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IMPACT OF MACROECONOMIC VARIABLES AND MORTALITY RATES UNDER 5 ON CO_2 EMISSIONS: A CASE STUDY OF LITHUANIA

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ABSTRACT

This study examined how Lithuania's CO_2 emissions were affected by macroeconomic variables and mortality rates between 1995 and 2020. ARDL analysis, cointegration regression, diagnostics test, and robustness test were used to quantify the impact of mortality rates, macroeconomic variables, and CO_2 emissions. The findings of the unit root test confirmed that all variables are stationary. Similarly, the ARDL bound test values show that the variables are cointegrated and that a long-run relationship exists between them. However, the ARDL methods both showed that mortality rates, trade openness, and economic growth have a significant positive impact on CO_2 emissions. Hence, renewable energy consumption helps reduce CO_2 emissions. Furthermore, diagnostic tests confirmed no serial correlation, no heteroscedasticity exists, and robust tests also show that the model is stable. While cointegration regression results are similar to the ARDL model test. The study analysis suggests the essential policy recommendations aimed at reducing CO_2 emissions and the need to improve health sectors (specifically, mortality rates under 5). This study expands the existing literature on environmental economics, and its findings will help improve policy and frameworks in Lithuania to reduce carbon emissions.

Keywords: *Mortality Rates, Renewable Energy Consumptions, Trade Openness, Economic Growth, CO_2 Emissions*

JEL: I18; Q20; Q56; F18; F64

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Introduction

The healthcare sector has emerged as increasingly vital to a country's development in recent years. Presently, economic growth is pivotal for a country's capacity to expand economically, as the growth of both the economy and the healthcare sector are closely intertwined. However, economic expansion can occasionally precipitate various environmental challenges, including climate change, greenhouse gas emissions, escalating temperatures, and health concerns. According to Adeleye et al. (2023), the UN's third SDG goal is to provide healthy lives and improve health for all ages by 2030. Furthermore, consumption-based carbon emissions increased in the European Union (27 countries) and Lithuania from 2020 to 2021. The amount of consumption-based carbon emissions has raised from 3.21 (bt) to 3.50 (bt) in the European Union and from 20.05 (mt) to 22.24 (mt) in Lithuania (Our World in Data, 2022). Moreover, in Lithuania, economic growth increased from 2020 to 2021, rising from 56.96 (USD billion) to 66.8 (USD billion) (World Bank, 2020).

However, health factors and ecological effects are naturally connected and have natural roles (Li et al., 2023). Study shows that, if CO_2 emissions increase, it causes mortality rates to rise (Sinha, 2014). The effect of CO_2 emissions varies from country to country or region to region based on different characteristics (Disli et al., 2016). The rise in carbon emissions contributing to climate change and global warming is harmful to environmental sustainability (Shayanmehr et al., 2020). Global carbon emission levels from burning fossil fuels have grown dramatically during the last three decades, reaching 37.15 billion tons in 2022 compared to 19.48 billion tons in 1980 (Our World in Data, 2022). The combustion of fossil fuels releases carbon emission gases into the atmosphere, which is the key driver of climate change (Miralles-Quirós et. al., 2022). This confirms that the globe is experiencing warming as a direct effect of CO_2 emissions from fuels (Mathew, 2022; Millar et al., 2018).

Renewable energy plays an important role in achieving the SDGs and helps reduce carbon emissions (Dong et al., 2018). The share of primary energy consumption from renewable sources increased globally by 12.25% to 13.45% from 2020 to 202 (Our World in Data, 2022). Similarly, in Lithuania, the share of primary energy consumption from renewable sources increased by 11.21% to 11.80% from 2020 to 2021 while, Turkey, as a developing state, possesses a surplus of renewable energy resources (Karaaslan et al., 2022). According to the IEA policy report, Lithuania is an excellent spot in the Baltic region for renewable energy and energy security (International Energy Agency, 2022). Additionally, renewable energy sources help reduce CO_2 emissions (Rahman et al., 2022).

Trade openness is another important variable in this study. The World Bank defines trade openness as the entire sum of the GDP percentages associated with imports and exports. The average value for trade openness among Lithuanians was 122.6% throughout that time, varying between a minimum of 74.82% in 1999 and a maximum of 177.1% in 2022 (World Bank, 2020). However, trade also contributes 20%-30% of CO_2 emissions (Kyriakopoulou et al. 2023). It is essential to decrease trade emissions for ecological sustainability (Kyriakopoulou et al., 2023). Additionally, influences of composition, scale, and technology determine how trade openness affects the environment (Farhani et al., 2014). The main factor influencing environmental quality may be global trade (Mutascu, 2018; Shahbaz et al., 2017).

According to Ozcan et al. (2020), the world's most developed regions have begun to synchronize their environmental policies with their patterns of economic expansion and energy use. Meanwhile, renewable energy is a factor that helps enhance economic growth and at the same time reduces CO_2 emissions (Dilanchiev et al., 2024). In Lithuania, economic growth increased from 2020 to 2021, rising from 56.96 (USD billion) to 66.8 (USD billion) (World Bank, 2020). As a result, the amount of consumption-based carbon emissions increased from 3.21 (bt) to 3.50 (bt) in the European Union and from 20.05 million tons to 22.24 million tons in Lithuania (Our World in Data, 2022). Furthermore, economic growth contributes to increased pollution levels and damages the environmental quality (Surya et al., 2020).

To the best of the author's knowledge, this study is unique and expands the existing literature. The study analyzes the impact of the under-5 mortality rates, renewable energy consumption, trade openness, and economic growth on CO_2 emissions. To achieve the research objectives, this research employs the ARDL model. Furthermore, robustness tests confirm the validity of the ARDL model findings, and diagnostic tests check the model's stability. This study investigates the long-run and short-run relationships between the variables, and its findings are helpful for stakeholders in making policy-related decisions based on the present research outcomes.

Literature Review

Carbon Emissions and Mortality Rates

Many researchers have explored the association between carbon emissions and mortality rates (Adeleye et al., 2023; Azam et al., 2024; Fotio et al., 2024; Guo et al., 2024; Magazzino et al., 2022). For instance, environmental damage, with negative effects on public health, was caused by the transport sector's reliance on oil products and carbon emissions from fuel burning (Azam & Adeleye, 2024; Magazzino et al., 2022). Furthermore, carbon emissions directly influence mortality rates both in the long run and in short-run studies in SAARC countries (Guo et al., 2024). Although the study's findings indicate that in 47 Sub-Saharan African nations, real per capita income lowers mortality rates, while real per capita income increases them, carbon emissions and renewable energy raise them (Adeleye et al., 2022). In contrast, the outcomes of the mediation analysis indicate that economic growth has an adverse effect on mortality rates through emissions of greenhouse gases, as well as its direct effect (Fotio et al., 2024).

Hypothesis 1: What is the effect of mortality rates on CO_2 emissions in Lithuania?

Carbon Emissions and Renewable Energy Consumption

Many environmental scholars have explored the link between renewable energy and CO_2 emissions. In the instance of Algeria, Bélaïd et al. (2017) combined the Granger causality method with the VECM model and argued that adopting renewable energy has beneficial environmental effects over the long run. Likewise, in their study conducted in Turkey between 1980 and 2016, Karaaslan et. al. (2022) utilized the ARDL technique to examine the long- and short-run effects. The results demonstrate a sustained link between CO_2 reduction and REC. The most recent study by Adebayo et al. (2022) used a dataset from 1980 to 2019 in Portugal to apply frequency domain causality analyses, wavelet correlation, numerous and continuous wavelet consistencies to study variables, as well as constant wavelet changes. The results show that Portugal's medium- and long-term CO_2 emissions decrease as a result of using renewable energy. Renewable energy sources for energy production help to reduce emissions (Mohamed et al. 2024).

Hypothesis 2: Does the significant use of renewable energy significantly reduce CO_2 emissions in Lithuania?

Carbon Emissions and Trade Openness

The environmental impact of trade openness and other variables is gaining more attention from scholars in the age of globalization. Some studies indicate that when trade opens up, the environment suffers (Ghazouani et al., 2020; Shahbaz et al., 2017). While trade openness helps to increase carbon emissions in China-Japan-ROK FTA countries (Dou et al., 2021), instead, some scholars' findings show that the development of renewable energy and open trade decreases CO_2 emissions in the long run (Kim, 2022). In addition, trade openness helps to increase environmental sustainability in the short run, but in the long run, trade openness is harmful for environmental sustainability (Udeagha et al., 2022). Conversely, trade openness is responsible for damaging environmental sustainability in Pakistan (Usman et al., 2023).

Hypothesis 3: How does trade openness impact CO_2 emissions in Lithuania, with both positive and negative effects?

Carbon Emissions and Economic Growth

Numerous research has revealed that growth in the economy and usage of energy has a directly impact on the environment caused by emissions of carbon dioxide (Nosheen et al., 2021). Nonetheless, several investigations demonstrate the connection between environmental deterioration and growing the economy in China, Japan, and the USA, based on the analysis of a few chosen economies with elevated carbon emissions (Azam et al., 2016). Carbon emissions from economic expansion vary substantially from country to country (Li et al. 2021). Likewise, economic growth affects the energy consumption in a country, likely leading to a rise in the amount of CO_2 emissions in the air. This outcome stems from the development of industry sectors, which use more energy for production (Malik et al., 2016).

Hypothesis 4: Is economic growth in Lithuania likely to lead to an increase in CO_2 emissions?

To the best of the author's information, this research is different from previous studies. i) This study aims to examine the mortality rates under 5 and macroeconomic variables' influence on CO_2 emissions in Lithuania. ii) This study includes many other variables to explore relationships and suggest policies and recommendations for stakeholders. iii) The current study aims to examine the long-run and short-run relations using the ARDL model. iv) The present research aims to make a significant contribution by employing cointegration regression as a robustness test and comparing the results with the ARDL model. Furthermore, this study employs diagnostic tests to check the model's stability, serial correlation, and heteroscedasticity.

Methodology

Data and Variables

Table 1: Variables Details

Variables	Detail variables
CO_2 emissions	Metric tons p/c
Mortality rates	Mortality rate, under-5 (per 1000 live births)
Renewable energy consumption	Percentage of total final energy consumption
Trade openness	Total sum of % of export and import values as a share of GDP
Economic Growth	GDP constant 2015 US dollars

Source: World Bank (2024)

The key objective of this study is to investigate how mortality rates and factors related to macroeconomics influence Lithuania's CO_2 emissions. Furthermore, the present study uses time series data from 1995 to 2020, sourced from the World Development Indicators. To carry out this study's significance, variables such as CO_2 emissions (Çobanoğulları, 2024), mortality rates under 5 (Adeleye & Tiwari, 2024), the usage of renewable energy consumption (Madaleno et al., 2023), trade openness (Ashraf et al., 2023), and economic growth (Idroes et al., 2024) are considered. In this study, mortality rate under 5 and renewable energy sources are the main independent factors, whereas CO_2 emissions are the dependent variable. Trade openness and economic growth are used as the control variables. Further information on the variables and their sources is provided in Table 1.

The present research investigation examines the associations, both short-run and long-run, among variables and carbon emissions. The study utilizes an econometric model as follows:

$$CO_{2t} = f(MORT_t, REC_t, TO_t, EG_t) \tag{1}$$

The variables in this equation are CO_2 for carbon emissions at time, MORT for the mortality rates at time, REC for energy from renewable sources used at time, TO for Trade openness at time, and EG for economic growth at time .

ARDL Model Estimations

The objective of this study is to examine how mortality rates and macroeconomic factors influence Lithuania's CO_2 emissions from 1995 to 2020. This study employs the ARDL model to achieve the research objective. The ARDL model has been utilized in most recent research studies (Çobanoğulları, 2024). The autoregressive distributed lag (ARDL) model, originally introduced by Pesaran & Shin (1999) and developed by Pesaran et al. (2001), deals with single cointegration. When contrasting this method of integration with previous methods of cointegration, as per Raihan (2023), it may be implemented in any investigative series integration situation. Compared to other econometric techniques, the ARDL model is seen to be the better method when the variables can be either stationary at I (0) or integrated of order I (l). Lastly, the ARDL technique is still applicable despite having fewer data points (Pesaran et al., 2001). The econometric model given in Eq. (2) is used to write the ARDL bound testing model.

$$\Delta CO_{2t} = \alpha_0 + \sum_{k=1}^{n} \alpha_1 \Delta Mort_{t-k} + \sum_{k=1}^{n} \alpha_2 \Delta Rec_{t-k} + \sum_{k=1}^{n} \alpha_3 \Delta TO_{t-k} + \sum_{k=1}^{n} \alpha_4 \Delta EG_{t-k} + \lambda_1 Mort_{t-1} + \lambda_2 Rec_{t-1} + \lambda_3 To_{t-1} + \lambda_4 EG_{t-1} + \epsilon_t \tag{2}$$

The variability of an aspect is represented by α_0 in this equation, where the initial variation is shown by Δ, and the white noise is represented by. Throughout the context of the research, the lag time is determined by making use of the Akaike information criterion (AIC). The long-term connections among each variable had initially been determined, and then the short-run characteristics were determined with the error correction model (ECM). The basic form of Equation (3)'s ECM is shown in Equation (2) below:

$$\Delta CO_{2t} = \alpha_0 + \sum_{k=1}^{n} \alpha_1 \Delta Mort_{t-k} + \sum_{k=1}^{n} \alpha_2 \Delta Rec_{t-k} + \sum_{k=1}^{n} \alpha_3 \Delta TO_{t-k} + \sum_{k=1}^{n} \alpha_4 \Delta EG_{t-k} + \emptyset ECM_{t-k} + \epsilon_t \tag{3}$$

In short-run dynamics, $\emptyset$ stands for the ECM coefficients, and Δ stands for the initial contrast. The speed at which the short-term disruption is adjusted to long-run equilibrium is shown by ECM.

Findings and Discussions

Descriptive Statistics

Table 2 summarizes the variable data and presents the results. Given that the skewness values were almost zero, it was obvious that the dataset was regular. Furthermore, the kurtosis values are lower than those provided for the three platykurtic variables. Based on the probability and Jarque-Bera values, each variable exhibits a normal distribution.

Table 2: Descriptive Statistics

Variable	CO_2	MORT	REC	TO	EG
Average	3.807642	7.900000	21.38346	119.1839	3.35E+10
Intermediate	3.900315	7.700000	18.20500	120.9095	3.46E+10
Max.	4.200152	15.10000	33.78000	155.8868	4.82E+10
Min.	3.004941	3.500000	10.34000	74.82150	1.79E+10
Standard Dev.	0.327221	3.274141	7.340050	25.16995	9.49E+09
Skewness	-0.946897	0.434162	0.407022	-0.095539	-0.150583
Kurtosis	2.948039	2.140011	1.980069	1.661007	1.790048
Jarque-Bera	3.888253	1.618032	1.844836	1.981863	1.684242
Sum Sq. Dev.	2.676841	268.0000	1346.908	15838.16	2.25E+21
Obs.	26	26	26	26	26

Unit Root Test

Table 3 explains that finding the unit root for each of the variables is critical for performing ARDL-bound testing. All variables have to be stable at points I (0) and I (l). The same enhanced unit root test (the ADF) that was used in a previous investigation (Rizwanullah et al., 2020) is employed to confirm the combination ordering for every variable. Table 3 indicates that every variable is consistent at first differenced.

Table 3: Unit Root Test

Variable	ADF at level	ADF at 1st difference
CO_2	-1.7107 (0.4139)	-4.7757 (0.0009)
MORT	-1.7566 (0.3907)	-3.6467 (0.0127)
REC	-1.3594 (0.5846)	-1.6670 (0.0895)
TO	-1.4183 (0.5571)	-4.6154 (0.0013)
EG	-0.6137 (0.8505)	-4.1009 (0.0046)

ARDL Bound Test

Table 4: ARDL Bound Test

F-Bound Test	Value	Sign.	I (0)	I (I)
F-Statistics	6.11	10%	1.9	3.01
		5%	2.26	3.48
		1%	2.62	3.9

Table 4 presents the results of this study regarding the ARDL-bound. An F-statistic of 6.11 exceeds the critical limits in both the higher and lower axes at a significance level of

5%. Given the evidence, it could be determined that there is a stable relationship between the variables, contradicting the null hypothesis, which states that there is no cointegration at various degrees of statistical significance.

Cointegration Test

The results of the research, as shown in Table 5, indicate cointegration between the variables. The present research outcomes and ARDL bound test indicate that we can employ further ARDL models to examine the long run and short run.

Table 5: Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Prob.*
None*	0.9184	0.0000
At most 1*	0.5997	0.0142
At most 2 *	0.5788	0.0000

ARDL Model (Long Run and Short Run)

Table 6: Results of the ARDL Long Run

Variable	Coefficient	t-Statistic	p-value
MORT	0.3769	3.3596	0.0033
REC	-0.0091	-0.7988	0.4343
TO	0.0065	2.2802	0.0343
EG	3.56E-11	2.8457	0.0103

The ARDL results are shown in Table 6. Carbon emissions and mortality rates are positively correlated; in this case, if a 1% increase in CO_2 emissions results in a 0.3769 increase in mortality rates, it means that mortality rates rise with CO_2 emissions in Lithuania. Besides, our study outcomes indicate a close correlation between CO_2 emissions and trade openness. If trade openness rises by 1%, CO_2 emissions also upsurge by 0.0065. Economic growth and CO_2 emissions are positively correlated; in Lithuania, every additional 1% increase in economic growth is associated with a significant increase in CO_2 emissions of 3.56. Therefore, this suggests that economic growth has an impact on carbon emissions. Even though renewable energy reduces CO_2 emissions in Lithuania, indicating a negative association between renewable energy and CO_2 emissions, the statistical significance of this relationship is weak. The study findings show that a 1% increase in renewable energy causes CO_2 emissions to decrease by -0.0091.

Table 7: Results of the ARDL Short Run

Variable	Coefficient	t-Statistic	p-value
MORT	0.1049	5.4904	0.0000
REC	-0.0139	-0.7802	0.4449
TO	0.0099	2.2962	0.0332
EG	5.43E-11	3.3401	0.0034
	-0.6544	-6.0820	0.0000

The short-run outcomes of the ARDL test are shown in Table 7. The short-run results show that trade openness, economic growth and mortality rates have a positive relationship with CO_2 emissions, which can be harmful to ecological sustainability. However, if there is a 1% rise in mortality rates, trade openness, and economic growth, there will be a rise in emissions of carbon dioxide by 0.1049, 0.0099, and 5.43, respectively. Furthermore, renewable energy sources and carbon dioxide emissions have indirect relations. For instance, when energy from renewable sources rises by 1%, carbon dioxide emissions drop by -0.0139. The outcomes of the short-run equation of the ARDL model, along with the short-run and long-run stability relations, reveal an ECT value of -0.6544. Based on the results, the adjustment spread is approximately 65.44%.

Diagnostic Test

Table 8 outcomes indicate that the model does not include either serial correlation or heteroscedasticity. Figures 1 (a, b) display, where all fall below both the lower and upper critical limits at the significance level of 5%. The results show that the present study model is stable.

Table 8: Diagnostic Test

Test	X	P-value	Decision
Serial Correlation	3.3215	0.1900	No serial correlation
Heteroscedasticity Test	4.3825	0.6251	No heteroscedasticity
CUSUM Test	-	-	Stable
CUSUMSQ Test	-	-	Stable

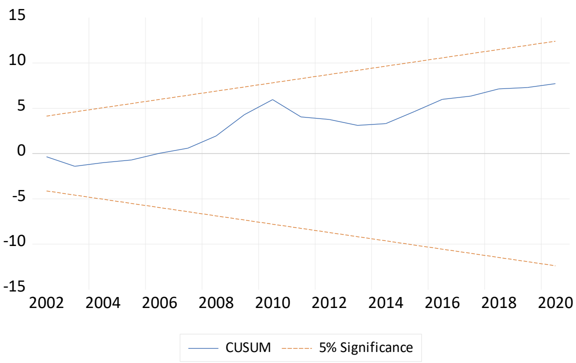

Figure 1: Stability Test for Model

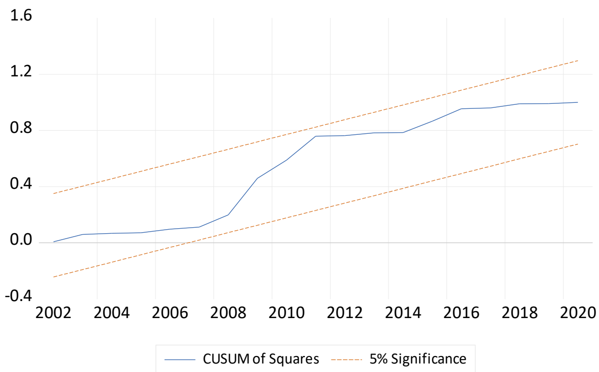

Figure 2: Stability Test for Model

Robustness Test

Table 9: Robustness Test

	FMOLS		DOLS	
Variables	Coefficient	Prob.	Coefficient	Prob.
Mort	0.1717	0.0422	0.1434	0.0000
REC	-0.0054	0.7890	-0.0167	0.4284
TO	0.0120	0.0252	0.0105	0.0508
EG	5.48E-11	0.0116	5.31E-11	0.0139

Table 9 shows the present study outcomes of cointegration regression (FMOLS, DOLS). The study outcomes indicate that mortality rates, trade openness, and economic growth have a positive connection with CO_2 emissions. The results suggest that these factors contribute to environmental damage in Lithuania. Furthermore, a 1% increase in mortality rates, trade openness, and economic growth results in CO_2 emissions increasing by 0.1717, 0.0120, and 5.48, respectively. However, renewable energy has a negative association with CO_2 emissions.

The results confirm that renewable energy reduces CO_2 emissions in Lithuania, albeit the relationship is weak. A 1% increase in renewable energy causes carbon emissions to decrease by -0.0054. The outcomes of cointegration regressions are similar to the ARDL model, and cointegration regressions in this study are used as a robustness test.

Discussion

This study examines the impact of macroeconomic variables and the under-5 mortality rates on carbon emissions in Lithuania between 1995 and 2020. For instance, the study findings show that the mortality rates and CO_2 emissions have a positive connection. The outcome is consistent with previous investigations (Adeleye et al., 2023; Arceo et al.,2016; Sokadjo et al., 2020), which indicated that mortality rates and CO_2 emissions were closely associated. The findings also confirm that mortality rates damage the ecological sustainability in Lithuania and the study hypothesis indicates that CO_2 emissions and mortality rates have a positive relationship. Renewable energy consumptions and carbon dioxide emissions exhibit an adverse and statistically weak association, revealing Lithuania's emissions are still rising as an outcome of energy generated from renewable sources. This outcome is in accordance with earlier studies (Idroes et al., 2024; Ike et al., 2020; Mamkhezri et al., 2024; Nathaniel et al., 2021), which concluded that the renewable energy consumption sources and carbon emissions were inversely related. Additionally, the World Bank (2020) reports a decrease in Lithuania's use of renewable energy from 2019 to 2020, dropping by 33.54% to 31.7%. The World Bank data also supports our results; renewable energy consumption reduces carbon emissions but is not effective in reducing them significantly. The research hypothesis validates the negative association between REC and CO_2 emissions. The present research hypothesis confirmed a positive relationship between trade openness and CO_2 emissions. Likewise, there is a positive connection between trade openness and carbon emissions, as evidenced by the outcomes of research by (Wang & Zhang, 2021; Li et & Haneklaus, 2022; Mamkhezri et al.2024). The aforementioned research also shows that trade and carbon emissions are closely linked. The outcomes demonstrate that trade directly impacts Lithuania's environment. According to the World Bank (2020), Lithuania has an open economy, with foreign trade accounting for 156% of the country's GDP. Statistics Lithuania report highlights the top three export categories for the nation in 2021, which are expected to be mineral goods (10%), machinery and electrical equipment (13.5%), and chemicals and related industries (14.9%). In addition, the share of CO_2 emissions embedded in trade increased in the European Union and Lithuania from 2020 to 2021, rising from 22% to 24.7% and from 48.1% to 60.8%, respectively. Moreover, from 2020 to 2021, consumption-based CO_2 emissions rose in Lithuania and the 27 member states of the European Union. The European Union's consumption-based CO_2 emissions have climbed from 3.21 billion to 3.50 billion tons, whereas Lithuania's emissions have increased from 20.05 million to 22.24 million tons (Our World in Data, 2022). The Our World data also confirmed our results, and our study findings indicate that CO_2 emissions and trade openness are directly linked. Economic growth has an influence on carbon emissions in Lithuania. The study findings confirmed that economic growth and CO_2 emissions have a positive correlation. These findings correspond to those of (Osobajo et al. 2020; Adebayo et al.2022; Chen et al. 2024; Tran et al.2024), who believed that increased growth in the economy enjoyed an influence on emissions of carbon dioxide. At the same time, in Lithuania, economic growth increased from 2020 to 2021, rising from 56.96 (USD billion) to 66.8 (USD billion) (World Bank, 2020). The study findings show that economic growth is one of the factors damaging the environment in Lithuania and also this study hypothesis indicates that economic growth and CO_2 emissions have a positive association.

Conclusion and Policy Implications

This study examines how Lithuania's carbon emissions were affected by macroeconomic variables and the under-5 mortality rates between 1995 and 2020. To achieve the long-run and short-run objectives, this study employs the ARDL model. A unit root test indicates that all variables are stationary. Besides, the study's outcomes reveal strong and significant long-term connections among the variables, as evidenced by the Johansen cointegration test. As well, the ARDL bound test demonstrates long-term cointegration. These tests confirmed further study can employ the ARDL model to achieve the objective. In addition, diagnostic tests confirmed neither serial correlation nor heteroscedasticity was present in the model. The 5% significance level lies between both the upper and lower critical limits, implying that the model remains stable based on the outcomes. To confirm the test validity, the present study uses cointegration regression test as a robustness test; these tests are similar to the ARDL model. The findings of the present study indicate that trade openness and CO_2 emissions, along with economic growth and CO_2 emissions, are strongly positively correlated in both the long run and the short run. Similarly, CO_2 emissions and mortality rates also confirm a positive relationship. The study analysis shows that these variables are harmful for environmental sustainability. Although the statistical association with renewable energy is weak, renewable energy reduces CO_2 emissions. The findings suggest that higher mortality rates in Lithuania would lead to increased carbon dioxide emissions in both the short and long term. Furthermore, the ARDL findings show a statistically negligible relationship between rising renewable energy consumption and reduced carbon dioxide emissions. This implies that, although it may be less effective overall, increasing the use of renewable energy sources may contribute to improving the quality of the environment in both the short and long term.

This study recommends some policies based on its findings in Lithuania from 1995 to 2020. The study shows that the mortality rates and CO_2 emissions are directly linked. Initially, adopting healthcare reforms that can improve the general well-being of the public could help decrease mortality rates; however, these policies must also be ecologically friendly. Secondly, to reduce CO_2 emissions and promote environmental sustainability and long-term health benefits in Lithuania, this study recommends supporting and investing in renewable energy sources. Additionally, our analysis shows that energy and renewable energy consumptions have a negative association and a statistically weak link, which may help decrease the country's carbon dioxide emissions somewhat, but not be very effective. Thirdly, many economies have experienced historically high growth as a result of the development of global trade in the late 1990s, especially in developing countries. However, it has also sparked worries about growing carbon dioxide emissions, which contribute to global warming (Yang et al., 2022). For instance, in Lithuania, the share of CO_2 emissions embedded in trade increased from 48.1% to 60.8% from 2020 to 2021, respectively (Our World in Data, 2022). Regarding the definition of emission obligations and measures taken, there are still significant disparities between nations (Ali & Kirikkaleli, 2022). This study suggests, however, that trade helps economic growth but at the same time damages the environment in Lithuania. Stakeholders should make policies to reduce trade CO_2 emissions, as trade links many sectors of economic activities. It is essential to ensure that policies protecting the public's health and welfare are balanced with trade openness. Fourth, while economic growth is a gauge of a country's degree of development, many countries prioritize economic growth over other considerations, compromising public health and the environment. No doubt, Lithuania's economic growth increased in the last few years, but at the same time CO_2 emissions also increased and aligned with trade CO_2 emissions increases, resulting in negative impacts on the health sector. However, to protect the environment and encourage balanced economic growth, our research proposes that Lithuania enact ecologically friendly policies based on the study's conclusions. These policies may also assist in lowering the country's carbon dioxide emissions and help also improve the health sector.

The present research has several limitations. Firstly, the availability of data is a serious issue during this research; perhaps further research is possible with the latest data and with new variable proxies. Secondly, the present study is based on single countries; further study might be possible in African regions, ASEAN, and also South Asian countries. Thirdly, further research on energy use (renewable energy and non-renewable energy sources), health expenditure, FDI, human capital, population, and total natural resources is warranted. Fourthly, researchers might use QARDL, NARDL, and BARDL for econometric analysis.

Declaration

Conflict of Interest

The authors declare no conflict of interest related to this study.

Availability of Data and Materials

The data and materials used in this study are available upon reasonable request from the corresponding author.

Authors' Contribution

Atif Yaseen conceived the study and devised the methodology; Priyonggo Suseno contributed to the manuscript through writing, critical review, and editing; Syed Ghulam Hussain Shah authored the initial draft and undertook the proofreading.

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