

The Impact of Economic Growth, Foreign Direct Investment, Urbanization and Trade Openness on CO₂ Emissions in Sri Lanka

R.M.M. Mayoshi

Faculty of Economics Sciences and Business Administration
Transilvania University of Brasov
Romania

Universitatii Street, No. 1, Building A, 500068 Brasov, Romania
rathnayaka.mayoshi@unitbv.ro

Abstract

Climate change in Sri Lanka is a big issue in recent years and CO₂ emission is continuously rising in Sri Lanka. The main objective of the study is to examine the impact of economic growth, foreign direct investment, urbanization and trade openness on CO₂ emissions in Sri Lanka during the period 1978-2019. To accomplish the objective, applied Autoregressive Distributed Lag (ARDL) model to determine the long-run and short-run effects. CO₂ emission is used as the dependent variable. Foreign direct investment, per capita GDP, trade openness and urbanization variables, which act as the independent variables in the model. The results indicate that GDP per capita, urbanization and trade openness could lead to increased environmental emissions in the long-run. However, GDP per capita could lead to decreased environmental emissions in the short-run. In order to prevent the increase of CO₂ emissions caused by economic growth, urbanization and trade openness, the level of CO₂ emissions should be considered when making policies to improve economic growth, and urbanization. Moreover, the government should design the trade reforms and policies to be accompanied by strong environmental policies in the long-run.

Key words:- Economic Growth, Foreign Direct Investment, Urbanization, Trade Openness, CO₂ Emission.

1. INTRODUCTION

CO₂ emission is one of the main factors of human induced climate change and increase global warming. The level of CO₂ in the earth has been on the increase since the industrial revolution (Ayoade, 2003). We should attempt to cut down on our personal CO₂ emission because climate change in Sri Lanka is a big issue in recent years. According to the Global Climate Risk Index 2019, Sri Lanka has been ranked the second most affected country by extreme weather events in the past 20 years (Eckstein et al., 2019, p. 6).

According to the definition of the World Development Indicator (2020), “Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement and it includes carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring”. Figure 1 represents the per capita CO₂ emissions in Sri Lanka has been showing an increasing trend since 1990s. The value for CO₂ emissions (metric tons per capita) in Sri Lanka was 1.31 as of 2019. According to the World Development Indicator Database (2020), over the past 41 years, this indicator reached a maximum value of 1.31 in 2019 and a minimum value of 0.2036 in 1989.

Figure 2 represents the annual share of global CO₂ emission,

which is measured as each country's emissions divided by the sum of all countries' emissions in a given year plus international aviation and shipping (known as 'bunkers') and 'statistical differences 'in carbon accounts. Sri Lanka produces less than 0.1 percent of the world's carbon dioxide emissions. However, the level of CO₂ emission in the country is continuously rising in Sri Lanka in recent years.

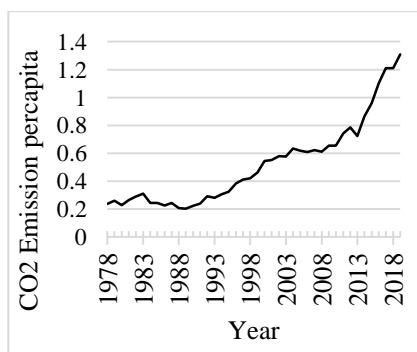


Figure 1: Carbon Dioxide Emissions Per Capita in Sri Lanka (1978-2019).

Source: World Bank, World Development Indicator in Sri Lanka. (2020).

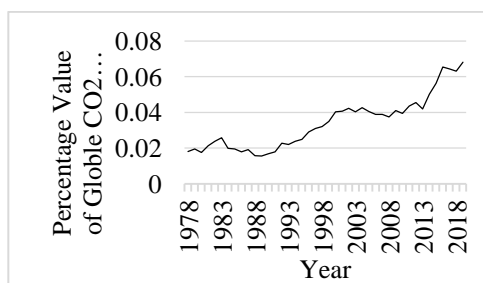


Figure 2: Annual Share of Global CO₂ Emission in Sri Lanka.

Source:

<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>

The majority of studies have analyzed economic growth and energy consumption as the two most important variables related to environmental degradation (Osobajo et al., 2020; Mizra and Kanwal, 2017; Kasman and Dunman, 2015; Dritsaki and Dritsaki, 2014 etc.). However, economic growth and energy consumption alone may not be enough to explain CO₂ emissions (Ozturk et al., 2010). Therefore, it is very important to consider other macroeconomic variables such as foreign direct investment, urbanization and trade openness on CO₂ emissions.

“Foreign direct investment (FDI) inflows play a strong impetus for economic development and growth and it is considered as one of the major drivers of globalization” (Rathnayaka Mudiyansele et al., 2021). The foreign direct investment is very important for both developed and developing countries and believe that FDI can positively affect their economies. According to the World Development Indicator in Sri Lanka (2020), the net inflows of FDI in Sri Lanka increased from 1.47 million US dollars in 1978 to 758 million US dollars in 2019. Data on FDI inflows have increased steadily from 2015 to 2018. However, it decreased in 2019 in line with the changing global economic situation and the political environment. Theoretically, the effect of FDI on the CO₂ could have two possible effects. The effect could be negative, in the sense that

increased FDI inflows could lead to increased environmental emissions and increased FDI inflows could lead to decreased environmental emissions (Demena and Afesorgbor, 2020; Seker et al., 2015; Kim, 2020).

(“Kuznets curve”, 2021), there exists a U-shaped relationship between the level of CO₂ emissions and economic growth, according to the Environmental Kuznets Curve (EKC) hypothesis, which was introduced by Kuznets (1950s and 1960s). The EKC hypothesis indicates that growing per capita GDP leads to increasing CO₂ emissions and when reaching a high enough per capita GDP at the certain turning point, CO₂ emissions start to decrease. The effect of economic growth on the CO₂ could have two possible effects. The effect could be negative, in the sense that increased GDP per capita could lead to increased environmental emissions and increased GDP per capita could lead to decreased environmental emissions. The higher level of income increases demands for more energy or promotes industries, which effect environmental pollution. On the other hand, environmental quality may improve if higher income leads to adoption of environmentally friendly production techniques and consumption of clean and green energy (Aye and Edoja, 2017).

Urbanization is one of the major changes taking place worldwide. There is a significant difference in

urban population change between the more developed countries and the less developed countries. Many studies have indicated that urbanization as the one of important variable related to environmental degradation (Gasimli et al., 2019; Sharma, 2011; Cole and Neumayer, 2004 and Shahbaz et al., 2014). According to the theories of ecological modernization, urbanization can have positive as well as negative impact on the environment (Sadorsky, 2014). An increase in urban population causes a high level of CO₂ emission. On the other hand, it does not increase CO₂ emission. The impact of urbanization on the environment differs with the level of development (Poumanyvong and Kaneko, 2010). Considering the trend of urban population growth in Sri Lanka, the data reveal that Sri Lanka has a slow tempo of urbanization. There was an increase in urban population growth, reaching the 18.585 percent in 2019 (World Development Indicator, 2020).

The relationship of trade openness and CO₂ emission has been examined in many studies. Several studies have found the mixed results. Some researchers argue that trade openness is harmful for environmental quality; while some researchers found trade openness is good for environmental quality. Some others have found even no relationship between trade openness and CO₂ emission. Trade openness towards greenhouse gas emission is considered as an

important issue within the context of human induced climate change (Naranpanawa, 2011). Trade openness could increase production and income; it affects the emissions (Fotros and Maaboudi, 2011). However, the virtue of trade theories indicated that, there are no clear relationships between environmental quality and trade openness (Fotros and Maaboudi, 2011 as cited in Copeland and Taylor, 2005).

There are some studies that are conducted in Sri Lanka to examine the impact of trade, and urbanization on environmental degradation (Gasimli et al., 2019), the impact of liberalization on CO₂ emission (Kariyawasam and Sumanaratne, 2020), the relationship between trade openness and carbon emissions (Narampanawa, 2011). There is not study that examines the impact of economic growth, foreign direct investment, urbanization and trade openness on CO₂ emission together in Sri Lanka uses recent data and sophisticated econometric technique. Thus, this study tries to bridge this gap. Considering the trend of CO₂ emission, foreign direct investment, economic growth, urban population growth, and trade openness in Sri Lanka, it is very important to examine the impact of these factors on CO₂ emission in Sri Lanka. In the study, seek to answer the following question; namely, are there any impact on economic growth, foreign direct investment,

urbanization and trade openness on CO₂ emission in Sri Lanka during the period 1978-2019?

The objective of this study is to examine the impact of economic growth, foreign direct investment, urbanization and trade openness on CO₂ emission in Sri Lanka. The main hypotheses are developed as follows;

H_A = Economic Growth has an impact on CO₂ emission

H_B = Foreign direct investment has an impact on CO₂ emission

H_C = Urbanization has an impact on CO₂ emission

H_D = Trade openness has an impact on CO₂ emission

The paper is organized as follows: In the first part, introduction, research questions and objectives of the study. In the second part, a review of the literature field gives empirical evidence of earlier studies. Next, the research methodology is used data and sources, model specification and estimation techniques are covered. Further describes the results of the study and some concluding remarks are made in final section.

2. LITERATURE REVIEW

2.1 Country Specific Analysis

Gasimli et al., (2019) examined the nexus between energy, trade, urbanization and environmental degradation in Sri Lanka from 1978 to 2014 using ARDL bound testing method. In this study, carbon emission (metric tons) per capita is used as a proxy for environmental degradation, energy

consumption is proxied by energy consumption per capita (kg of oil equivalent per capita), income level is proxied by real GDP per capita and trade openness is measured as the ratio of the exports plus imports to GDP. The urban population is used as a proxy for urbanization. The long-run results indicated that there is a U-shaped relationship existing between CO₂ emission and income in the long-run. Trade openness, energy consumption positively contributed to carbon emissions. Urbanization in Sri Lanka is very interesting, as urbanization was significant with a negative sign implying that urbanization does not aggravate environmental degradation throughout the years.

Narampanawa (2011) has examined the relationship between trade openness and carbon emissions in the case of Sri Lanka using Autoregressive Distributed Lag (ARDL) bounds testing approach and the Johansen-Juselius maximum likelihood approach over the period 1960 to 2006. The results suggested neither a long run equilibrium relationship, nor a long term causality exists between trade openness and carbon emissions in Sri Lanka. However, the results indicated that there is a short run relationship between trade openness and carbon emissions.

Kariyawasam and Sumanaratne (2020) have examined the impact

of liberalization on CO₂ emission in Sri Lanka from 1977-2011 using ARDL model. The variables, which are Gross Domestic Product (GDP), Trade Openness (total trade as a % of GDP), Per capita Carbon Dioxide (CO₂) emission and per capita energy consumption used in the model. The long-run results indicated that all variables have positive and statistically significant impact on CO₂ emissions.

Kazilkaya (2017) has examined the relationship between carbon dioxide emissions, economic growth, foreign direct investment and energy consumption in Turkey over the period of 1970-2014 using ARDL bound testing method. Turkey is considered as a developed country. The results indicated that economic growth and energy consumption have positive and statistically significant impacts on CO₂ emissions in the long-run and short-run. However, there is not any significant relationship between foreign direct investment and CO₂ emissions in the long-run and short-run. He suggested some policy recommendations that produce and implement more effective and more efficient policies in the context of sustainable development in Turkey.

To examine the long and short-run linkages between economic growth, energy consumption and CO₂ emission in Tunisian (Chebbi and Boujelbene, 2008) conducted

a study using VECM technique over the period 1971-2004. The results indicated that there is a positive linkage between output and energy use and CO₂ emission and energy consumption are positively related in the long-run. The results of the short run, economic growth positively affects the growth of energy consumption.

Kim (2020) has examined the effects of foreign direct investment, economic growth, industrial structure, renewable and nuclear energy, and urbanization on Korean greenhouse gas emission from 1981 to 2014 using ARDL bound test. The dependent variable is CO₂ emissions per capita, which is a proxy for greenhouse gas emissions. Independent variables are the net inflows of FDI, the share of renewable and nuclear energy in primary energy supply as a proxy for renewable and nuclear energy, the urban population in the total population as a proxy for urbanization and the share of manufacturing in GDP as a proxy for industrial structure in the model. The results indicated that economic growth, FDI and urbanization increase of greenhouse gas emissions, while manufacturing industry share, renewable energy and nuclear energy contributed to the reduction of GHG emissions in the long-run. In the short run results indicated that economic growth increases in GHG emissions, while renewable and nuclear energy have contributed to the

reduction in GHG emissions. FDI and urbanization did not play a role in increasing HG emissions in the short term.

Seker et al., (2015) have examined the impact of foreign direct investment, gross domestic product. The square of GDP and energy consumption on carbon dioxide emissions in Turkey over the period 1974-2010 using the autoregressive distributed lag model. The long-run results indicated that the effect of FDI on CO₂ emissions is positive, while the effects of the GDP and energy consumption on CO₂ emissions are positive and statistically significant. In the short-run, the results are found to be similar to those of the long-run model. Granger causality test causality test results indicated the existence of a causality running from all explanatory variables to CO₂ emissions in the long run. They suggested that Turkey should promote energy efficiency with sustainable growth, and encourage more FDI inflows particularly in technology-intensive and environment-friendly industries to improve environmental quality.

2.2 Cross-country Analysis

A large number of studies have been conducted on the relationship among foreign direct investment, economic growth, urbanization and trade openness on carbon emission in developed and developing countries as cross-country analysis. Baek et al.

(2009) have examined the dynamic relationship among trade, income and environmental quality using cointegration analysis for a sample of developed and developing countries. The results suggest that trade and income growth increase environmental quality in developed countries and the reverse is evident in most developing countries.

Shaari et al., (2014) investigated the effect of foreign direct investment and economic growth on CO₂ emission in 15 developing countries for the period of 1992 to 2012 applying Johansen cointegration test. The results indicated that increase in FDI does not have any impact on CO₂ emission in developing countries. However, in the developing countries, an increase in economic growth contributes to increase CO₂ emission.

Parikh and Shukla (1995) examined the impact of urbanization on energy use and toxic emissions using a data set of 83 developed and developing countries for the year 1986. According to the results, urbanization has a positive and significant impact on CO₂ emissions.

Martínez-Zarzoso and Maruotti (2011) analyzed the impact of urbanization on CO₂ emissions in developing countries from 1975 to 2003 using the dynamic panel data framework. The results indicated different patterns for three groups

of countries. For the first and third group of countries the elasticity emission-urbanization is positive for low and negative for high urbanization levels. In the second group, urbanization is not statistically significant. Huynh and Hoang (2019) have studied the impact of FDI on air pollution in a sample of 19 developing countries of Asia for the time period of 2002 to 2015. The results indicated that the inflow of FDI in initial stage increases air pollution in developing countries.

Bernard and Mandal (2016) have conducted a study on the trade environment relationship in 60 developing and emerging countries for the period of 2002 to 2012. The study employed fixed effect and GMM model and found that trade openness improves environmental quality and GMM model indicated that population and income have negative impact on environmental quality. Anwar et al., (2020) examined the relationship among CO₂ emissions, economic growth, urbanization and trade openness for a panel of nine Far East Asian countries from 1980 to 2017, using a fixed effect approach. The results indicated that an increase in GDP, urbanization and trade openness have positive impact on CO₂ emission. They suggested encouraging green and sustainable urbanization, strategically regulating and improving industrial structure and sharing of

renewable energy in total energy consumption to reduce CO₂ emission.

Liobikiene and Butkus (2019) have examined the impact of GDP, FDI, trade, urbanization, industrialization, energy efficiency, and renewable energy consumption on environmental degradation. This study was conducted using panel data of 147 countries between 1990 and 2012 and system GMM estimator. Greenhouse gas emission was the dependent variable of the model. The GDP variable has a positive and significant impact on greenhouse gas emission and urbanization and FDI variables have not a statistically significant impact on greenhouse gas emission. Fan et al., (2006) examined the impact of population, affluence and technology on the total CO₂ emissions of countries at different income levels over the period 1975–2000. The results indicated that there is a negative relationship between urbanization and CO₂ emissions and economic growth has the greatest impact on CO₂ emissions. Sharma (2011) has examined the determinants of carbon dioxide emission for a global panel consisting of 69 countries. The results indicated that urbanization does have a negative and statistically significant impact on carbon emissions for the global panel. Furthermore, it reveals that urbanization has a negative, but an insignificant impact on carbon emissions in the low income,

middle income and high-income panels. GDP per capita has a positive impact on CO₂ emission in the low income and middle-income panels.

3. METHODOLOGY

3.1 The Co-integration Analysis (ARDL)

To investigate the impact of economic growth, foreign direct investment, urbanization and trade openness on CO₂ emission in Sri Lanka, we adopted the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran et al., (2001). The data are of mixed type of I (0) and I (1). This requirement fulfills employing the ARDL model to identify the long-run and the short-run relationship between variables.

3.2 Data and Sources

The data used in the empirical analysis was mainly secondary data available in the World Development Indicators. Data on the GDP per capita, foreign direct investment inflows, urbanization and trade openness on CO₂ emission from the year 1978 to 2019 were collected for the study purpose. The study is used only 41 period of data. The justification for the important variables used in this study is based on reviewing the existing theoretical and empirical studies.

Table 1: Details of the Variables

Variable, Description	Measure	Source
(CO₂) Carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.	Logarithm of CO ₂ emissions (Metric tons per capita)	Gasimli et al.,(2019), Kariyawasam and Sumanaratne (2020), Kim (2020), Anwar et al., (2020)
(LFDI) This is a measure of inward direct investment/inflows made by foreigners' in the host country.	Logarithm of foreign direct investment, net inflows (BOP, current US\$)	Huynh and Hoang (2019), To et al., (2019)
(LGDPP) GDP per capita is gross domestic product divided by midyear population.	Logarithm of GDP per capita (Current US\$)	Gasimli et al., (2019), Sharma (2011), Kazilkaya (2017), Anwar et al., (2020), To et al., (2019)
(URBAN) Urban population refers to people living in urban areas.	Urban population growth (Annual %)	Kim (2020), Anwar et al., (2020)

(TR) Trade Openness	(Summation of import and export and divided it by gross domestic product* 100)	Gasimli et al., (2019), Narampana wa (2011), Kariyawasana and Sumanaratne (2020)
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Source: Created by the author cited in World Bank, World Development Indicators. (2020).

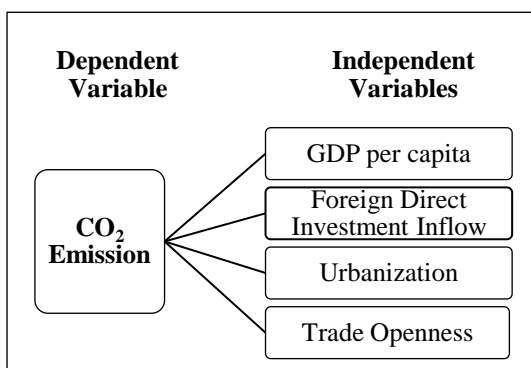


Figure 3: Conceptual Framework

Source: Created by the author

3.3 Model Specification

This study adopted the Anwar et al., (2020) theoretical framework to examine the impact of economic growth, urbanization and trade openness on CO₂ emission. Furthermore, to examine the foreign direct investment on CO₂ emission modified the model adding foreign direct investment inflow variable in the model. The model could be specified as follows:

$$CO_2 = f(FDI, GDPP, URBAN, TR) \quad (1)$$

Where, (CO₂) CO₂ emissions, (FDI) Foreign direct investment inflows, (GDPP) GDP per capita, (URBAN) is a proxy for urbanization and Trade openness (TR). We converted the variables of per capita CO₂ emissions, foreign direct investment inflows and GDP per capita into their natural logarithmic forms, as the natural logarithms of all variables smooth out the entire data used for analysis.

In an econometric form, equation (1) can be stated as:

$$LCO_{2t} = \beta_0 + \beta_1 LFDI_t + \beta_2 LGDPP_t + \beta_3 URBAN_t + \beta_4 TR_t + \varepsilon_t \quad (2)$$

The ARDL model and the error correction specification are given in Equation (3)

$$\begin{aligned} \Delta \text{LCO}_2 t &= \beta_0 + \beta_1 \text{LCO}_2 t-1 \\ &+ \beta_2 \Delta \text{LFDI}_{t-1} + \beta_3 \Delta \text{LGDP}_{t-1} \\ &+ \beta_4 \Delta \text{URBAN}_{t-1} + \beta_5 \Delta \text{TR}_t \\ &+ \sum_{i=1}^n \gamma_{1i} \Delta \text{LCO}_2 t-i \\ &+ \sum_{i=0}^n \gamma_{2i} \Delta \text{LFDI}_{t-i} \\ &+ \sum_{i=0}^n \gamma_{3i} \Delta \text{LGDP}_{t-i} \\ &+ \sum_{i=0}^n \gamma_{4i} \Delta \text{URBAN}_{t-i} \\ &+ \sum_{i=0}^n \gamma_{5i} \Delta \text{TR}_{t-i} + e_t \quad (3) \end{aligned}$$

Where, Δ denotes the first difference operator, β_0 is the drift component, e_t is the usual white noise error term, ($\beta_2 \rightarrow \beta_5$) correspond to the long-run relationship, the remaining expressions with the summation sign ($\gamma_{1i} \rightarrow \gamma_{5i}$) represent the short-run dynamic of the model. In the next step of the estimation procedure, we obtain the short run dynamics of parameters and long run adjustment of the model by estimating the error correction version of ARDL model pertaining to the variables in the equation (4) is as follows:

$$\begin{aligned} \Delta \text{LCO}_2 t = &\alpha_0 + \sum_{i=1}^n \alpha_{1i} \Delta \text{LCO}_2 t-i + \\ &\sum_{i=0}^n \alpha_{2i} \Delta \text{LFDI}_{t-i} + \\ &\sum_{i=0}^n \alpha_{3i} \Delta \text{LGDP}_{t-i} + \\ &\sum_{i=0}^n \alpha_{4i} \Delta \text{URBAN}_{t-i} + \\ &\sum_{i=0}^n \alpha_{5i} \Delta \text{TR}_{t-i} + \\ &\gamma \text{ETC}_{t-1} + \mu_t \quad (4) \end{aligned}$$

where, γ is speed of adjustment coefficient, μ_t is pure random error term.

3.4 Estimation Techniques

In order to make the model and variables free from problems associated with time series data employed Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root test approaches to test stationary of the variables. The second step of the estimation bound testing procedure is employed in order to investigate the existence of a long-run relationship the bound tests approach developed by Pesaran et al. (2001). If the calculated F-statistics is greater than the appropriate upper bound critical values, the null hypothesis is rejected implying co-integration. After establishing the evidence of the existence of the co-integration between variables, the lag orders of the variables are chosen by using the appropriate Schwarz Info Criteria. In the next step of the estimation procedure, we obtain the short run dynamics of parameters and long run adjustment of the model by estimating the error correction version of ARDL model pertaining to the variables in the equation (4). Moreover, Diagnostic tests were conducted to check whether the results are robust.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistic

Descriptive statistics shows the basic characteristics of the data set. The descriptive statistics table highlighted the main features of the examined data set such as mean and median values, maximum and minimum values and values of standard deviation, etc. According to the results of descriptive statistics, all the variables have positive mean values. The estimated values of skewness show that LFDI and TR variables are negatively skewed while on the other hand LCO₂, LGDPP and URBAN variables are positively skewed.

Table 2: Descriptive Statistic

	LCO ₂	LFDI	LGDP P	URBAN	TR
Mean	0.81	18.92	6.84	1.05	67.4
Median	0.81	19.03	6.73	1.00	68.4
Maximum	0.27	21.20	8.31	2.36	88.6
Minimum	-1.59	14.20	5.24	0.05	46.4
Std. Dev.	0.56	1.47	0.94	0.52	12.1
Skewness	0.25	-0.66	0.26	0.78	-0.24
Kurtosis	1.84	3.64	1.83	3.35	1.81
Jarque-Bera	2.79	3.76	2.87	4.46	2.91
P- Value	0.25	0.15	0.24	0.11	0.23
Sum	-33.96	794.46	287.34	43.92	2831
Sum Sq. Dev.	12.90	88.39	36.41	11.14	6029

Source: Author’s computation using E-views 11

4.2 Unit Root Test

The Augmented Dickey-Fuller (ADF) test and Phillips Perron (PP) test were used for testing the stationarity of the data (See below Table 3). The results indicated that the null hypothesis of series contain a unit root cannot be rejected at levels for all variables except LFDI in ADF and PP unit root approaches. The results of the Unit Root Test confirmed that LFDI variable is stationary at the first differences, This reveals that LFDI is integrated in order zero I(0) while all other series, namely LCO₂, LGDPP, URBAN and TR variables are integrated in order one I(1). It means the data are of mixed type of I (0) and I (1). This requirement fulfills employing the ARDL model to identify the long-run and the short-run relationship between variables.

Table 3: Unit Root Test Results

Augmented Dickey-Fuller (ADF) Unit Root Test

Variable	Level		1 st Difference		I(0)
					I(I)
LCO₂	-1.9	-3.5	-7.0	-3.5	I
LFDI	-7.5	-3.5	-6.3	-3.5	0
LGDPP	-1.7	-3.5	-4.5	-3.5	I
URBAN	-1.8	-3.5	-5.9	-3.5	I
TR	-1.5	-3.5	-5.7	-3.5	I

Note: t- Stat values are given in the table (Trend & Intercept)

Source: Author’s computation using E-views 11

Phillips-Perron (PP) Unit Root Test

Variable	Level		1 st Difference		I(0)
					I(1)
LCO₂	-1.9	-3.5	-7.0	-3.5	I
LFDI	-7.5	-3.5	-19	-3.5	0
LGDPP	-1.9	-3.5	-4.8	-3.5	I
URBAN	-1.8	-3.5	-5.9	-3.5	I
TR	-1.7	-3.5	-5.7	-3.5	I

Note: t- Stat values are given in the table (Trend & Intercept)

Source: author’s computation using E-views 11

4.3 Bound Test Approach to Co-integration Test

The results of the ARDL bound test are presented in table 3 below. The F-statistics in the entire model (6.2882) is higher than upper critical values at 1%, 2.5%, 5% and 10% level of significance. Therefore, the null hypothesis of absence of co-integration is rejected, which implies that there is a long-run relationship among the dependent variables and the explanatory variables in the models.

Table 4: Bound Test Approach to Co-integration

Sample: 1978-2019		
Included observations: 41		
Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	K
F-statistic	6.2882S	4
Significance	I(0)	I(1)
10%	2.2	3.09
5%	2.56	3.49
2.5%	2.88	3.87
1%	3.29	4.37

Source: Author’s Computation Using E-views 11

4.4 Long-run Coefficient Estimates

Table 5: ARDL Long-run Form

Variable	Coefficient	Prob.
LFDI	-0.1539	0.3492
LGDPP	1.1508	0.0006*
URBAN	0.2051	0.0891***
TR	0.0261	0.0025*
C	-7.5475	0.0000*
R²	0.9865	
F-statistics	252.3103	

Source: Author’s Computation Using E-views 11

Note: Probability values are given in the Table. *, **, and *** imply the rejection of the null hypothesis at 1%, 5% and 10%, level of significance respectively.

The regression results indicate, R squared value is 0.9865. This means that 98.65 percent of total variations in CO₂ emission Sri Lanka is explained by changes in economic growth, foreign direct investment, urbanization and trade openness. The F-statistic of with a p value is 252.3103 of 0.000 at 1 percent significance level reveals that all the independent variables were jointly significant in predicting CO₂ emission in Sri Lanka.

Table 5 reveals that long term coefficients. LGDPP, and TR variables are statistically significant at the 1% significance level. URBAN variable is statistically significant at the 10% significance level. LFDI with a coefficient of 0.1539 has negative impact on CO₂ emissions for the period of 1978-2019 in Sri Lanka. However, LFDI variable is insignificant. It indicated that, LFDI variable can not significantly explain the variation in LCO₂ throughout the years. Theoretically, the effect of FDI on the CO₂ could have two possible effects. The effect could be negative, in the sense that increased FDI inflows could lead to increased environmental emissions and increased FDI inflows could lead to decreased environmental emissions (Demena

& Afesorbor, 2020; Seker et al., 2015 and Kim, 2020). Some researchers found that insignificant relationship between foreign direct investment and CO₂ emissions (Kazilkaya, 2017).

LGDPP with a coefficient of 1.1508 has a positive and statistically significant impact on CO₂ emissions in the long-run. This result is in line with these empirical studies (Kazilkaya, 2017; Kim, 2020; Sekeret al., 2015; Chebbi & Boujelbene, 2008; Fan et al. 2006, Kariyawasam and Sumanaratne, 2020 and Sharma 2011). URBAN with a coefficient of 0.2051 has a positive and statistically significant impact on CO₂ emissions in the long-run. This result is in line with these empirical studies (Kim, 2020; Martínez-Zarzoso and Maruotti, 2011). TR has positive and statistically significant impacts on CO₂ emissions in the long-run. In the sense that increased trade openness could lead to increased environmental emissions in the long-run (Kariyawasam and Sumanaratne, 2020).

4.5 Short-run Coefficient Estimates and Error Correction Representation

Table 6: ARDL Short-run Form

Variable	Coefficient	Prob.
LFDI	0.0243	0.1593
LGDPP	-0.2350	0.0668***
URBAN	-0.0714	0.1970
TR	0.0026	0.2731
ETC(-1)*	-0.2725	0.0000*

Source: Author’s Computation Using E-views 11

Note: Probability values are given in the Table. *, **, and *** imply the rejection of the null hypothesis at 1%, 5% and 10%, level of significance respectively.

Table 6 reveals that short-run coefficients. LGDPP variable is statistically significant at the 10% significance level. LGDPP variable has a negative impact on CO₂ emissions in short-run. It indicated that increased LGDPP could lead to decreased CO₂ emissions in the short-run.

The error correct term (ECT(-1)) coefficient is significant at 1% significance level with the negative sign which is between 0 and -1, implying that the model can converge back to long-term equilibrium quickly after a short-term shock. The value of -0.2725 indicates that the disequilibria from this period’s shock can be adjusted in the next period about 27.25%.

4.6 Diagnostic Tests

The model is free from serial correlation and heteroscedasticity. Moreover, the functional form is correct and stochastic residuals are normally distributed. The estimated model satisfies all indispensable diagnostic tests.

Table 8: The Results of the Diagnostic Test

Items	Test Applied	P Value
Serial correlation	Breusch-Godfrey Serial Correlation LM Test	0.2658
Normality	Normality Test (Jargu- Bera)	0.7174
Heteroscedasticity	Breusch-Pagan-Godfrey	0.4636
Functional Form	Ramsey’s reset test	0.1891

Source: Author’s Computation Using E-views 11

4.8. The Results of Stability Test

The graphs of the CUSUM and CUSUM of squares test confirms that the model is stable since the residual plot lies between the lower and upper critical bounds at the 5% level of significance. That is, the selected model has stable parameters, which can be used for long-term forecasts.

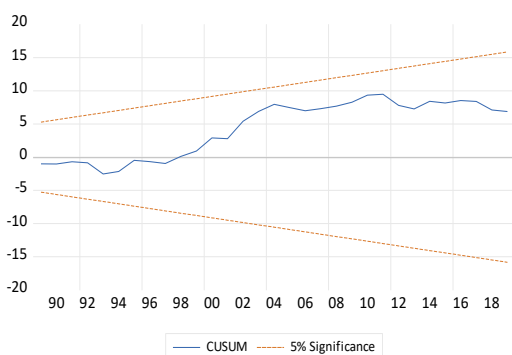


Figure 4: CUSUM Stability Test

Source: Author’s Computation Using E-views 11

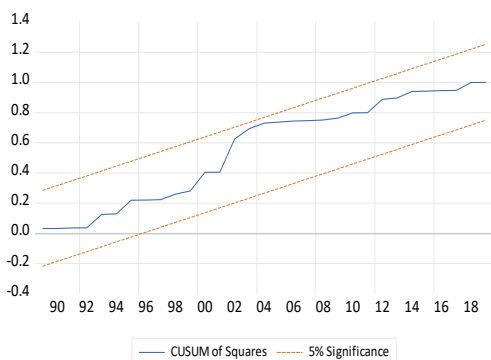


Figure 5: CUSUM of Squares Stability Test

Source: Author’s Computation Using E-views 11

5. CONCLUSION

This study analyzed the impact of foreign direct investment, per capita GDP, urban population growth is a proxy for urbanization and trade openness on CO₂ emission in Sri Lanka over the period 1978-2019. The

econometric methodology used in this paper is the Autoregressive distributed lag model. According to ARDL bounds test, the long-run equilibrium among the variables is confirmed. Then, the long-run and short-run coefficients were estimated using ARDL error correction model.

In the long run, the foreign direct investment can not significantly explain the variation in carbon dioxide emission throughout the years. However, the results indicated that increased economic growth, urbanization and trade openness could lead to increased environmental emissions in the long-run. However, GDP per capita could lead to decreased environmental emissions in the short-run. In order to prevent the increase of CO₂ emissions caused by economic growth, urbanization and trade openness, the level of CO₂ emissions should be considered when making policies to improve economic growth, and urbanization. Sri Lanka should design more green and sustainable urbanization and promote renewable energy consumption in urban area. Moreover, the results suggest the importance of trade reforms and policies to be accompanied by strong environmental policies in the long-run.

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