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Research Article

Nexus between economic growth, natural resources rents, trade globalization, financial development, and carbon emissions toward environmental sustainability in Uruguay

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ABSTRACT

There have been variances in environmental quality as the globe continues to become a globalized society, however, research including trade globalization into the environmental policy framework remains inconclusive. Using the Uruguayan time series dataset between 1990 and 2020, this study investigated the impact of economic growth, natural resource rents, trade globalization, and financial development on carbon dioxide (CO2) emissions. Using an Autoregressive Distributed Lag (ARDL) model, this inquiry quantifies short- and long-run dynamics. The results of the ARDL bounds test indicate a long-term relationship between carbon emissions and these variables. Additionally, the ARDL short-and long-run analyses demonstrated a positive and statistically significant effect of economic growth, natural resource rents, and trade globalization on Uruguay's CO2 emissions. However, both the short-run and long-run coefficients of financial development are statistically significant and negative, indicating that financial development has no effect on environmental deterioration in Uruguay. Furthermore, by using Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), and Canonical Cointegration Regression (CCR), the findings were confirmed. Based on the findings of this study, it is recommended that international trade regulations be reevaluated and export limitations for goods with high levels of pollution are strengthened.

Keywords: carbon emissions; economic growth; natural resources rents; trade globalization; financial development

1. INTRODUCTION

Over the course of the years, global warming and other environmental concerns have swiftly progressed, posing major dangers to the objectives of policymakers for sustainable development (Raihan et al., 2018; Raihan et al., 2019; Raihan et al., 2021a; Ali et al., 2022; Isfat and Raihan 2022;). Following the advent of industrialization, the world economy entered an era of rapid expansion, which coincided with a widening of the wealth divide (Begum et al., 2020; Voumik et al., 2022a). This simultaneous economic progress brings with it the difficult problem of environmental deterioration, which poses a risk to the continued existence of civilization (Raihan and Tuspekova, 2022a). The primary reasons for these problems are that significant amounts of industrial waste are being produced, substantial amounts of fossil fuels are being used, and natural resources are being depleted (Raihan et al., 2021b, Raihan and Said, 2022). In a similar vein, the harmful influence on the environment and the increased awareness of the importance of environmental issues have continued to pique the concern of politicians all over the world (Raihan et al., 2022a). At recent conferences on climate change and environmental regulation, a number of governments made announcements regarding their plans to reduce carbon emissions and reach a carbon peak (Raihan et al., 2022b). These announcements were made in an effort to reach net zero emissions and achieve integrated economic development and environmental protection (Raihan and Tuspekova, 2022b). According to this point of view, the goal of the leaders of the world is to achieve carbon neutrality within the next several decades by passing policies that have net-zero emissions. Uruguay has been dealing with environmental disasters for a number of years, and it is currently under a great amount of pressure from the outside world to find solutions to environmental problems.

The acceleration of Uruguay's economic growth can be attributed, in part, to the facilitation of the quick flow of goods and services across international borders that is made possible by globalization. In addition to these factors, Uruguay's abundant natural resources give the country the ability to foster economic expansion. Emissions of carbon continue to be a detrimental environmental externality (Raihan et al., 2022c), particularly for energy-reliant economies such as Uruguay. However, the worsening economic prospects brought about by COVID-19 put pressure on the government's ability to ensure sustainable growth while simultaneously limiting its reliance on energy derived from fossil fuels (Raihan et al., 2022d). This is a significant problem. The gradual depletion of natural resources and the resulting increase in demand for them cause the environment to deteriorate over time (Jaafar et al., 2020). The processes that are now used to generate energy and manufacture products cannot be maintained indefinitely. The importance of energy efficiency and energy

conservation measures in reducing the strain that is being placed on natural resources. Despite this, there are considerable environmental concerns brought up by the widespread utilization of natural resources (Raihan and Tuspekova, 2022c). Both the fact that Uruguay is rich in natural resources and the possibility that the country's current rate of progress could not be maintainable should be brought to people's attention. As a result, the country might have little choice but to rely on its stockpiles of natural resources in order to satisfy its demand for energy. The vast majority of these natural resources are made up of hydrocarbon molecules, and the oxidation process that occurs when they are used leads in the production of carbon dioxide. The increase in both the use of natural resources and the number of people living in an area both contribute to a trajectory that is detrimental to the quality of the environment (Raihan and Tuspekova, 2022d). Nevertheless, natural resources may have a considerable impact on both the expansion of the economy and the progression of climate change (Raihan and Tuspekova, 2022e). As a consequence of this, it is absolutely necessary to assess the role that natural resources play in protecting the environment (Raihan and Tuspekova, 2022f). In the past, there have only been a few research conducted on this topic. Therefore, it is difficult to draw broad conclusions from the results of these investigations. By investigating the effect that natural resource rents have on CO2 emissions in Uruguay, this study has the potential to initiate an examination of the relationship between natural resources and the surrounding environment.

The influence of globalization on climate change (particularly the globalization process related to trade) has been greatly underestimated due to the fact that the rate of globalization continues to accelerate at an increasing rate. As a result of the globalization of commerce, many countries with open economies have reaped enormous benefits in terms of wealth, advancement, and quality of life (Raihan et al., 2022e). As a direct result of globalization, the demand for energy in the industrial sector continues to rise, and despite recent improvements in the energy business, this level of emissions has not been able to be reduced. Financing for economic operations can be provided by underdeveloped financial institutions in the form of low-cost borrowing to individuals and enterprises. This contributes to an increase in the demand for energy while concurrently degrading the environment (Raihan et al., 2022f). Numerous pieces of research have presented a variety of points of view on whether or not the globalization of commerce contributes to the destruction of the environment; these points of view can be grouped into two categories. According to the "Pollution Haven Hypothesis," which is supported by a number of studies, the "Pollution Haven Effect" occurs when industrialized nations that have strict environmental management standards move their energy- or pollution-intensive manufacturing operations to developing nations that have laxer environmental regulations.

Some people believe that the activities involved in commerce are to blame for the deterioration of the environment in developing countries. However, as the level of globalization in trade continues to increase, several rising economies are feeling pressured to lower their environmental standards in order to entice a greater amount of investment from overseas. The consumption of significant amounts of energy and the activity of the economy have both contributed to the destruction of the environment in these developing nations (Raihan and Tuspekova, 2022g). However, the goal of sustainable development is undermined by the wasteful consumption of the earth's natural resources (Raihan and Tuspekova, 2022h). It is the obligation of each generation, in accordance with the idea of intergenerational fairness, to maintain and protect the natural and cultural variety of the world. This generation has a specific responsibility to be especially dedicated to the preservation of natural and cultural resources for the generations who will come after them. In accordance with the "Pollution Halo Hypothesis," one viewpoint asserts that globalization of trade can be a significant influence in resolving environmental degradation. This viewpoint is supported by evidence. Countries that have fewer environmental restrictions are able to obtain access to current pollution control technologies through the influx of patent transfer and cross-regional production factors (Raihan et al., 2022g). This could help improve the quality of the environment in countries that currently have fewer environmental restrictions. This research examines the globalization of trade as one of the key factors influencing CO2 emissions in order to provide policy solutions for resolving this difficult issue and to provide evidence that supports the assertion that globalization of trade is one of the most important factors influencing CO2 emissions.

The nation of Uruguay is seeing tremendous economic growth, and with it comes modest improvements in its banking sector. The expansion of people's wealth is one of the most important drivers of globalization in the trading sector. According to this rationale, one of the most significant factors to take into consideration in the ongoing research is financial growth (Raihan and Voumik, 2022a). By committing more resources to clean energy and by raising the cash necessary to invest in environmentally friendly infrastructure and assure environmental sustainability, a robust financial sector may make a contribution to the improvement of environmental sustainability (Raihan and Voumik, 2022b). The advancement of a nation's economy, particularly in the areas of research and development and technological advancements, tends to result in an improvement in the quality of the environment (Raihan and Tuspekova, 2022b). Additionally, financial development contributes to an increase in economic efficiency as well as an expansion of options to adopt cutting-edge technology that has a lesser impact on the environment. On the other hand, a number of studies have found that a growing economy is one of the key reasons that contribute to an increase in CO2 emissions (Raihan and Tuspekova, 2022i). It was determined that financial development is required for the expansion of the private sector, which stimulates economic activity and helps alleviate poverty by lowering the costs of financial systems (Raihan and Voumik, 2022a). This conclusion was reached after it was examined and determined that financial development is required. It is possible to develop new financial markets, intermediaries, and contracts by lowering the costs associated with getting financial information, forming relationships, and carrying out transactions. As a consequence of this, it involves the formation and expansion of financial institutions, markets, and instruments; nonetheless, it has a number of repercussions that are detrimental to the environment (Raihan and Voumik, 2022b). Because of the amount of energy required in their manufacture, the purchase of any item of machinery or vehicle will have some sort of impact on the natural world (Raihan et al., 2022h). As a consequence of the progress made in the financial sector, investors prefer to put their money into the establishment of plants and machinery whose operations demand a significant quantity of energy, which in turn results in the emission of carbon.

This study focuses on Uruguay since pollution in the country is a significant economic and environmental concern that affects not just the country but also the Latin American area as a whole. The reason for this concentration is due to the fact that Uruguay is the most polluted country in Latin America. In recent months, the gap in Uruguay between the availability of energy and the demand for it has grown wider, and the country's efforts to achieve sustainable economic growth face a significant obstacle posed by the worsening state of the environment. For example, Extreme events, such as the drought that occurred in 2008 or the floods that occurred in 2014, resulted in a significant loss for the economy. Recent records from 2015 suggest that the country's water deficit has, on several occasions, had a severe influence on the agricultural industry. This has resulted in a number of negative outcomes for the agricultural sector. This drought has lasted longer than any other in recent memory, which has led to issues with production as well as significant economic losses. As a consequence of the elimination of obstacles posed by international trade as a part of the ongoing process of globalization, Uruguay has emerged as a significant participant in the framework governing trade in Latin America. Furthermore, because Uruguay's economy is so small and open, the country is dependent on free trade restrictions and market distortions. This is especially true in the agricultural sector, which is responsible for the majority of the country's exports. This has a negative impact on the state of the environment throughout the country. The Clean Development Mechanism (CDM), Nationally Appropriate Mitigation Actions (NAMAs), and the Reducing Emissions from Deforestation and Forest Degradation (REDD+) are some processes and methods that Uruguay has used to facilitate and significantly enhance its environmental policies. Other processes and methods include the Clean Development Mechanism (CDM), Nationally Appropriate Mitigation Actions (NAMAs), and the Reducing Emissions from Deforestation and Forest Degrad (Reducing emissions from deforestation and forest degradation).

Taking into account the aforementioned goals and the current condition of the environment, the objective of this study is to conduct an analysis of the impact on Uruguay's carbon emission of natural resource rents, economic expansion, financial development, and the globalization of trade. Specifically, the evaluation will focus on how these factors interact with one another. It is the country in the Latin American region that has the greatest GDP per capita despite having one of the smallest populations and the fewest options for its domestic market. In 2018, the GDP per capita reached a record high of $16,037, having tripled over the previous year (World Bank, 2022). Uruguay is a member of the nation that exports the most food in the world, so the country's natural resources are constantly growing (together with Argentina, Brazil, and Paraguay). Because of its rapidly expanding economy and relatively small population, Uruguay is currently the ninth-largest carbon emitter in all of Latin America (World Bank, 2022). As a direct result of the expansion of the economy, environmental deterioration has been a major source of concern in recent years. The research adds new information to the existing body of work, and it does so in a variety of different ways. To begin, it was necessary to investigate the ways in which several factors, such as the expansion of the country's economy, its natural resources, the globalization of commerce, and the rise of its financial sector, affected the country's carbon emissions. It is essential to gain a better understanding of the contradictory viewpoints of multiple-research regarding the source of the increase in carbon emissions and whether some of the parameters used could also help in reducing the elevated level of carbon emissions produced by other parameters. It is also essential to determine whether some of the parameters used could also help in reducing the elevated level of carbon emissions produced by other parameters. Second, the research utilized the most latest and comprehensive data that was compiled over a period of 31 years (1990–2020). Thirdly, in order to validate the results of our research, we utilized a number of unit root tests, diagnostic tests, and cointegration regression models (ARDL, DOLS, FMOLS, and CCR), all of which were designed to assess the reliability of our findings. Last but not least, the empirical data that was gathered through the course of this work provides important policy recommendations for the implementation of natural resource rents, trade globalization, financial development, and other associated economic methods in order to accomplish sustainable economic and environmental growth.

2. RESEARCH METHOD

2.1 Data

This study examines the effects of economic expansion, natural resource rents, globalization of trade, and financial development on Uruguay's CO_2 emissions. This analysis utilizes a data set spanning the years 1990 to 2020. This study's endogenous variable is carbon emissions, whereas the exogenous variables are natural resource rents, economic growth, financial development, and trade globalization. To eliminate heteroscedasticity, all variables of the inquiry are turned into natural logs. Table 1 provides a description of the variables, together with their measurement units and data sources.

Table 1. Description of the variables

Variables	Description	Logarithmic forms	Units	Sources
CO2	CO2 emissions	LCO2	Metric tons per capita	WDI
GDP	Economic growth	LGDP	GDP per capita (constant Peso Uruguayo)	WDI
NNR	Natural resources rents	LNRR	Total natural resources rents (% of GDP)	WDI
TG	Trade globalization	LTG	Globalization index measured by trade	KOF
FD	Financial development	LFD	Domestic credit to private sector (% of GDP)	WDI

2.2 Econometric model

The model for this study is constructed by following Cobb and Douglas's (1928) production function:

$$CO_{2t} = f\ (GDP_t;\ NRR_t;\ TG_t;\ FD_t) \quad (1)$$

Equation (2) depicts the empirical model:

$$CO_{2t} = \tau_0 + \tau_1 GDP_t + \tau_2 NRR_t + \tau_3 TG_t + \tau_4 FD_t \quad (2)$$

Equation (3) is further expanded as the econometric model in the following form:

$$CO_{2t} = \tau_0 + \tau_1 GDP_t + \tau_2 NRR_t + \tau_3 TG_t + \tau_4 FD_t + \varepsilon_t \quad (3)$$

where τ_0 and ε_t denote intercept and error term while τ_1, τ_2, and τ_3 represent the coefficients.
Moreover, Equation (4) shows the logarithmic arrangement of Equation (3):

$$LCO2_t = \tau_0 + \tau_1 LGDP_t + \tau_2 LNRR_t + \tau_3 LTG_t + \tau_4 LFD_t + \varepsilon_t \quad (4)$$

2.3 Strategies for estimation

Before analyzing the cointegration between variables, empirical literature acknowledges the necessity of defining the integration sequence. It is crucial to begin estimating with a unit root test in order to avoid erroneous regression (Raihan and Tuspekova, 2022j). This method assures that the variables in the regression are stationary by differentiating them and using stationary processes to estimate the equation of interest. Due to the fact that the effectiveness of unit root testing varies with sample size, a number of studies propose utilizing numerous tests to establish the optimal sequence for series integration (Raihan and Tuspekova, 2022k). The unit root test was utilized to ensure that no variables in this study exceeded the order of integration and to give additional evidence for the superiority of the ARDL technique over conventional cointegration methods. This study identified the autoregressive unit root using the Augmented Dickey-Fuller (ADF), the Dickey-Fuller generalized least squares (DF-GLS), and the Phillips-Perron (P-P) unit root test.

When the integration sequence of the series was determined, the analysis confirmed the long-term association of the proposed model. The analysis adhered to the method described by Pesaran et al. (2001), known as the ARDL model, as an efficient estimation technique for revealing both short- and long-term correlations between the model's parameters. This approach has numerous advantages over prior cointegration strategies. Before applying previous cointegration processes, it was necessary to determine the integration property of a series, however, this method did not require such preliminary testing. Taking into account the variable's lag length, the ARDL model can be used to account for endogeneity. Second, it is appropriate in any circumstance of investigative series integration. Even with a small number of observations, the ARDL model maintains its validity. The ARDL bound testing approach can be formulated using the econometric model illustrated in Equation (5):

$$\Delta LCO2_t = \tau_0 + \tau_1 LCO2_{t-1} + \tau_2 LGDP_{t-1} + \tau_3 LNRR_{t-1} + \tau_4 LTG_{t-1} + \tau_5 LFD_{t-1} + \sum_{i=1}^{q} \gamma_1 \Delta LCO2_{t-i} + \sum_{i=1}^{q} \gamma_2 \Delta LGDP_{t-i} + \sum_{i=1}^{q} \gamma_3 \Delta LNRR_{t-i} + \sum_{i=1}^{q} \gamma_4 \Delta LTG_{t-i} + \sum_{i=1}^{q} \gamma_5 \Delta LFD_{t-i} + \varepsilon_t \quad (5)$$

Once the long-term relationship between series has been established, the short-run coefficient must be accounted for. As demonstrated by Equation (6), this study evaluated the error correction model and determined its short-run coefficients.

$$\Delta LCO2_t = \tau_0 + \tau_1 LCO2_{t-1} + \tau_2 LGDP_{t-1} + \tau_3 LNRR_{t-1} + \tau_4 LTG_{t-1} + \tau_5 LFD_{t-1} + \sum_{i=1}^{q} \gamma_1 \Delta LCO2_{t-i} + \sum_{i=1}^{q} \gamma_2 \Delta LGDP_{t-i} + \sum_{i=1}^{q} \gamma_3 \Delta LNRR_{t-i} + \sum_{i=1}^{q} \gamma_4 \Delta LTG_{t-i} + \sum_{i=1}^{q} \gamma_5 \Delta LFD_{t-i} + \theta ECT_{t-1} + \varepsilon_t \quad (6)$$

In the above equation, the error-correction dynamics and long-term relationships between the series are depicted. The lag length of the series is denoted by q and Δ stands for the first difference operator. In addition, ECT stands for the error correction term, and θ is the ECT's coefficient. As a robustness evaluation, this study utilized the FMOLS, DOLS, and CCR on the aforementioned model to examine how different parameters affected CO_2 output over time. Two primary issues necessitated the implementation of these strategies. Before using the FMOLS, DOLS, or CCR, the cointegration requirement among the I(1) parameters must be satisfied. Second, these techniques account for endogeneity and serial correlation biases resulting from the cointegration connection (Raihan et al., 2022i). Consequently, it produces results with

asymptotic efficiency. The flowchart for the analysis is depicted in Figure 1.

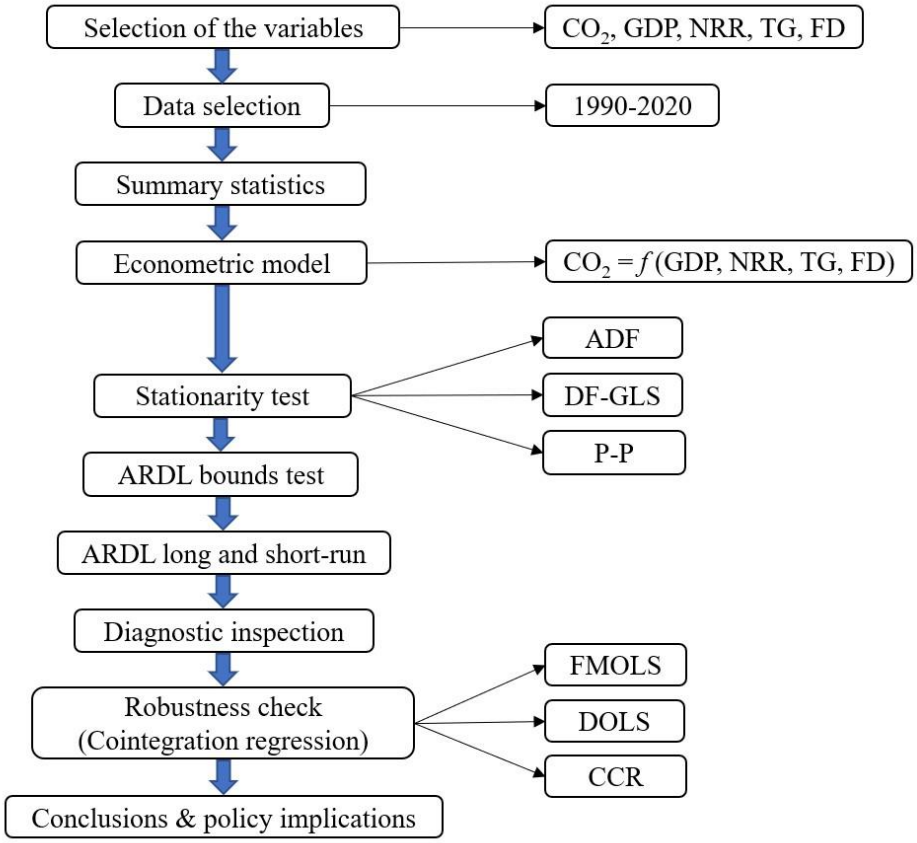

Figure 1. The analysis flowchart

3. RESULTS AND DISCUSSION

3.1 Summary statistics

Before undertaking the actual assessment (such as unit root, cointegration, and other modeling techniques), the descriptive nature of the dataset, which includes the normality of the data utilized, must be exposed. Table 2 shows the descriptive characteristics of the dataset in question. The findings indicate that the mean values of the variables fall within the normal range, indicating that the dataset contains no outliers. However, the estimated standard deviation values show that the data for all parameters under examination include an adequate amount of volatility. Moreover, the estimated skewness of all employed parameters lies between 1 and +1. The calculated value for Kurtosis is less than three for all factors under consideration. The Jarque-Bera value and probability support the conclusion that all employed parameters are normally distributed. Consequently, the dataset has an adequate level of normality and can be utilized for future studies and policy decisions.

Table 2. Summary statistics of the variables

Variables	LCO2	LGDP	LNRR	LTG	LFD
Mean	0.5592	12.803	-0.2197	3.7812	3.3556
Median	0.5719	12.728	-0.2206	3.8123	3.2500
Maximum	0.9272	13.153	0.8184	4.0485	4.2558
Minimum	0.2119	12.408	-1.6434	3.4789	3.0215
Std. Dev.	0.1819	0.2441	0.7253	0.1626	0.2889
Skewness	0.0168	0.1750	-0.2749	-0.1820	0.5879
Kurtosis	2.2787	1.6038	1.8117	1.8719	1.7584
Jarque-Bera	0.6733	2.6761	2.2145	1.8149	1.4754
Probability	0.7141	0.2623	0.3305	0.4035	0.2003
Observations	31	31	31	31	31

3.2 Results of unit root tests

Before implementing cointegration, unit root tests should be conducted to determine the nature of stationarity of the parameters, following descriptive statistical evaluations to determine normalcy. This stage is crucial since it not only aids in evaluating the type of stationarity of the employed parameter but also aids in selecting a suitable test for further research. This study employed ADF, DF-GLS, and P-P unit root testing strategies. All of the parameters under examination are stationary at the first difference, as seen in Table 3. Consequently, the data are optimal for co-integration and the ARDL estimator.

Table 3. The results of unit root tests

Logarithmic form of the variables		LCO2	LGDP	LNRR	LTG	LFD
ADF	Log levels	-2.466	-1.453	-0.392	-1.839	-1.943
	Log first difference	-5.844***	-3.569***	-4.641***	-4.922***	-4.514***
DF-GLS	Log levels	-1.772	-0.996	-0.419	-0.889	-1.940
	Log first difference	-5.509***	-3.659***	-4.657***	-4.912***	-4.115***
P-P	Log levels	-2.466	-1.154	-0.392	-1.839	-2.126
	Log first difference	-5.945***	-3.569***	-4.629***	-4.922***	-4.467***

*** denotes significance at the 1% level

3.3 Results of ARDL bounds test

The unit root evaluation gives information regarding the dataset's stationarity. Consequently, the research conducted the ARDL bounds test to assess whether or not there is a cointegration relationship between the employed parameters. Table 4 presents the findings of the co-integration analysis. The Akaike information criterion (AIC) was chosen as the lag specification due to the model's consistent results from each alternative's information criteria. Table 4 demonstrates that the computed cointegration F-statistic (6.67) exceeds the upper critical criterion. The independent variable and the regressors are cointegrated, according to this study's findings.

Table 4. ARDL bounds test results

F-bounds test		Null hypothesis: No degrees of relationship		
Test statistic	Estimate	Significance	I(0)	I(1)
F-statistic	6.675644	At 10%	2.2	3.09
K	4	At 5%	2.56	3.49
		At 2.5%	2.88	3.87
		At 1%	3.29	4.37

3.4 Results of ARDL short-run and long run

This study focuses on determining whether globalization of trade contributes to CO_2 emissions. In addition, this study investigates the influence of economic growth, natural resource rents, and financial expansion in Uruguay. The results of the ARDL long- and short-run estimation are shown in Table 5. The outcome suggested that economic expansion had a substantial effect on Uruguay's CO_2 emissions. According to calculations derived from the ARDL method, a 1% rise in Uruguay's economic growth boosts the country's carbon emissions by 1.27 percent over the long run and 0.96 percent over the short term. Moreover, ARDL calculations indicate that natural resource rents have a favorable effect on carbon emissions in Uruguay. As shown in Table 5, a one percent rise in natural resource rents will result in a 0.19 percent increase in CO_2 emissions over the long run and a 0.14 percent increase over the near term. In addition, the result revealed a positive relationship between the globalization of trade and CO_2 emissions. The findings found that a 1% increase in trade globalization will increase CO_2 emissions by 0.53 percent in the medium term and 0.39 percent in the short term. Meanwhile, trade globalization fosters economic growth while having negative consequences on the environment. Therefore, the balance between globalization of trade and the environment should be mutually beneficial rather than unilateral. Since one-way situations represent long-term environmental risks, they must be avoided. Lastly, in light of the importance of financial development to an economy, this study examined the impact of financial development on carbon emissions. The data demonstrate that financial development has little effect on the long-term or short-term carbon emissions of Uruguay. This study established a negative correlation between financial development and CO_2 emissions, indicating that a 1% rise in financial development might reduce CO_2 emissions by 0.21% in the medium term and 0.18% in the long run. The ECT was also discovered to have extremely negative effects. This estimate of 0.516 demonstrated the evolution of the short-run equilibrium as it proceeded toward a stable long-run equilibrium with annual adjustments of 52%.

Table 5. ARDL long and short-run results

Variables	Long-run			Short-run		
	Coefficient	t-Statistic	p-value	Coefficient	t-Statistic	p-value
LGDP	1.274***	2.183	0.006	0.963***	2.049	0.003
LNRR	0.194**	1.176	0.019	0.137**	1.303	0.013
LTG	0.531***	1.369	0.004	0.391**	1.112	0.007
LFD	-0.213*	-1.986	0.058	-0.179*	-1.481	0.051
C	15.667	3.404	0.122	-	-	-
ECT (-1)	-	-	-	-0.516***	-3.104	0.000
R2	0.8766					
Adjusted R2	0.8690					

The significance levels depicted by *, **, and *** are 1%, 5%, and 10% respectively.

3.5 Diagnostic inspection

According to Table 6, the results of diagnostic tests indicate that the present study's model is free of heteroscedasticity, non-normality, misspecification, and serial correlation. Figure 2 also depicts the plots of the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) stability tests, which are within the 5% significance threshold, showing the stability of the model. This research concludes, based on the diagnostic evaluations conducted, that the ARDL approach's predictions can be used to formulate solid and reliable policy initiatives.

Table 6. The results of diagnostic tests

Diagnostic tests	Coefficient	p-value	Decision
Jarque-Bera test	0.490357	0.7826	Residuals are normally distributed
Breusch-Godfrey LM test	1.728002	0.1086	No serial correlation exits
Breusch-Pagan-Godfrey test	1.309529	0.2925	No heteroscedasticity exists
Ramsey RESET test	1.099658	0.2820	The model is properly specified

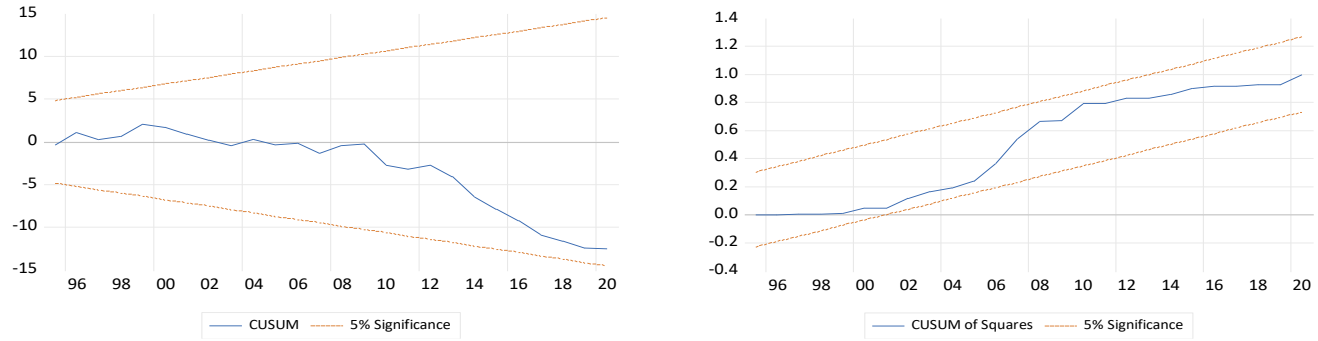

Figure 2. The plots of CUSUM and CUSUMQ tests

3.6 Robustness check

With the use of the FMOLS, DOLS, and CCR tests, the ARDL framework's conclusions were also evaluated over the long term. Table 7 depicts the anticipated outcomes of utilizing FMOLS, DOLS, and CCR. The consistency and dependability of the FMOLS, DOLS, and CCR outcomes have been demonstrated. In the long run, this causes them to generate the same findings as the ARDL simulations. Specifically, the data revealed that growth in GDP, natural resource rents, and trade globalization leads to an increase in CO_2 emissions, whereas an increase in financial development reduces CO_2 emissions. As a result, judgments based on the findings can be made with an element of certainty.

Table 7. Robustness results

Variables	FMOLS		DOLS		CCR	
	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
LGDP	1.319***	2.282	1.295***	2.176	1.310***	2.136
LNRR	0.194**	0.186	0.192**	0.277	0.193**	0.184
LTG	0.512***	1.642	0.520**	1.631	0.546***	1.554
LFD	-0.213*	-1.186	0.204*	-1.197	0.254**	-1.098
C	16.562	3.067	14.281	3.163	17.001	3.906
R2	0.8767		0.8769		0.8755	
Adjusted R2	0.8660		0.8662		0.8645	

The significance levels depicted by *, **, and *** are 1%, 5%, and 10% respectively.

Discussion

The present analysis demonstrated that an increase in Uruguay's economic growth corresponds to a rise in the nation's CO_2 emissions. Long-term and short-term patterns show that Uruguay tends to accept and enjoy higher economic advantages at the expense of environmental quality. This outcome can be anticipated on the basis of the fact that the majority of emerging economies, including Uruguay, have enjoyed significant economic expansion over the course of the past decade while also rising their levels of CO_2 emission. An overreliance on fossil fuels to fulfill the requirements of the business and residential sectors is a primary contributor to increased CO_2 emissions (Voumik et al., 2022b). The implications of Uruguay's severe environmental repercussions of economic expansion are demonstrated to be proven under these conditions. The conclusions of this study are consistent with the findings of Begum et al. (2020), Raihan et al. (2023a), Raihan and Tuspekova (2022a), Raihan and Voumik (2022b), Voumik et al. 2022a), and Raihan et al. (2023b) who all came to the conclusion that there is a link between a nation's GDP and the amount of carbon dioxide that it emits in a number of countries all over the world.

In addition, policies pertaining to natural resources serve as an essential foundation for the administration, consumption, and preservation of those resources. In light of the issues posed by climate change and the depletion of natural resources across the nation, this study highlighted the impact that natural resource rents have on CO_2 emissions. As a result, the findings of this study can serve as a foundation for the establishment of natural resources and environmental management guidelines. The results of the present study demonstrate that natural resource rents harm the quality of the environment in Uruguay, as CO_2 emission levels increase. This result is consistent with the earlier observation that the majority of the revenue from the natural resource is redirected toward further production paths or exploitations of natural resources, which may lead to future environmental degradation. This is the case because this result shows that the majority of the revenue is from natural resources. This result is consistent with the findings of Adebayo et al. (2022), Awosusi et al. (2022), Caglar et al. (2022), and Liu et al. (2022), which state that the renting out of natural resources has a negative impact on the environment.

This study indicates a positive association between the globalization of trade and carbon emissions. According to the findings of this study, the globalization of trade policies will have a detrimental impact on the natural environment of Uruguay. It is now abundantly clear that the expansion of global trade is one of the primary factors that contribute to the deterioration of the environment. This conclusion is bolstered by the fact that Uruguay is largely dependent on fossil fuels, which means that the country retains its competitive edge in the manufacturing of items that are characterized by high levels of pollution by making use of fossil fuels. Therefore, Uruguay's determination to gradually integrate its economy could improve and encourage the growth of polluting industries, causing the country to become a net exporter of these goods and contributing to the rise in carbon emissions in major sectors such as agriculture, manufacturing, and energy. Consequently, this could have an adverse effect on the environment. The findings of the current research are in agreement with the findings of Murshed et al. (2022), who found that the globalization of trade is detrimental to the health of the ecosystem. However, Ahmed and Le (2021)'s study gave an alternative opinion by demonstrating that trade globalization reduces CO_2 emissions. As a direct result of the findings, a new dialogue regarding the development of policy is being begun from the point of view of emerging nations.

In addition, the results of this study demonstrated that financial development in Uruguay has a negative impact on the deterioration of the environment. Because developing countries like Uruguay have a financial sector that is not yet fully developed, money that is borrowed for investments is often intended to be used in polluting businesses without the risk of paying penalties in accordance with environmental protection regulations. It is highly improbable that the additional financial resources will be required to be invested in environmentally friendly industrial activities given that developing nations in the Latin American region rely considerably on the importation of fossil fuels. This study's outcome is supported by Adebayo et al. (2021) who reported that financial development does not significantly alter CO_2 emission. On the contrary, recent research that was carried out by Raihan and Voumik (2022a) discovered a positive correlation between financial development and CO_2 emissions.

4. CONCLUSION

This study investigates how Uruguay's CO_2 emissions have changed as a result of economic growth, increases in the value of natural resource rents, the expansion of global trade, and the growth of the financial sector. The years 1990 through 2020 are included in the scope of this study. In this particular piece of work, the ARDL cointegration approach was applied in order to evaluate the long-term correlations between the various factors. It was revealed that economic growth, natural resource rents, and trade globalization each had a positive and significantly favorable effect on Uruguay's CO_2 emissions both in the short run and in the long term. This was true for both the short term and the long term. In addition, the results of this study demonstrated that the economic expansion of Uruguay has a negligible impact on the country's CO_2 emissions. In this study, the dependability of the ARDL outcomes was investigated through the use of FMOLS, DOLS, and CCR techniques. In light of the findings, the research concluded with suggestions for public policy toward environmental sustainability.

In light of the fact that economic growth has an effect on CO_2 emissions, the government needs to link its current plans for economic growth with environmentally friendly measures in order to guarantee that Uruguay's future economic growth will not put the country's existing high environmental standards at risk. This highlights how important it is for Uruguay to go through a transition to a more sustainable energy system, one in which the country's energy needs are satisfied by renewable energy sources. The second finding from this body of research is that the profits made from natural resource rents are bad for the ecology. As a consequence of this finding, the government needs to take measures to prevent the

excessive use of natural resources. This objective can be attained by strengthening and refining the natural resource tax legislation that is currently in place. In addition, concepts of green taxation that are both environmentally beneficial and sustainable should be developed in order to encourage green investment.

In addition, because the globalization of trade has a negative effect on the environment, it is recommended that policies oriented toward international trade be reevaluated and that export limits on goods that produce a lot of pollution be tightened. A project of this nature would prevent the expansion of industries that cause pollution while simultaneously stimulating the expansion of industries that produce less pollution. As a direct result of this, carbon emissions from the agricultural, industrial, and manufacturing sectors can be significantly cut. The empirical findings suggest that overall financial development has a minimal impact on CO_2 emissions, as the conclusion of this paragraph indicates. In light of this, Uruguay ought to make the necessary investments to ensure that the financial sector achieves its environmental sustainability aim. As a result, efforts must be concentrated on the implementation of green financing solutions, which will ensure that necessary support will be provided for green investment activities. In a similar vein, our research argues that the government of Uruguay should raise funds to assist programs aimed at reducing global warming; hence, climate financing is essential to improving the environmental repercussions that are related to financial development.

Despite the fact that the study would have made a significant contribution to the body of environmental literature, particularly in Uruguay, it was not published. In the meanwhile, there are other shortcomings associated with this study. These deficiencies are the direct outcome of the study's inadequate utilization of parameters. In subsequent research, it may be possible to study the effect that additional parameters have on a variety of environmental measures. In addition, the Environmental Kuznets curve or the Stochastic Impacts by Regression on Population, Prosperity, and Technology should be utilized in further research in order to study this relationship. In light of the dearth of data sets at researchers' disposal, it would be advantageous for future studies to find ways to circumvent these constraints. In subsequent research, a non-linear method might be utilized to find out how the components under investigation have an influence.

AUTHOR'S CONTRIBUTIONS

All authors discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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