pc$	3.092	2.341	-0.854	0.128	-1.685	-2.446	-
$lnGDP\ pc$	-0.467	-0.159	-1.937**	-0.696	-2.727***	-2.857**	-
$(lnGDP\ pc)^2$	-0.472	-0.025	-1.908**	-0.645	-2.702***	-2.959***	-
lnTR	-0.391	0.969	-2.946***	-1.679**	-2.746***	-3.280***	-
lnURB	-0.864	-2.934***	-1.849**	0.053	-2.429**	-2.863**	-
	middle high weekly attendance panel				middle high weekly attend		
$lnCO_2\ pc$	-1.223	1.943	-0.440	1.181	-2.643***	-2.654*	-
$lnGDP\ pc$	0.119	0.898	-1.518*	-0.963	-2.077	-2.158	-
$(lnGDP\ pc)^2$	0.151	0.961	-1.411*	-0.705	-2.016	-2.082	-
lnTR	-0.403	1.855	-2.171**	-1.194	-2.027**	-2.418	-
lnURB	-3.961***	-0.789	0.198	1.529	-3.147***	-2.896***	-
	middle weekly attendance panel				middle weekly attendance		
$lnCO_2\ pc$	0.636	2.683	0.022	0.599	-1.456	-1.692	-
$lnGDP\ pc$	0.240	1.621	0.486	1.027	-1.440	-1.343	-
$(lnGDP\ pc)^2$	0.506	1.595	0.424	1.201	-1.382	-1.437	-
lnTR	-1.009	-0.465	-1.028	0.586	-2.110	-2.532	-
lnURB	-2.498***	-3.494***	-1.318*	-0.992	-4.117***	-3.914***	-
	middle low weekly attendance panel				middle low weekly attenda		
$lnCO_2\ pc$	1.958	5.078	0.337	0.158	-1.641	-1.855	-
$lnGDP\ pc$	-1.724***	0.313	-1.521*	-1.319*	-2.665***	-2.784**	-
$(lnGDP\ pc)^2$	-1.726**	0.274	-1.542*	-1.460*	-2.602***	-2.743*	-
lnTR	0.986	2.228	-2.776***	-1.404*	-2.481***	-2.607	-
lnURB	2.756	4.071	2.517	3.222	-1.604	-1.660	-
	low weekly attendance panel				low weekly attendance par		
$lnCO_2\ pc$	3.005	0.339	0.146	1.500	-1.168	-2.317	-

$lnGDP\ pc$	1.205	4.247	0.081	1.531	-2.188	-2.066
$(lnGDP\ pc)^2$	1.623	4.308	0.366	1.476	-1.927	-1.791
lnTR	1.221	5.179	-0.591	-1.112	-1.680	-1.345
lnURB	-2.109**	-1.611*	-1.771**	-2.451***	-2.248**	-2.397

Notes: The number of lags of the series is chosen in such a way that the AIC for the regression is minimized. *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

In the subsequent phase, an investigation was conducted to determine whether a long-term relationship existed between the variables. The Pedroni and Westerlund tests for cointegration were utilized for this purpose. Similar to the procedure employed while calculating the Pedroni unit root test, the method proposed by Levin, Lin, and Chu was utilized to reduce the influence of cross-sectional dependence. The outcomes of the Pedroni tests are presented in Table 4. The outcomes of within-dimension and between-dimensions statistics demonstrate that in most cases, except for the low weekly attendance panel, the null hypothesis of no cointegration can be dismissed at 1% and 5% levels of significance. The results of the Westerlund tests provide further evidence of the existence of cointegration between variables by dismissing the null hypothesis of no cointegration in the global, middle high, and middle weekly attendance panels at significance levels of 1%, 5%, and 10% (Table 4). In general, it can be concluded that a long-term relationship exists between variables in the panels, with the exception of the low weekly attendance panel.

Table 4. Pedroni and Westerlund panel cointegration tests results.

Models	statistic	p-value	statistics	p-value	statistics	p-value
Panels	global		high attendance (11)	weeklymiddle	high attendance (17)	weel
Pedroni tests AR parameter: Same						
Modified variance ratio	-1.6384*	0.0507	-1.9332**	0.0266	0.9235	0.1779
Modified Phillips–Perron t	-1.1939	0.1163	-0.0053	0.4979	-1.9225**	0.0273
Phillips–Perron t	-6.8255***	0.0000	-2.4016***	0.0082	-5.1716***	0.0000
Augmented Dickey–Fuller t	-5.9951***	0.0000	-2.7397***	0.0031	-3.6062***	0.0002
Pedroni tests AR parameter: Panel specific						
Modified Phillips–Perron t	0.0940	0.4626	0.8018	0.2113	-1.2061	0.1139
Phillips–Perron t	-7.0920***	0.0000	-2.0855**	0.0185	-5.7378***	0.0000
Augmented Dickey–Fuller t	-5.9957***	0.0000	-1.7920**	0.0366	-3.9411***	0.0000
Westerlund tests						
AR parameter: Same	-2.2823**	0.0112	-0.2226	0.4119	-1.5726*	0.0579
AR parameter: Panel specific	-3.9333	0.0000	-0.3172	0.3756	-2.7246***	0.0032

Panels	middle weekly attendance (9)		middle low weekly attendance (12)		low weekly attendance (7)	
droni tests AR parameter: Same						
nel Modified variance ra-	-0.7984	0.2123	-2.4081***	0.0080	-1.5189*	0.0644
nel Modified Phillips–rron t	-1.1751	0.1200	2.4233***	0.0077	0.4858	0.3136
nel Phillips–Perron t	-4.2128***	0.0000	0.9731	0.1652	-1.1782	0.1194
nel Augmented Dickey–ller t	-4.8886***	0.0000	1.0280	0.1520	-1.1119	0.1331
droni tests AR parameter: Panel specific						
odified Phillips–Perron t	-0.4180	0.3380	1.3889*	0.0824	1.0599	0.1446
illips–Perron t	-4.7530***	0.0000	-1.0020	0.1582	-0.9547	0.1699
gmented Dickey–Fuller t	-4.9254***	0.0000	-1.1502	0.1250	-0.8930	0.1859
esterlund tests						
R parameter: Same	-1.2529	0.1051	0.7123	0.2381	-0.8284	0.2037
R parameter: Panel ecific	-2.0762**	0.0189	-0.8237	0.2051	-1.2512	0.1054

Notes: Null hypothesis: *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

In the final phase, the FMOLS approach was utilized to investigate the impact of economic growth on CO_2 emissions. The results confirm the inverted U-shaped environmental Kuznets curve and indicated that GDP per capita and squared GDP per capita had a significant impact on CO_2 emissions in almost all panels at a significance level of 1% (Table 5). It is noteworthy that the coefficients of GDP per capita indicate the scale effect, whereas the coefficients of squared GDP per capita represent the composition effect. Furthermore, the other outcomes provided intriguing information. Urbanization had a strong negative influence on CO_2 emissions in the low and middle low weekly attendance panels at a significance level of 1%. The results regarding the influence of trade openness were significant in all panels. Furthermore, trade openness was found to have the most significant impact on CO_2 emissions in less developed countries, particularly those with high weekly worship attendance, such as Niger, Guinea-Bissau, Mali, Rwanda, among others. This is due to several reasons. Firstly, these countries often rely on the export of primary goods and natural resources, such as oil and minerals, which are carbon-intensive and emit large amounts of CO_2. Additionally, trade liberalization often leads to an increase in foreign investment and the development of manufacturing industries, which are known to produce significant amounts of greenhouse gases. Moreover, the lack

of environmental regulations and weaker enforcement mechanisms in these countries can exacerbate the negative environmental impacts of increased trade openness.

Nowadays, in most developed countries, and in some others, these types of regulations have been implemented after major bilateral or international agreements that establish targets and frameworks for reducing greenhouse gas emissions. For example, the various the Conferences of Parties (COP), especially COP21 (held in Paris in 2015), the Kyoto Protocol (adopted in 1997), the EU "Fit for 55 Package" (announced in 2021), and other agreements have been instrumental in driving global action on climate change. The importance and impact of the Paris Agreement regulations on environmental protection are shown by the results of research conducted, among others, by M.W. Zafar et al. [78] in Asian countries, or C. Su et al. [79] in United States. Y. Kim et al. [80] suggest that participating in the Kyoto Protocol agreements has a significant positive impact on reducing CO_2 emissions, but has a negative impact on the GDP of participating countries in the long run. In this case, the authors suggest that future global climate change frameworks should aim to balance the impact on economic and environmental performance to ensure sustainable development, particularly for developing countries with limited capacity to mitigate emissions. Therefore, the carbon pricing proposals included in „Fit for 55 Package" represent a major challenge [81, 82].

Table 5. Panel Fully Modified Ordinary Least Squares (FMOLS) test results.

Panel	$lnGDP\ pc$	$(lnGDP\ pc)$	$lnTR$	$lnURB$
global panel	10.79***	-0.56***	0.08**	-2.05***
high weekly attendance	1.16	-0.05	0.34***	0.35***
middle high weekly attendance	17.72***	-1.01***	0.05***	0.04***
middle weekly attendance	5.92***	-0.28***	-0.06**	0.60***
middle low weekly attendance	10.56***	-0.49***	0.00***	-4.23***
low weekly attendance	15.72***	-0.71***	0.04*	-10.56***

Notes: *p-value* for two-tailed hypothesis; *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively; turning point in constant 2010 US$.

In countries where weekly worship attendance is high, religious institutions may play a significant role in improving the quality of the environment. This panel includes Ghana, Kenya, Niger, and Nigeria. The small coefficients for squared GDP per capita in countries with high weekly worship attendance indicate a small composition effect, which can be explained by the fact that composition processes take place more slowly in those countries. At the same time, we observe that in countries where weekly worship attendance is moderately high, there are the highest values of the GDP per capita coefficient (17,72), which indicates large-scale effects. As mentioned earlier, Sarkodie [25] and Ouédraogo et al. [26] have argued that the scale effect is still more influential

than technical and composition effects in some African countries. Examples of references to scale effects in African countries can be found in publications by Shahbaz et al. [83, 21] or Ajanaku and Collins [84].

The research carried out in countries that have high weekly worship attendance, such as the study conducted by Minlah and Zhang [85] in Ghana, confirms our findings. To reduce the growth of CO_2 emissions associated with economic growth, the authors recommend that Ghana should make it compulsory for industrial sector enterprises to adopt green manufacturing policies and enforce green technologies in their production processes (technique effects). Mensah et al. [86] suggested a somewhat different solution to this problem. Although they concluded that the environmental Kuznets curve was not significant in Ghana, they confirmed the pollution haven hypothesis, stating that the "one district, one factory" policy would only be useful if Ghana attracted cleaner industries, made environmental regulations stricter, and raised environmentally-related taxes. Similar results were obtained by Sarkodie and Ozturk [87] in Kenya, who confirmed an inverted U-shaped curve. Their study showed that an increase in energy consumption exacerbated carbon dioxide emissions in the long run. Due to rural-urban migration, which increased the burden on electricity consumption, energy efficiency was reduced.

Our findings confirm the results obtained by Prastiyo and Hardyastuti [88] in Indonesia. In their study, the authors confirmed the inverted U-shaped environmental Kuznets curve hypothesis and stated that regional government policies had reduced the level of greenhouse gas emissions in the land-based agriculture sector, thereby limiting scale effects.

A different situation can be observed in countries that belong to the panel of countries with low and moderately low weekly worship attendance. These include countries in Europe, mainly in the European Union, South American countries such as Argentina, Chile, and Uruguay, as well as Australia and China. The squared GDP per capita coefficients are relatively high in these countries, which means that changes in carbon dioxide emissions resulting from economic growth occur at a relatively faster rate (similar to the panel of countries with moderately high weekly attendance). This phenomenon may be explained by greater investment in structural changes and innovations, reflecting composition and technology effects. This is supported by an inverted U-shaped EKC hypothesis pattern observed in EU countries, where increased investment in research and development has been shown to improve environmental sustainability [89]. It is noteworthy to mention that Maranzano et al. [90] indicates the Educational Environmental Kuznets Curve (EKC) hypothesis holds true for countries in Europe with high income inequality. Additionally, the relationship between emissions and income appears to weaken when considering the level of education. It is noteworthy to mention that Maranzano et al. [90] indicate that the environmental Kuznets curve hypothesis holds true for countries in Europe with high income inequality. Furthermore, the relationship between emissions and income appears to weaken when taking into account the level of education.

The composition and technique effects in low and middle low weekly worship attendance countries have been confirmed in many studies. For example, the composition effect is confirmed in Spain by Carvalho [31]. His results through the autoregressive distributed-lag (ARDL) estimation strategy, confirm that even though all economic activities tend to be more and more sustainable, it is the development of service sector that is fundamental in the reduction of per capita CO_2 emissions. It is worth noting that a similar study conducted in Spain by Roca et al. [91] indicates that it cannot be thought that economic growth, by itself, will solve environmental problems. The technique effects can be observed in practically all countries in this group. For example, Shahbaz et al. [21] have found that the relationship between economic growth and CO_2 emissions in France is an inverted-U, which is a validation of the environmental Kuznets curve (EKC), and that the energy research innovations have a negative impact on carbon emissions in France. Similarly, Ma et al. [66] also confirmed an inverted U-shape relation between CO_2 emissions and real GDP in long run in France. They stated that innovative renewable energy sources significantly reduced carbon emissions while non-renewable energy consumption added to carbon emissions. Moreover, we observe a high degree of urbanization in these countries, favouring environmental protection (Table 5). This relationship is confirmed in the studies by Xie et al. [89] and Jóźwik et al. [93].

It is worth looking at environmental degradation and innovations in China, a country that has been the subject of much research in recent years. Zhou et al. [65] indicate that the low-carbon energy transformation of China is crucial for achieving the global warming target of the Paris Agreement. They emphasise that China's energy system should undergo substantial low-carbon transformation. In this respect, the results published by Li and Wei [94] are optimistic, as they indicate that carbon emissions attenuate the effects of financial development and innovation on economic growth. On the other hand, Zhang [32] has found a positive effect of energy consumption and a negative effect of urbanization on CO_2 emissions in the long run. He suggested that a breakthrough in terms of policymaking and energy innovation under China's specific socio-economic and political circumstances, is required for future decades. Such actions are already being taken. For example, Balsalobre-Lorente et al. [95] showed a significant direct effect of government expenditure on improving overall environmental quality in the Chinese provinces during 2007–2017, which increases with economic growth. Whereas improvement in socio-economic circumstances may be helped by better education, as noted by Balaguer et al. [96] and Zhang et al. [97]. They conducted a study in Australia, which also belongs to the low weekly worship attendance group. They point out that "in most of the period 1950-2014, expansion in education rate has increasingly compensated the rise of per capita CO_2 emissions stemming from the economic growth."

It should be noted that there is a distinctively high coefficient for trade openness, which can be observed primarily in countries with high weekly wor-

ship attendance (Table 5), i.e., in countries with low GDP per capita. For example, the significant relationship between domestic energy consumption and exports in the long run was confirmed in Nigeria, by Chibueze et al. [98], among others. On the other hand, research by Ali et al. [99] demonstrates that trade openness in Nigeria has a negative impact on CO_2 emissions. Similar conclusions can be found in the studies by Güngör et al. [100], which show that globalization and regulatory quality exert a negative pressure on ecological footprint.

In summary, our results and discussion aim to demonstrate the potential impact of religious institutions on environmental quality in countries where a large proportion of the population regularly attends religious services, a problem that has rarely been discussed in the literature. Our findings suggest that these institutions may play a significant role in this regard. The small coefficients for squared GDP per capita in countries with high weekly worship attendance indicate a smaller composition effect, which can be explained by the fact that composition processes take place more slowly in those countries. At the same time, we observe that countries where weekly worship attendance is moderately high have the highest values of the GDP per capita coefficient, indicating large-scale effects. Overall, our research contributes to a better understanding of the relationship between religious institutions, economic growth, and environmental quality.

CONCLUSIONS

To date few researchers have addressed the relationships between religiosity, economic growth, and degradation of the environment. Previous work on this issue has mainly used qualitative methods. The main goal of the article was to examine and compare the long-run relationship between environmental degradation, GDP per capita, trade openness and urbanization in five groups of countries, which have been classified based on weekly worship attendance: low, middle-low, middle, middle-high and high weekly worship attendance.

Based on the Pedroni and Westerlund tests, it can be concluded that that there is a long-run relationship (cointegration) between variables in the panels, with the exception of the low weekly attendance panel. The results indicated that GDP per capita and squared GDP per capita had a weighty impact on CO_2 emissions in almost all panels at a significance level of 1%. Urbanization had a strong negative influence on CO_2 emissions in the low and middle low weekly

attendance panels at a significance level of 1%. The results regarding the influence of trade openness were significant in all panels. Furthermore, trade openness was found to have the most important impact on CO_2 emissions in less developed countries, particularly those with high weekly worship attendance, such as Niger, Guinea-Bissau, Mali, Rwanda, among others.

As a result, we contend that religious institutions can have a significant impact on improving the environment's quality in countries where weekly worship attendance is high. Based on the environmental Kuznets curve, these institutions can protect the environment by promoting sustainable practices and raising awareness about the relationship between economic growth and environmental degradation. At the early stages of economic development, the EKC suggests that environmental degradation worsens due to increased industrialization, urbanization, and consumption. Religious institutions can play a role in reducing this trend by promoting environmentally conscious practices.

As countries reach a certain level of economic growth, the EKC suggests that environmental quality improves due to better investment in environmental protection and the development of cleaner technologies. Moreover, it is important to prevent legal regulations, which may favour creating pollution havens in some countries and de-localising dirty industries there. These issues require more in-depth research that would help to identify and support structural changes in industry and development of pro-environmental investments. Religious institutions can play a role in this stage by advocating for government policies that promote environmental protection. Religious institutions can also support the development of clean technologies by investing in research and development and supporting companies that are committed to sustainability.

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Appendix A

Table A1. Weekly worship attendance by country.

		country		
	Cameroon (70%) Chad (77%) Ghana (84%) Guatemala (75%) (81%)	Guinea-Bissau Indonesia (72%) Kenya (81%) Mali (79%)	Niger (88%) Nigeria (89%) Rwanda (80%)	
%)	Algeria (48%) Bangladesh (48%) Brazil (45%) Colombia (50%) Costa Rica (52%)	Dominican Rep. Egypt (62%) El Salvador (61%) Honduras (64%)	Malaysia (45%) Mexico (45%) Morocco (55%) Nicaragua (55%) (55%)	Pakistan (59%) Panama (48%) South Africa Tunisia (47%)
	Bolivia (42%) Ecuador (38%) Iran (38%) Iraq (42%)	Paraguay (32%) Peru (36%) (36%) South Korea (29%) Turkey (44%)	United States	
	Argentina (20%) Australia (17%) Austria (11%) Chile (19%)	France (12%) Greece (16%) (12%) Ireland (20%) Italy (23%)	Netherlands Portugal (25%) Spain (15%) Uruguay (14%)	
	Belgium (6%) China (1%)	Norway (7%) Sweden (6%) United Kingdom		

Denmark (3%)	(8%)
Finland (4%)	

Notes: the numbers in brackets indicate the share of the population weekly attending worship.

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