The impact of Foreign Direct Investment (FDI) and Trade Openness (TR) on Environmental Quality: The Case of Brazil

تأثير الاستثمار الأجنبي المباشر (FDI) والانفتاح التجاري (TR) على جودة البيئة: حالة البرازيل

لميس العربي

مدرس – الجامعة المصرية الصينية

Lamees.elaraby@ecu.edu.eg

زينب محمد نوار

مدرس – الجامعة البريطانية

Zeinab.nawar@bue.edu.eg

Abstract:

This paper investigates the effect of Foreign Direct Investment (FDI) and the Trade Openness on the environment quality in Brazil for the period from 1990 to 2020. Using a time series analysis, which begins with investigating the stationarity of the variables, and with the use of ARDL co-integration methodology, in addition to estimating the short-run and the long-run elasticity. The main findings of the paper show that all variables have a significant positive impact except the energy usage at 1% level of significance on the CO2 emissions in Brazil, i.e., higher Foreign Direct Investment (FDI) and Trade Openness (TR) will result in more carbon emissions into the atmosphere (more air pollution) and hence lower environmental quality.

المستخلص:

تبحث هذه الورقة في تأثير الاستثمار الأجنبي المباشر (FDI) والانفتاح التجاري على جودة البيئة في البرازيل للفترة من 1990 إلى 2020. باستخدام تحليل السلاسل الزمنية ، والذي يبدأ بالتحقيق في ثبات المتغيرات ، واستخدام منهجية التكامل المشترك ARDL ، بالإضافة إلى تقدير مرونة المدى القصير والمدى الطويل. تظهر النتائج الرئيسية للورقة أن جميع المتغيرات لها تأثير إيجابي كبير باستثناء استخدام الطاقة عند مستوى 1٪ من الأهمية على انبعاثات ثاني أكسيد الكربون في البرازيل ، أي أن زيادة الاستثمار الأجنبي المباشر (FDI) والانفتاح التجاري (TR) سيؤدي إلى المزيد من انبعاثات الكربون في الغلاف الجوي (المزيد من تلوث الهواء) وبالتالي انخفاض جودة البيئة.

1. Introduction

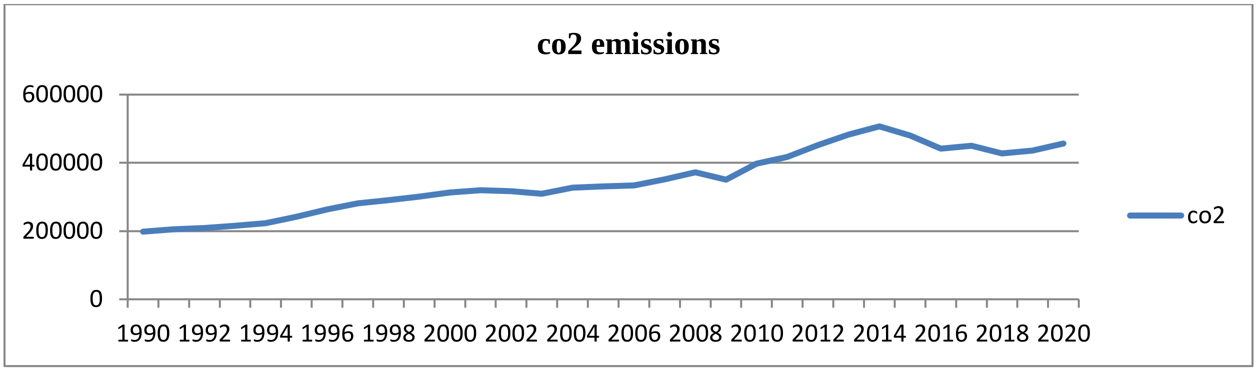
All over the past decades, attracting foreign direct investment form developed to developing countries, and adopting trade liberalization policies, where trade openness allows developing countries to import from developed countries, both have a significant positive impact on economic growth which significantly showed positive results quantitatively by creating a huge pressure on the environment. (Aydin 2020)

According to The United Nations Framework Convention on Climate Change—Paris Agreement 2015 countries agreed to reduce carbon dioxide emissions (CO2) and other greenhouse gases (GHG) to achieve sustainable development, and to adapt to the impacts of climate change, they agreed to enhance efforts to keep the temperature level not to exceed 1.5◦C. (Mendonça,2020)

As one of the progressive developing countries in the Latin America countries, Brazil, is considered one of the world's largest countries with special social and political traits, its continental size and massive population imply a high level of social, economic, and environmental complexity (World Bank, 2018). In comparison to the emissions from the world's major economies, Brazil's GHG emissions per capita are considered quite low. As of 2003, there had been a significant drop in LULUCF (Land Use, Land Use Change, and Forestry) emissions in Brazil, owing primarily to the reduction in deforestation. In addition to government efforts in the field of environmental conservation, going back to 1981 with the passage of the National Environmental Policy Act, and to 2021, when general guidelines for payments for environmental services were established, and the creation of the Federal Payment Program for Environmental Services (PFPSA). Also, by 2021, the Brazilian government launched the Green Growth Program which is a federal government project aimed at becoming carbon neutral by 2050 and generating employment and income while taking into account regional disparities in Brazil. In addition, the government has set some goals for the coming years to emphasize its interest in environmental issues including: 1- The target for 2025 remained the same as presented in 2015, which is to reduce greenhouse gas emissions by 37% compared to the year 2005. 2- The country aims to become carbon neutral by 2050 (SECRETARIAT FOR INTERNATIONAL ECONOMIC AFFAIRS, 2021).

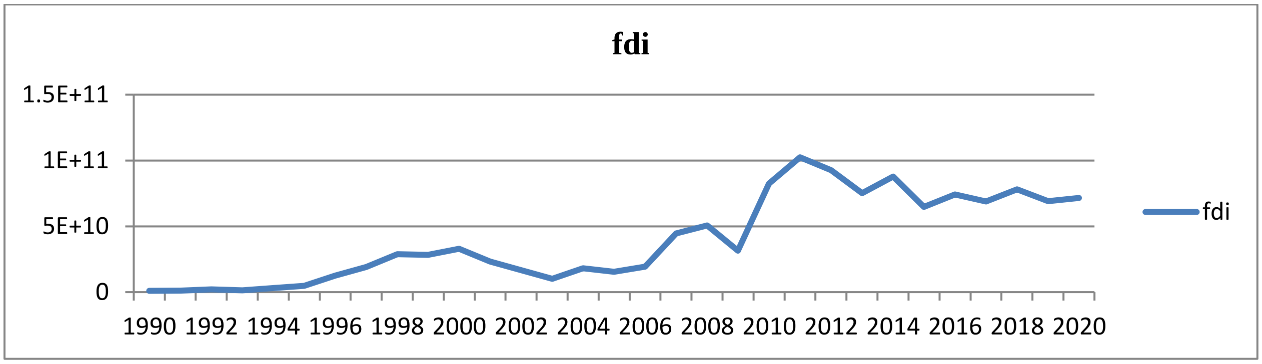
Despite all of these actions, Brazil still suffers from environmental degradation and high CO2 emissions, and this is had been shown clearly in the graphs below, where there is an increasing trend in the CO2 emissions from years 1990 to 2020 along with the increasing trend of FDI and Trade Openness.

Figure (1) : CO2 emissions in Brazil from 1990 to 2020 from World Bank Database



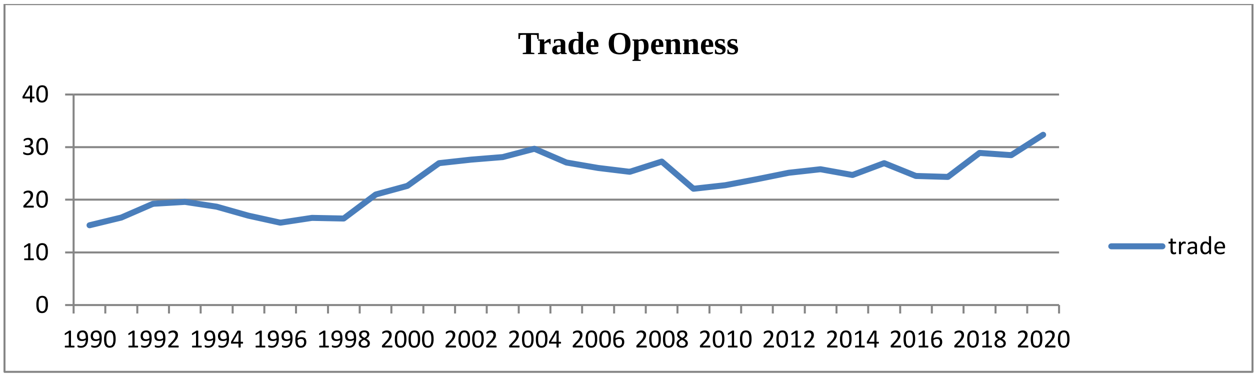
(World Bank Database)

Figure (2) : FDI in Brazil from 1990 to 2020 from World Bank Database



(World Bank Database)

Figure (3) : Trade Openness in Brazil from 1990 to 2020 from World Bank Database



(World Bank Database)

The main objective of this paper is to examine the impact of FDI and TR on the environmental quality in Brazil, the paper studies these effects through the use of the (ARDL) Model, as the rest of the paper is organized as follows. Section 2 presents the literature review, whereas Section 3 presents the data, econometric specification, and methodology, Section 4 is about the empirical results, and the final section is about the conclusion.

2. Literature Review:

Several studies had determined and investigated **the effect of FDI and trade openness on CO2 emissions**, (Omri et al, 2014) aimed to examine the causality between CO2 emissions, foreign direct investment, and economic growth for a global panel of 54 countries during the period from 1990 to 2011. The results indicated that there is bidirectional causality between FDI inflows and economic growth for all the panels and between FDI and CO2 for all the panels, except Europe and North Asia, as well as there is a unidirectional causality running from CO2 emissions to economic growth, except the Middle East, North Africa, and sub-Sahara panel.

(Kostakis et al, 2017) by using a variety of models (ARDL, FMOLS, and OLS) for the period from 1970 to 2010, the study aimed to measure the effect of foreign direct investment (FDI) inflows on environmental quality, measured by CO2 emissions in both Brazil and Singapore. The study found that the foreign direct investment FDI inflows led to environmental degradation in the case of Brazil but it was not the case for Singapore.

(Kilicarslan & Dumrul, 2017) examined the environmental impact of foreign direct investment (FDI) on carbon dioxide (CO2) emissions for the period from 1974 to 2013. The results of the paper indicated that foreign direct investment positively affects carbon dioxide emissions in the long run.

(Gunarto, 2020) analyzed the relationship between carbon dioxide gas emission, economic development, energy consumption, and FDI in Asian states for the period (1970 – 2014). The results showed that there is a direct relationship between energy consumption and carbon dioxide gas emission, while there is no existence of a significant relationship between FDI and gas emission of carbon dioxide.

On the same stance (Hdom & Fuinhas, 2020) and for the variables: the electricity production (hydro, natural gas, and renewables), trade opening, GDP, and CO2 emissions in Brazil, it was found that electricity generation, GDP and trade liberalization had a positive effect on Brazil's economy, while GDP, hydropower, and renewables have negative effect on the CO2 emissions.

(Hongxing et al, 2021) aimed to address the impact of foreign aid, CO2 emissions, trade openness, and energy consumption on economic growth in Africa. According to the findings of this study, foreign aid, energy consumption, trade openness, and CO2 emissions are all positively correlated with economic growth.

Moreover, (Singh, 2021) examined the relationship among CO2 emissions, economic growth, Foreign Direct Investment (FDI), Gross Value Added (GVA) of different sectors namely agriculture, service, manufacturing, and resource extensive industries including construction sectors in four European regions for the period (2000 -2018). The results of the paper showed that the causality among variables CO2 emission, economic growth, FDI, and all four sectors GVA is varied according to the regions.

In the same context, it is worth mentioning that some papers focused on investigating the effect of foreign direct investment (FDI) on CO2 emissions in developing countries as (Acharyya, 2009) and for the period from 1980 to 2003, as the paper found the long-run growth impact of FDI inflows on CO2 emissions that proved to be in the paper quite large.

As for the effect of environmental laws on foreign direct investment (FDI) flows, (Ali et al, 2017) analyzed the effect of lax environmental laws on foreign direct investment (FDI) inflows to developing countries using multiple regression data during the period from 1982 to 2013. The hypothesis of the paper is that the Lax environmental laws in developing countries may attract polluting FDI that usually escapes from stringent environmental laws in other countries and it was rejected for only four countries which are Mexico, India, China, and Brazil.

(Mahmood et al 2019) **examined the impact of trade openness on CO2 emissions** in Tunisia during the years from 1971 to 2014 using the integration analysis. The effect of increased and decreased trade openness on CO2 emissions are determined to be positive and insignificant, respectively.

In addition, (Ali et al, 2020) aimed to determine the impact of trade openness, FDI, and institutional performance on environmental quality in the OIC (Organization of Islamic Cooperation) countries. The results of the paper showed that trade openness, FDI, and urbanization have a positive and significant relationship with the ecological footprint.

Also, (Hou et al, 2021) aimed to investigate the relationship between the actual use of Foreign Direct Investment FDI and carbon emissions in China during the period (1997 – 2018), using Regression analysis to address the effect of Foreign Direct Investment FDI on carbon emissions in China on the national level and the regional levels. The result indicated that FDI will play a positive role in China's overall carbon emissions.

(Khan et al, 2021) examined the effect of trade openness, renewable energy consumption, and foreign direct investment on carbon emission in the world developing and developed countries. The result showed that trade openness has been found to have a decreasing effect on carbon emission in developed countries while degrading the quality of the environment in developing countries, whereas renewable energy consumption improves environmental quality in both samples. FDI increases emissions in developed countries while decreasing carbon emissions in developing countries.

(Chen et al,2021) investigates the impact of trade openness on carbon dioxide (CO2) emissions using panel data from 64 countries along the Belt and Road from 2001–2019. The empirical results indicate that the improvement in trade openness has a significantly positive effect on CO2 emissions, and it also shows that the impact varies with different levels of CO2 emissions.

3. ECONOMETRIC SPECIFICATION AND METHODOLOGY

To investigate the impact of FDI, Trade openness, Gross capital formation, and energy use on CO2 emissions, Time series analysis was used. In this model, we find that the time series is a function of its autoregressive values and the current values of the explanatory variables and lags by one period or more. ARDL model can be applied regardless of whether the variables under study are integrated at zero I (0) or order one I (1) or integrated of different degrees, i.e. it can be applied when the order of integration is unknown or not uniform for all variables, but it must also be mentioned that it cannot be applied if there is one of the variables integrated at order two

3.1 Data:

For the data source, this study used annual time series data for the period from 1990 to 2020. The data for CO2, FDI, TR, GCF, and EU were collected from World Development Indicators Database (WDI) (2022).

The variables of the study are: CO2 emissions (a measurement of environmental quality), FDI net inflows in current US dollars, Gross Capital Formation (Formerly gross domestic investment, consists of outlays on additions to fixed assets of the economy plus net changes in the level of inventories), Energy use (which refers to primary energy before transformation to other use fuels), and Trade openness (trade as a percentage of GDP).

3.2 Methodology:

For the empirical analysis, the variables were assessed for stationarity using the traditional Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests after reporting the descriptive analysis and the correlation matrix. To avoid inaccurate results, the Distributed Autoregressive Distributed Lag (ARDL) bounds are only allowed if the tested variables are stationary at level or after taking the first difference, but not if the variables are stationary after taking the second difference. Next, for checking co-integration the study used the ARDL co-integration, commonly known as the bounds test, proposed by Pesaran et al. (2001) to verify the presence of long-run interactions in the model. Under the null hypothesis of no co-integration, the Bounds test is mostly dependent on the common F statistic, whose asymptotic distribution is non-standard. If the calculated value of F is greater than upper bounds, then in this case the null hypothesis is rejected and the alternative hypothesis is accepted, meaning that there is a co-integration, and then the long-term equation must be estimated. On the contrary, if the computed F is less than the lower bounds, then the null hypothesis is accepted, meaning that there is no co-integration, that is, there is no relationship in the long term. If the calculated value of F falls between upper and lower bonds, then the result is inconclusive.

The following is unrestricted error correction model (UECM) form of the ARDL model, which includes both short and long-run dynamics:

$$DCO2_t = \delta_0 + \delta_0 CO2_{t-1} + \delta_1 FDI_{t-2} + \delta_2 TR_{t-1} + \delta_3 GCF_{t-1} + \delta_4 EU_{t-1} + \sum_{i=1}^{p} \beta_i DCO2_{t-i} + \sum_{i=0}^{q} \alpha_i DFDI_{t-i} + \sum_{i=0}^{r} \beta_i DTR_{t-i} + \sum_{i=0}^{s} \beta_i DGCF_{t-i} + \sum_{i=0}^{t} \beta_i DEU_{t-i} + U_t$$

Where D represents the operator of first-difference and U_t indicates the white-noise residual term, which has to be serially uncorrelated, and the model has to be stable. The model mentioned above can be considered as an ARDL model of order (p q r s t). In addition to estimating short and long run elasticity, this study used a vector autoregressive (VAR) model to perform Toda and Yamamoto's (1995) Granger non-causality test to verify the direction of causality between the variables: Co2 emissions, Foreign Direct Investment (FDI), Trade Openness (TR), Gross Capital Formation (GCF), and Energy Use (EU). Additional inputs for policy suggestions will come from the knowledge on the direction of causation between the variables in the models. Based on the authors' views, this approach is valid whether the variable is I (0), I (1), or I (2), non-co-integrated, or co-integrated in any arbitrary order. The ideal lag for each model is calculated via VAR lag order selection based on AIC before the test is executed. The lag length used in the Ganger causality test is quite important. If the chosen lag length is smaller than the genuine lag length, the exclusion of important lags can result in biased conclusions, whereas if the chosen lag length is greater than the true lag length, the presence of irrelevant lags in the equation can result in inefficient estimations.

3.3 Empirical Results and Discussion

Before going to the estimation results, the descriptive statistics and the correlation matrix for the variables under study are summarized in table (1) and table (2). First, table (1) represents that the mean values of the CO2 emissions is 345158.4, respectively. Looking at the min. and max. Values of CO2 and the explanatory variables, the GCF has the lowest value among the variables with 1.49E+11 while the CO2 has the largest value with 506780.0. Regarding standard deviation values, most of them reflect little variance except for CO2, which indicates that the study model is now more robust and stable, and inconsistencies and variability in the data returns are no longer a problem. Second, Table (2) shows the correlation coefficients among the variables under study, the outcomes indicate that all the variables are positively correlated with each other.

Table (1) Descriptive Statistics

Variable	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**
FDI	31	3.97E+10	3.24E+10	9.89E+08	1.02E+11
TR	31	23.43470	4.709889	15.15560	32.35430
CO2	31	345158.4	91969.62	198260.0	506780.0
EU	31	1234.462	237.8994	935.7465	1674.226
GCF	31	2.46E+11	6.77E+10	1.49E+11	3.81E+11

Note: Obs denotes Observation, Std. Dev. is standard deviation, min and max are minimum and maximum respectively.

Table (2) Correlation Matrix

	FDI	**TR**	**EU**	**GCF**	**CO2**
FDI	1				

TR	0.497048	1			
EU	0.887238	0.660843	1		
GCF	0.932205	0.495107	0.821361	1	
CO2	0.916079	0.684871	0.941566	0.915080	1

Next, Table (3) represents the results of the unit root tests for all the variables in the study, which illustrates that most of the variables are stationary after the first difference so some of them are integrated at the level and at order one, which suggests the possibility of using the ARDL estimation technique.

Table (3) Results of unit root tests

Variables	**Test**	**Level (0)**		**First Difference (1)**	
		Constant	**Constant &trend**	**Constant**	**Constant &trend**
FDI	**ADF**	-2.434220	-1.288845	-6.030487***	-5.928795***
	PP	-2.457914	-1.288845	-6.039780***	-5.937289***
TR	**ADF**	-1.230776	-1.944736	-5.293941***	-5.167819***
	PP	-2.133944	-1.314490	*-5.318629***	-5.198181**
GCF	**ADF**	-1.474003	-4.056329**	-3.524950**	-3.516420*
	PP	-1.446665	-1.646227	-3.509848**	-3.541868*
CO2	**ADF**	**-1.073806	-4.650097*	-4.317968***	-4.291444**

	PP	-1.081318	-1.980994	-4.310483***	-4.283395**
EU	**ADF**	1.930989	-1.446952	-7.304578***	-8.242342 ***
	PP	1.872933	-1.808481	-7.061970***	-8.091476 ***

Note: ***, ** and * denotes 1%, 5% and 10% significant level.

Table (4) reports the result of the ARDL bounds test for checking the presence of co-integration between the variables of the study. The maximum lag of (3) was used in each model as represented by the Akaike Information Criterion (AIC). The critical values are given under the number of variables, k = 4. The F-statistic (7.217) is greater than the corresponding upper I (1) critical values in the table for k=4, and this makes the model significant at 1 percent level, thus, confirms the presence of the long run association among the variables.

Table (4) Results of bounds test for co-integration :

F-Statistics	7.217***	
Maximum Lag	3	
Lag Order	(1,3,3,0,0)	
K	4	
Critical value	I(0)	I(1)
1%	3.29	4.37
5%	2.56	3.49
10%	2.2	3.09

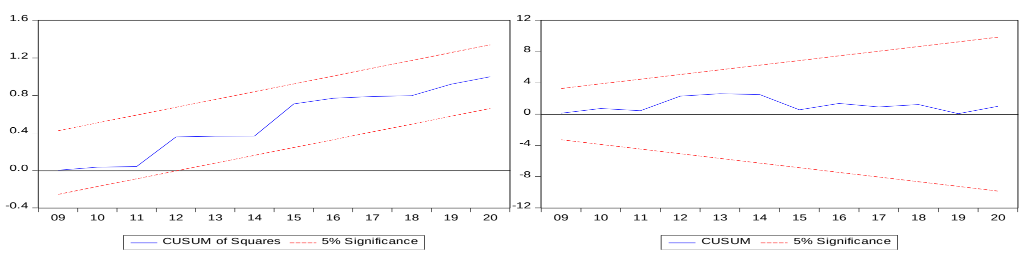
1-The critical values are based on Narayan (2004), case III: unrestricted intercept and no trend. 2-k is a number of variables. 3-***, ** and * denotes 1%, 5% and 10% significant level. 4- k =4 for the model.

Table (5) Diagnostic Check :

Serial Corr.	Normality	Heteroscedasticity
0.42 (0.66)	0.89 (0.63)	0.75 (0.67)

The results from Table (5) validate that this model doesn't suffer from any diagnostic problem, and this indicates that the long-term estimation of this model is reliable. The model represents no heteroscedasticity effects and no evidence of serial correlation in the residual terms. Also, the Jarque-Bera normality test suggests that the residual terms are normally distributed and this model is correctly specified. Furthermore, the results of the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of square of recursive residuals (CUSUMSQ) based on Figure (4) showing that the model is stable.

Figure (4) - Stability Test :



Source: constructed by authors

Table (6) below presents the results of the long-run estimation. The outcomes show that all variables have a significant positive impact except the energy usage at 1%

level of significance on the CO_2 in the country. Higher Foreign Direct Investment (FDI) and Trade Openness (TR) will result in more carbon emissions into the atmosphere (more air pollution) and hence lower environmental quality.

Table (6) long-Run Estimation

Variables	Coeff.
TR	3882.308***
FDI	1.91E-06***
EU	-47.49481
GCF	2.62E-07
C	156441.9***

Note: ***, ** and * denotes 1%, 5% and 10% significant level.

In this section, we explore the results of the short-run estimation as can be showed in Table (7) Here, we will just look at the short-term effects of FDI and TR. The results indicate a mix of signs for the variables at various lags. The result illustrates that both FDI and TR have significantly affected the environmental quality. The negative and significant value of the error correction term confirmed the estimations of long run elasticity (ECT). The speed of adjustment for each model is represented by ECT, and a negative number indicates that the variables in the model will converge with time. This suggests that in the current year, approximately 70 percent of the disequilibria from the previous year's shock of those models converge back to the long term equilibrium. Next, the R-squared values show that almost 99 % of the independent variables are able to explain the corresponding dependent variables (CO_2).

As for the Granger causality test, which is to test the presence of causality between variables in each model, the optimum lag detected for the model is 4. The results of Granger causality test are summarized in table (8). The outcomes show that there are two bi-directional causality relationships detected between the variables under study, which are: (1) EU and FDI, and EU and TR. Moreover, the following one-way directional causality is also found: CO2 causes TR and EU, FDI causes CO2 and GCF, TR causes FDI, GCF doesn't cause any variables except EU.

Table (7) Short Run Estimation Restricted Error Correction Model :

Variables	Coeff.
$CO2_{t-1}$	0.296060**
TR_t	2732.912***
FDI_t	4.36E-07*
FDI_{t-1}	1.22E-08
FDI_{t-2}	1.07E-07
FDI_{t-3}	7.87E-07***
EU_t	174.5667
EU_{t-1}	113.6564
EU_{t-2}	71.08158
EU_{t-3}	-392.7382**
GCF_t	1.84E-07
C	110125.7**

ECT	-0.703940***
R-Sq	0.99
Adj.R-Sq	0.98

Note: ***, ** and * denotes 1%, 5% and 10% significant level.

Table (8) Granger Causality test

Independent Variable					
Brazil	CO2	FDI	TR	GCF	EU
CO2	-	4.056285	8.627327*	2.521500	11.18640**
FDI	8.980657*	-	3.693717	8.433027*	11.55220**
TR	4.846755	14.13337***	-	7.123088	32.52764***
GCF	1.609191	4.466487	6.095338	-	8.076032***
EU	7.445910	25.98532***	8.643572*	9.027646	-

Note: ***, ** and * denotes 1%, 5% and 10% significant level.

4. Main findings and conclusion:

The model was conducted to investigate mainly, the effect of FDI and TR on the environment quality along with using the variables the gross capital formation and the energy use. The regression results for Brazil had shown the positive effect of FDI and TR on Co2 emissions. The long run estimate came with the result showing that all variables have a significant positive impact except the energy usage at a 1% level of significance on the CO2 in the country.

Higher Foreign Direct Investment (FDI) and Trade Openness (TR) will result in more carbon emissions into the atmosphere (more air pollution) and hence lower environmental quality. An increase in TR, for example, will lead to greater economic activities, and as these activities inherently entail environmental costs, they worsen the environmental quality. This result is similar to the recent findings on an environmental quality model for Malaysia conducted by Ridzuan et al. (2017).

5- Recommendations:

Many developing countries are already taking action that is significantly reducing their CO2 emissions growth, especially Brazil which is considered a global climate leader that approached the United Nations climate conference in Glasgow, with commitments to create cut carbon emissions and curb deforestation.

Brazil has a success story of reduction of CO2 Emissions from the energy sector to fell by 5% last year when compared to the previous year as renewable power continues to increase its share in the energy mix. Brazil also has a success story to be followed in effective anti-deforestation policies, including the National Forest Code, the Action Plan for Deforestation Prevention and Control in the Legal Amazon, were implemented and resulted in a reduction on LULUCF emissions of about 86% between 2005 and 2012.

In Brazil, Renewable energy is expected to represent 47% of the energy mix in 2027 and 48% in 2029 according to the 2020-2029 energy plan, this high renewable share in Brazil is enabled by the large shares of hydro in power generation and bioenergy in transport. However, still a lot of arguments to Question whether the policies for attraction of Foreign Direct Investment (FDI) and the Trade Openness (TR) in Brazil are considered environmentally friendly or environmentally costly. Analyzing CO2 emissions is becoming a more complex challenge, as the study results' showed a positive correlation between the FDI, TR and CO2 emissions. The results arguably show that the energy-saving policies are ineffective in reducing the CO2 emissions in Brazil, and these results challenge the actions of the Brazilian government in putting the reduction of CO2 emissions policies into action.

The future plans of Brazil concerning intensifying the use of renewable energy and the (2020-2029) energy plan may lead to better environmental preservation, but the access to cleaner technologies/practices, which is especially relevant for industrial activities, or a well-developed transport infrastructure is a must for all the business activities. More focus should be directed to energy intensity and technological advancements specifically concerning the FDIs and Trade Openness.

References:

Aydin M, Turan YE. The influence of financial openness, trade openness, and energy intensity on ecological footprint: revisiting the environmental Kuznets curve hypothesis for BRICS countries. Environmental Science and Pollution Research. 2020; 27(34):43233–45. https://doi.org/10.1007/s11356-020- 10238-9 PMID: 32734540

World Bank . (2018).A Agenda da Produtividade Emprego e Crescimento (Portuguese). Washington, D.C.

SECRETARIAT FOR INTERNATIONAL ECONOMIC AFFAIRS. (2021). BRAZIL'S GREEN MONITOR. Brazil

Ali, E. H., Raouf, E., & Fahmy, S. A. (2017). The Green Economy Policies and Foreign Direct Investment “A Comparative study”. حلوان .المجلة العلمية للبحوث والدراسات التجارية, 31(1), 533-549.

Ali, S., Yusop, Z., Kaliappan, S. R., & Chin, L. (2020). Dynamic common correlated effects of trade openness, FDI, and institutional performance on environmental quality: evidence from OIC countries. Environmental Science and Pollution Research, 27(11), 11671-11682

Kostakis, I., Lolos, S., & Sardianou, E. (2017). Foreign direct investment and environmental degradation: further evidence from Brazil and Singapore. Journal of Environmental Management & Tourism, 8(1 (17)), 45.

He, F., Chang, K. C., Li, M., Li, X., & Li, F. (2020). Bootstrap ARDL test on the relationship among trade, FDI, and CO2 emissions: based on the experience of BRICS countries. Sustainability, 12(3), 1060; https://doi.org/10.3390/su12031060

Acharyya, J. (2009). FDI, growth and the environment: Evidence from India on CO2 emission during the last two decades. Journal of economic development, 34(1), 43-58.

Gunarto, T. (2020). Effect of economic growth and foreign direct investment on carbon emission in the Asian states. International Journal of Energy Economics and Policy, 10(5), 563- 569

Kılıçarslan, Z., & Dumrul, Y. (2017). Foreign direct investments and CO2 emissions relationship: the case of Turkey. Business and Economics Research Journal, 8(4), 647-660.

Hongxing, Y., Abban, O. J., & Dankyi Boadi, A. (2021). Foreign aid and economic growth: Do energy consumption, trade openness, and CO2 emissions matter? DSUR heterogeneous evidence from Africa’s trading blocs. PloS one, 16(6). 0253457. https://doi.org/10.1371/journal.pone.0253457

Omri, A., Nguyen, D. K., & Rault, C. (2014). Causal interactions between CO2 emissions, FDI, and economic growth: Evidence from dynamic simultaneous-equation models. Economic Modelling, 42, 382-389.

Muthusamy, A., & Rani, P. J.(2019) FDI, GDP, and CO2 Emission: ARDL Bound Cointegration Relationship Examination. International Journal of Recent Technology and Engineering (IJRTE), 8(2), 132-138.

Hou, F., Su, H., Li, Y., Qian, W., Xiao, J., & Guo, S. (2021). The Impact of Foreign Direct Investment on China's Carbon Emissions. Sustainability, 13(21), 11911. https://doi.org/10.3390/su132111911

Singh, D. (2021). The Linkage between CO2, FDI, Economic Growth and Value-Added: A European Perspective. 17099910.https://doi.org/21203/rs.3.170999/v1

Li, F., Chang, T., Wang, M. C., & Zhou, J. (2022). The relationship between health expenditure, CO2 emissions, and economic growth in the BRICS countries—based on the Fourier ARDL model. Environmental Science and Pollution Research, 29, 10908–10927.

Hdom, H. A., & Fuinhas, J. A. (2020). Energy production and trade openness: Assessing economic growth, CO2 emissions and the applicability of the cointegration analysis. Energy Strategy Reviews, 30. 100488. https://doi.org/10.1016/j.esr.2020.100488

Khan, H., Weili, L., Khan, I., & Khamphengxay, S. (2021). Renewable energy consumption, trade openness, and environmental degradation: a panel data analysis of developing and developed countries. Mathematical Problems in Engineering. 6691046. https://doi.org/10.1155/2021/6691046.

Mahmood, H., Maalel, N., & Zarrad, O. (2019). Trade Openness and CO2 Emissions: Evidence from Tunisia. Sustainability, 11(12), 3295. https://doi.org/10.3390/su11123295

Chen F, Jiang G, Kitila GM. Trade Openness and CO2 Emissions: The Heterogeneous and Mediating Effects for the Belt and Road Countries. Sustainability. 2021; 13(4):1958. https://doi.org/10.3390/su13041958