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FINANCIAL DEVELOPMENT AND ENVIRONMENTAL QUALITY: EVIDENCE FROM SRI LANKAN PERSPECTIVE.

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Abstract

The effect of financial development on CO2 emissions has not been fully addressed in existing literature and CO2 emissions are connected to environmental challenges, posing a significant barrier to sustainable development. This unsolved issue is common in both developed and developing countries. As a developing country perspective, this study attempts to determine the impact of financial development on environmental quality in Sri Lanka, employing time series data covering the period of 1990-2021. The Autoregressive Distributed Lag Model (ARDL) is manipulated for the empirical investigation. The financial development is assessed through the financial market and institutional development. Alongside this, environmental quality is captured through CO2 emissions. Further, economic growth, energy consumption, and trade openness are employed as control variables in the model. The findings reveal that financial market development and energy consumption contribute to reduced environmental quality in Sri Lanka. Further, results show that economic growth can improve the environmental quality in the country. The outcomes of the study recommend that the policies should be implemented to minimize the ecological concerns of market-based financial development and energy consumption. In contrast, economic growth policies must be balanced and strengthened to maintain the environmental quality in the country.

keywords: Autoregressive distributed Lag Model, CO2 emissions, Environmental Quality, Financial Development, Sri Lanka.

INTRODUCTION

Global warming is a most popular phenomenon in the current world, which refers to the rise of average temperature on the planet's surface gradually over the years. It impacts every situation in human lives such as harsh weather conditions, an increase in sea level, a rise in forest fires, shortages in the supply of foods, etc. (Cramer et al, 2018). When considering the past few centuries, there has been enough evidence of climate change, which cannot be described by only natural reasons (Shehzad et al, 2022). Further, this might have dangerous consequences on biodiversity, human life, and the environment (Georgatzi et al, 2020). This is primarily driven by the emission of greenhouse gases resulting from human actions, especially from the manufacturing and utilization of goods and services (Sekali & Bouzahzah, 2019). Significant volumes of GHG especially, CO2, CH4, and fluorinated gases, are discharged throughout these activities. The most prevalent of these gases is CO2, which is consumed by fossil energies and is the primary contributor to CO2 emission (Kraft & Kraft, 1978; Lee & chang, 2008).

Crucially, the world has witnessed unprecedented growth through the emergence of large economies and trying to adopt better living standards for its population (Sekali & Bouzahzah, 2019). Similarly, this would drive to raise the utilization of polluting energies through the manufacturing of goods and services. Hence, this engages with the impacts of environmental quality and especially this concern is serious in most of the under-developing countries and for the developed countries. Several economists state that the expansion of manufacturing activities benefits EQ at a level of economic development. This situation was initially proven using the EKC by Grossman and Krueger in 1995. The EKC hypothesis states that environmental pollution rises with economic development, which is called the scale effect but after a specific point, the composition effect guides to establish the solutions for environmental degradation such as adopting 3R, promoting sustainable energies, adopting environmentally friendly practices in the industries, etc.

However, the implementation of environmentally friendly practices in the industries will help to reduce CO2 emissions (Grossman & Krueger, 1995). With these practices in industries while reducing emissions and without lowering production levels, economies must need to execute energy transition strategies that replace utilization of the massive primary energies with renewable energies. At this point, it is reasonable to discuss financial development which performs a significant task in the association between economic growth, CO2 emission, and the environment. Initially, FD emphasizes conquering “costs” experienced in the financial system (World Bank, 2016). FD arises where the financial markets, tools, and mediators minimize the effect of information, supervision, and transaction expenses (World Bank, 2016).

However, FD can affect the environment in different ways. For example, it promotes investment opportunities in a country that, ultimately demands energy and ecological distress (Baloch et al, 2021). As such, the modern world calls for an economic structure with an effective and workable financial sector capable of dealing with environmental destruction (Ampomah & Adu, 2022). 0782485142

To shape the well-being of our planet and its inhabitants FD and EQ are mostly important. Generally, FD supports EG and it can influence the EQ of every economy. Thus, Sri Lanka has no exception in this situation. As a developing nation, Sri Lanka is still heavily reliance on non-renewable energies rather than renewable energies. According to the Global Carbon Budget 2022, the annual CO2 emission is 17.33 million tons on average and 0.8 tons contributed by each person in Sri Lanka. Further, the share of global CO2 emissions was 0.05% in 2022. The Health and Environment scorecard report of the World Health Organization (WHO) states that Sri Lanka's air pollution increased up to 17ug/m3 annually in 2022 which the WHO's guideline annual value is 5ug/m3 (ug/m3= micrograms per cubic meter air). Further, the United Nations Development Programme Climate Promise reports state that the global share of GHG emissions in Sri Lanka is 0.08%, which gets 124 on the climate Vulnerability index ranking. Moreover, Sri Lanka expected to minimize GHG emissions by 14.5% and expand its forest areas by 32% in 2030, considering its low carbon footprint and extremely vulnerable status. Additionally, by 2030, the island state aimed to generate 70% of its electrical power from renewable sources.

According to the International Monetary Fund database, the FD indicator in 2021 is 0.26 in Sri Lanka. From 1980 to 2021, it indicates FD between 0.1 to 0.29. In 2022, the financial system persevered through the worst financial crisis since the country's independence. However, to overcome these problems the Central Bank of Sri Lanka (CBSL) has implemented roadmaps to achieve financial sustainability in Sri Lanka. For example, the CBSL launched the Green Finance Taxonomy and green bond framework in March 2022. When considering the above data both EQ and FD pose a problematic situation in Sri Lanka. Thus, the current study will mainly attempt to distinguish the impact of FD on EQ in Sri Lanka, and to fulfill the above research problem, the following Major Questions (MQ) and Sub Questions (SQ) research questions were designed in this paper.

MQ: What is the impact of FD on EQ in the Sri Lankan Perspective?

SQ1: What is the impact of FID on EQ in the Sri Lankan Perspective?

SQ2: What is the impact of FMD on EQ in the Sri Lankan Perspective?

The above questions are transformed into research objectives to conduct the experimental investigation as Major Objective (MO) and Specific Objectives (SO).

MO: To examine the impact of FD on EQ in the Sri Lankan Perspective.

SO1: To examine the impact of FID on EQ in the Sri Lankan Perspective.

SO2: To examine the impact of FMD on EQ in the Sri Lankan Perspective.

The remaining paper is organized as follows. Section 2 provides a comprehensive description of the research method set up in the study. Section 3 focuses on deeper investigation and discussion of empirical outcomes. Finally, Section 4 presents the conclusion and policy implications.

LITERATURE REVIEW

The earth is on track to hit 3°C of warming by the end of the century, which is double the amount of the most ambitious goal in the Paris Agreement (UNEP, 2023). This is occurring the result of human behaviours that end up with worsening EQ. Over the last many centuries, EQ has evolved as a central position of academic research. Hence, there are many environmental theories have been heavily disputed (Majeed & Mazhar, 2019). The theoretical base of EQ mainly depends on theories such as the EKC, Ecological modernization theory, and Environmental transition theory. Along with those theories, most of the researchers empirically studied the EKC framework. Initially, Grossman and Krueger developed the EKC in 1995. Under EKC, economic development leads to more pollution (scale effect). However, beyond a certain level of development, the pollution decreases while the growth is increased (Composition effect). The EKC hypothesis is validated by evidence of decreasing pollution with EG, increased disposable income, improved technology, adoption of green technologies, implementation of environmental regulations, and de-industrialization (shifting from manufacturing to service sector economy) (Javid & sharif, 2016). Taking into account of the EKC hypothesis there are large amount of previous empirical studies were developing an inverted U-shaped interaction among FD and CO2 emission. As same as the EG, initial level of FD raises the CO2 emissions and then decline once the financial sector matures (Charfeddine & Khediri, 2016).

Initially, the discussion among FD and EQ began in 1980 with the revolutionary studies of Aufderheide and Rich (1988), and Schmidheiny & Zorraquin (1998). Aufderheide and Rich (1998) underlined the duties of multilateral banks in influencing the EQ. They pointed out that the World Bank’s finance guidance system often neglects the environmental influence of loanable funds causing major environmental concerns in developing countries. Especially, in the case of India, funding in energy reserves worsens soil erosion, and the Green Bereby rubber program caused rainforests to deteriorate. Further, microfinance for cotton manufacturing caused anticipated agricultural lands useless due to the depletion of soil. Moreover, financial institutions often promote their short-term objectives and neglect the environmental issues associated with their goals. This will lead to resource exploitation (Schmidheiny & Zorraquin1998).

Regards to the Asian region, Hunjra et al (2020) explored the moderating influence of institutional quality on the FD and EQ of the five Asian nations. They discovered FD raises the CO2 discharge in this region. In addition, Tahir et al (2020) discovered the influence of FD and globalization on the EQ in South Asian nations from 1990 to 2014 and suggested that FD declined the EQ. This research recommended the government must regulate the distribution of funding for R&D, green financing, and efficient manufacturing that minimizes resource utilization and boosts EQ. Qayyum et al (2021) discovered the interconnection among FD, renewable energy consumption, technical innovation, and CO2 emission from an Indian perspective, and the results explored, that FD positively influences CO2 emission. They used Auto Regressive Distributed Lags and Vector Error Correction Model to the analysis.

Concerning the African region, Shobande and Asongu (2021) studied the FD, human capital development, and climate change in East and South Africa from 2000 through 2018. They applied CD tests, Combined panel unit root tests, Combined panel cointegration test, Panel VAR/VEC Ganger causality tests for the analysis, The empirical outcomes showed that FD is more vital in decreasing CO2 emissions and encouraging environmental sustainability in East and South Africa. Further, Shahbaz et al (2013a) explored that FD lowered CO2 emissions in South Africa in the time 1965-2008.

In a single country setting in Nigeria, Omoke et al (2020) investigated the asymmetric association of FD on EF for the period 1971-2014. The outcomes confirm that there is a negative interaction among FD and EF, in which, a positive shock in FD reduces the effect on EF and a negative influence in FD enhances the effect of EF in this country. In another single-country context, Sekali and Bauzahzah (2019) experimentally discovered the effect of FD on EQ in Morocco, from 1980 to 2015 by using Auto Regressive Distributed Lags. They concluded there is no significance between these two and highlighted the government's need to incorporate in developing programs highly, which should balance the environmental, economic, and social dimensions. Considering above all the empirical studies on FD and EQ, the outcomes indicate positive, negative, and insignificant in some cases and these findings differ due to the region or country, investigation econometric technique, and the level of development

However, a significant body of empirical research has been devoted to the linkage between FD and EQ in various kinds of contexts. To investigate this relationship, scholars have used most of the panel data analysis and single country investigations.

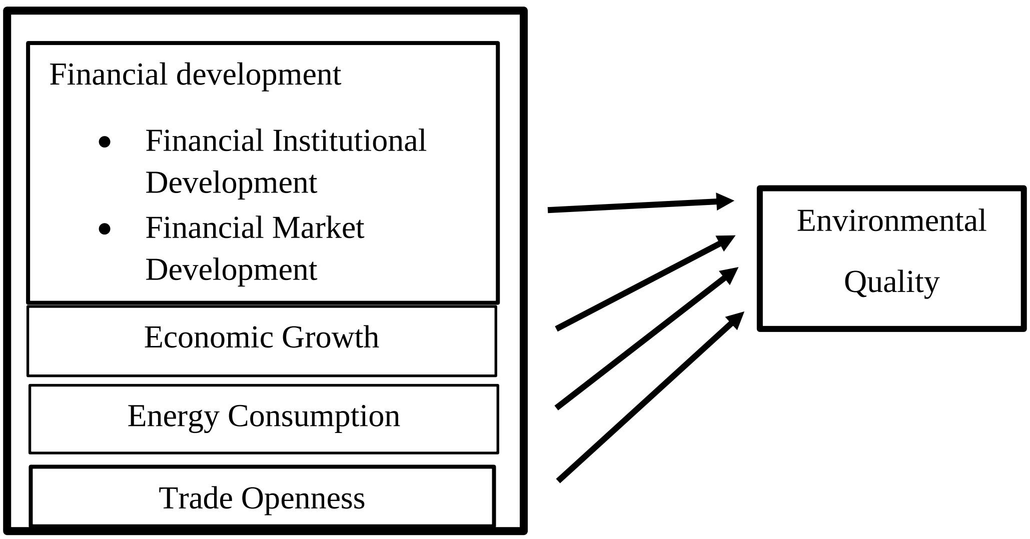
However, the proposed research has the following research gaps. There is an absence of the single country context approach for Sri Lanka. Most of the studies included Sri Lanka in the sample for the analysis. Due to this reason, it is unclear to identify the exact linkage between FD and EQ in Sri Lanka. Therefore, environmental effects of FD investigation regarding to the Sri Lankan context is necessary to fill literature gap. Further, many studies have investigated FD as an overall phenomenon. Nevertheless, this study will utilize FD as both FID and FMD. These two scenarios will help to identify which is the most influential phenomenon on EQ in the country and it will guide to establish the most suitable policies in the country. Finally, this current research will aim to address these gaps in the literature by discovering the environmental effects of FD in the Sri Lankan context.

METHODOLOGY

3.1 Conceptual framework

In this research, a positivist research philosophy is implied to figure out the connection between FD and EQ. The functional relationship of this philosophy is the association of independent and dependent variables, which can be expressed quantitatively, through direct or indirect effects (Park et al, 2020). By applying quantitative variables including FD, EC, EG, and TO, this study aims to find out uncover connections on EQ in Sri Lankan setting. Figure 1 portrays the conceptual frame of the selected variables.

Figure 1: Conceptual Framework



Source: Developed by author from several sources, 2024

Justification of variables.

FD is the primary emphasis of this study since it is the independent variable of the conceptual framework. On the other side, EQ is taken as, the dependent variable of the study. However, there is no agreement regarding this linkage, because FD may enhance, damage, or have no effect on EQ (Gok, 2020). The results varied due to the implied proxies, methods used, and the development levels of the countries (Gok, 2020). To achieve the specific objective of the investigation FID and the FMD will capture the FD and the CO2 emission will capture the EQ in Sri Lankan context. Further, this study validates the following hypothesis to confirm the theoretical viewpoint and the previous literature.

H1: FID has a significant impact on EQ in Sri Lanka.

H2: FMD has a significant impact on EQ in Sri Lanka.

In addition, FD is not the only factor that contributes to CO2 emission. Therefore, several control variables were employed in this study.

Economic growth (EG)

According to the EKC, EG is considered the key contributor to environmental pollution and it primarily influences through the scale effect, technical effect, and composite effect (Grossman & Krueger, 1995). Even so, not all EG is damaging the environment (Khan et al, 2021; Adedoyin et al, 2020). EG enables to increase in real income and individuals can dedicate resources to protect the environment (Irfan et al, 2020). Moreover, technological advancement inspired by EG can drive to boost productivity while reducing environmental impacts (Khan et al, 2021: Pettinger, 2021). Thus, the following hypothesis is employed to capture the influence of EG on EQ in the Sri Lankan setting.

H3: EG has a significant impact on EQ in Sri Lanka.

Energy consumption (EC)

Although every economic activity requires energy, it is always a key component of production (Cetin et al, 2018; Stern, 1996). Therefore, EC is determined as one of the primary contributors to environmental degradation among countries and regions (Adebayo et al, 2021; (Kirikkaleli & Adebayo, 2020)). In addition, prior studies by Dogan et al (2020) emphasize that the utilization of traditional energy sources are major contributors to rising CO2 levels. Further, Higher levels of consumption and production result in higher utilization of gas and oil, which, adds to an increase in environmental pollution and resource deterioration (Dissanayake et al, 2022; Mirza & Kanwal, 2017). To reduce this massive environmental damage, green energy innovations and upgrades to environmentally friendly and sustainable solutions (clean energy options) that, ensure efficient usage of energy are required (Adebayo et al, 2021; Sun et al,2021; Sharif et al,2019). As an outcome, it is reasonable to propose the following hypothesis for evaluating the effect of EC on EQ in Sri Lankan setting.

H4: EC has a significant impact on EQ in Sri Lanka.

Trade openness (TO)

Studies on environmental pollution have identified TO also a significant variable that influences EQ (Ali et al, 2020; Villanthenkodath & Arakkal, 2020: Grossman & Krueger, 1991). Studies have discovered that trade impacts have different benefits on emissions than the EG gain (Villanthenkodath & Arakkal, 2020). Free trade rise real income while also altering the structure of national output, so influencing the rate and the amount of pollution (Copeland & Taylor, 1995). According to Copeland and Taylor (1995), when the income differs among countries, a shift from autarky to free trade would increase global pollution. Apart from this kind of negative consequences, Shahbaz et al (2013a, b) assert that nations have superior access to wider international markets, and strengthen manufacturing and output of countries that support the imports of carbon-free technologies. For this reason, the present study utilized TO as a factor to define the EQ, and its hypothesis is listed as follows.

H5: TO has a significant impact on EQ in Sri Lanka.

3.2: Sample period

The present study utilized time series data from 1990 to 2021. This period is chosen based on the availability of data in the IMF database on FD and the IEA database on CO2 emissions.

3.3: Data sources

Table 1: data description, measurements, and sources

Variable	Variable Measurement	Data source
EQ	Total CO_2 emission metric tons per capita	International Energy Agency
FD	Financial institution index Financial market index	International Monetary Fund
EG	GDP per capita income in US$	World bank

EC	Primary energy consumption in Terawatt hours (TWH)	U.S. Energy Information Administration
TO	Trade intensity ratio	CBSL annual report

Source: Developed by researcher adopting from several sources, 2024

3.4. Empirical model

Various studies assessed the interaction among FD and CO2 emissions but discovered mixed empirical results (Shahbaz et al, 2016). EG, EC, and TO are add here to supplementary determinants of FD and EQ. To assess the FD on EQ in Sri Lanka, this study relies on Sekali and Bruzahzah (2019) which is assist by the previous literature. The general form of this connection among CO2 emission, FD, EG, EC, and TO is as follows,

$$\mathbf{CO2_t = f\,(FID_t, FMD_t, EG_t, EC_t, TO_t)}$$

Equation 01

The logarithm-linear equation is as follows,

$$\log(CO2_t) = \beta_1 + \beta_2 \log(FID_t) + \beta_3 \log(FMD_t) + \beta_4 \log(EG_t) + \beta_5 \log(EC_t) + \beta_6 \log(TO_t)$$

Equation 02

Where t represents time.

3.5 Estimation Technique

The ARDL approach and its variants will be used to estimate the models in this thesis. It is essential to determine stationary for the time series data before applying the ARDL approach to verify the integrating order of the data set. This is mandatory due to the ARDL technique implies that all variables are integrated in order I (0) or I (1). If a variable falls under I (2), estimated F statistics are no longer valid (Pesaran et al, 2001). In this regard to establish the integration order of variables, the study utilized the most common and widely ADF test outlining the null hypothesis of $H_0: \beta = 0$ and the alternative hypothesis$H_1: \beta < 0$.

Secondly, to define the optimal lag selection, this analysis employed the AIC, and the model that suits the Smallest AIC value is chosen as the best-fitting ARDL model. Later on, the validity of the long-run connection is confirmed by running an F-test for the joint significance of coefficients of lag levels of the variables employing the ARDL bound test method. The selection of the bound test carried several advantages. This can be utilized in non-stationary time series without being limited by the same order of integration. Since each of the underlying variables is represented by a single equation, endogeneity is less issue in the ARDL approach because it lacks residual interrelation. It also allows us to analyse the reference model (Nkoro & Uko, 2016; Sekali and Bruzahzah 2019). Further, if there is a long-term association the ARDL approach can classify between dependent and independent variables. Thus, the technique requires there is only one reduced form equation linkage between the dependent variable and the exogenous variables. The estimated ARDL model is as follows,

$$\begin{aligned}\Delta \mathbf{lCO2_t} = \boldsymbol{\beta_0} &+ \sum_{i=1}^{p} \boldsymbol{\delta}\,\Delta \mathbf{LCO2_{t-1}} + \sum_{t-1}^{p} \boldsymbol{\alpha}\,\Delta \mathbf{LFID_{t-1}} + \sum_{t-1}^{p} \boldsymbol{\gamma}\,\Delta \mathbf{LFMD_{t-1}} \\ &+ \sum_{t-1}^{p} \boldsymbol{\omega}\,\Delta \mathbf{LEG_{t-1}} + \sum_{i=1}^{p} \boldsymbol{\rho}\Delta\, \mathbf{LEC_{t-1}} \\ &+ \sum_{i=1}^{p} \boldsymbol{\sigma}\Delta \mathbf{LTO_{t-1}} + \mathbf{A_1 LCO2_{t-1}} + \mathbf{A_2 LFID_{t-1}} + \mathbf{A_3 LFMD_{t-1}} \\ &+ \mathbf{A_4 LEG_{t-1}} + \mathbf{A_5 LEC_{t-1}} + \mathbf{A_6 LTO_{t-1}} + \cup_t\end{aligned}$$

Equation 03

Where, $\beta_0$is the drift component, $\cup_t$is white noise. The term with summation denotes the ECM and the p_t represents the long-term interaction. Δ is the first-difference operator.

Once these have been identified, the ECM can be measured. The ARDL-ECM is utilized to measure the short-run dynamics of variables with their long-term behavior across time (Nkoro & Uko, 2016). The ECM equation can be portrayed as follows,

$$\begin{aligned}\Delta \mathbf{LCO2} = \boldsymbol{\delta_0} &+ \sum_{i=1}^{p} \boldsymbol{\delta_1}\,\Delta \mathbf{LCO2_{t-1}} + \sum_{i=1}^{p} \boldsymbol{\delta_2}\Delta \mathbf{LFID_{t-1}} \\ &+ \sum_{i=1}^{p} \boldsymbol{\delta_3}\Delta \mathbf{LFMD_{t-1}} + \sum_{i=1}^{p} \boldsymbol{\delta_4}\Delta \mathbf{LEG_{t-1}} \\ &+ \sum_{i=1}^{p} \boldsymbol{\delta_5}\Delta \mathbf{LEC_{t-1}} + \sum_{i=1}^{p} \boldsymbol{\delta_6}\Delta \mathbf{LTO_{t-1}} + \boldsymbol{\varphi}\mathbf{ECT_{t-1}} + \boldsymbol{\epsilon_t}\end{aligned}$$

Equation 04

Finally, the validation test is employed to identify if the fitted model exhibits homoscedasticity and autocorrelation in residuals, and the CUSUM test verifies the stability of the fitted model. As a summary, the steps of the ARDL application are listed as follows:

Step 1: Stationary test

Step 2: Select the optimal lag length

Step 3: ARDL bound test to identify the long-run linkage

Step 5: measurement of long-term and short-term coefficients

Step 6: Validation tests (Sekali and Bruzahzah, 2019)

RESULTS AND DISCUSSION

4.1: Descriptive statistics

Table 1 displays the descriptive statistics of mean, median, standard deviation, skewness, kurtosis, and the Jarque-Bera test of normality for all the selected variables. Further outcomes of skewness indicate that CO2, FID, FMD, EG, and EC are skewed to the right side (positively skewed), TO is skewed to the left side (negatively skewed). The kurtosis evaluates whether the distribution is overly peaked or is not (George & Mallery, 2019). The positive Kurtosis values among variables display that the distribution is more peaked than normal. Further kurtosis values of CO2 emission, FID, FMD, are EC are greater than two (+2) which means this distribution is too peaked.

Table 1: Descriptive Statistics

Variable	CO_2	FID	FMD	EG	EC	TO
Mean	0.621375	0.276615	0.160315	2044.815	3243.803	0.539813
Median	0.609500	0.263302	0.155994	1331.854	3137.281	0.578500
Std. Dev.	0.248193	0.044173	0.040401	1463.282	1024.313	0.136811
Skewness	0.092831	0.058953	0.093162	0.455220	0.350529	-0.247645
Kurtosis	2.106986	2.119199	2.359802	1.476855	2.019211	1.514498
Jarque-Bera	1.109260	1.052950	0.592761	4.198495	1.937908	3.269369
Probability	0.574285	0.590684	0.743504	0.122549	0.379480	0.195014

Source: Results of analysis of EViews, 2024

4.2: Unit root test

Prior to proceed with unit root and other steps data must be transform in to the log form to eliminate the exponential variances in the sample. The ADF test results confirm that all the variables show stationary features at first difference, which means the probability value of all variables, is lower, compared to the 5% significant level. Considering the above results all the variables are intergraded at I (1), no variables integrated below order one and choose variables can perform with the ARDL approach.

Table 2: Unit root test outcomes for the variables (at a 5% significant level)

Variable	Level series	1st difference	Order of integration
LCO2	0.2651	0.0000	I (1)
LFID	0.6861	0.0000	I (1)
LFMD	0.2805	0.0000	I (1)
LEG	0.7098	0.0073	I (1)
LEC	0.6706	0.0011	I (1)
LTO	0.8476	0.0000	I (1)

Source: Results of analysis of EViews, 2024

4.3: Cointergration Test

According to Pesaran et al (2001), the ARDL bound test is used to determine co-integration between variables since it makes easier to figure out the economically driving variables, which determine the long-term interaction among the independent and dependent variables. The null hypothesis (H_0) verifies there is no co-integration in the data series and the alternative hypothesis (H_1) verifies that there is a co-integration between variables. The calculated F value is 6.7720, larger than the lower and higher bound at a 5% significance level (Table 4). These findings confirm that there are long-run linkages among variables that support the alternative hypothesis.

Table 3: Outcomes of the ARDL Bound Test

F-statistic	6.7720			
Sample Size	30		35	
	I (0)	I (1)	I (0)	I (1)
10%	2.407	3.517	2.331	3.417
5%	2.910	4.193	2.804	4.013
1%	4.134	5.761	3.900	5.419

Source: Results of analysis of EViews, 2024

4.4: Estimation of Long-run coefficients

Table 4: Results of long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFID	0.6132	0.4060	1.5103	0.1435
LFMD	0.3568	0.1013	3.5195	0.0017**

LEG	-0.2313	0.1124	-2.0571	0.0502*
LEC	1.3859	0.2249	6.162	0.0000**
LTO	-0.0231	0.1580	-0.1464	0.8847
C	-8.5398	2.2806	-3.7444	0.001

Note: **and * denote statistically significant at 5% and 10% level, C means constant.

Source: Results of analysis of EViews, 2024.

Regards to the Table 4 the log of FID (LFID) is equal to 0.6132, which statistically insignificant, implying that 1% rise in FID would result in 0.6132% rise in CO2 emission per capita. In simply, the FID has no impact on EQ in the long run. The log of FMD (LFMD) coefficient is equals 0.3568, which is statistically significant and indicates that the 1% increase in FMD would increase the CO2 emission per capita by 0.3568%. In other words, an increase in FMD will lead to a decrease in the EQ in the country in the long run and there is a negative connection among FMD and EQ. Considering the previous experimental works, Further, the log of EG (LEG) shows a negative sign and is statistically significant at a 10% level which implies that the 1% enhancement in EG would result in a decline in the CO2 emission per capita by 0.2313%. On the other hand, this means, in the long run, EG reduce CO2 emission and an increase in economic growth can result in increasing the EQ in the country and there is a positive linkage among EG and EQ in the long term.

The log of EC (LEC) is statistically significant and the positive sign states that the 1% improvement in EC would enhance the CO2 emission by 1.3859% and indicates that EC has an influence on EQ in the country. On the other side, EC outcomes establish a negative interconnection among EC and EQ in the long run. In other words, increasing EC would result in decreasing EQ in the long run. Finally, the log of TO (LTO) is equal to -0.0231 and the value implies that the 1% increase in TO will lead to reduce the CO2 emission per capita by 0.0231% but it is not statistically significant. Simply it means TO have no impact on EQ in the Sri Lankan context.

4.5: Short-term results

Table 5: Measurement of short-run dynamics

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Dependent variable: LCO_2				
LFID	0.5170	0.3319	1.5575	0.1330
LFMD	0.3008	0.1027	2.9279	0.0076**
LEG	-0.1950	0.0982	-1.9861	0.0591*

LEC	1.1685	0.3068	3.8086	0.0009**
LTO	-0.0195	0.1332	-0.1463	0.8849
COINTEQ	-0.8431	0.1090	-7.7311	0.0000

Note: **and * denote statistically significant at 5% and 10% level

Source: Results of analysis of EViews, 2024

The above results (refer to Table 5) report that the coefficient of ECT is negative (-0.8431) as it is significant at the 5% level (p-value < 0.05) which suggests the speed of adjustments of log of CO2 emission to change in FD and other control variables are about 84.31% within the first year to ensure full convergence to its equilibrium level. Additionally, statistically significant ECT confirms the Bound test for co-integration that short-run connection among CO2 emission and regressors.

In the short run, the log of FMD (LFMD) coefficient is 0.3008, and the log of EC (LEC) coefficient is 1.1685, which, gets a positive value and is statistically significant at 5% level. The positive sign points out that there is a positive association between LFMD, LEC, and LCO2 in the short term. On the other side, if the rise in FMD and EC will also raise the CO2 emission in Sri Lanka and they would result in a decrease in the EQ in the country in the short run. On the other side, the coefficient of the log of EG (LEG) is statistically significant at a 10% level, but it holds a negative value, which indicates that there is a negative association between LEG and the log of CO2 (LCO2) in the short run. However, the log of FID (LFID), and the log of TO (LTO) do not statistically significantly influence on the log of CO2 emission which means, these variables have no impact on EQ in the country in the short run.

4.6: Validation tests

Table 6: Validation test results

Jarque-Bera	0.2747
Breusch-Pagan-Godfrey heteroscedasticity test- Chi-Square	0.7899
Breusch-Godfrey serial correlation LM test- Prob. F	0.8856

Source: Results of analysis of EViews, 2024

The Jarque-Bera value test follows the null hypothesis that the residuals are distributed normally and the alternative hypothesis is the residuals are not normally distributed. The probability value of the Jarque-Bera in the above corresponding Table 7 is 0.2747, which exceeds the 5% significant level. Therefore, it guides us to accept the null hypothesis that residuals are distributed normally and reject the alternative hypothesis.

The results of the Breusch-Pagan-Godfrey heteroscedasticity test Chi-Square probability value is 0.7899, which is larger than the significant level of 5%. Thus, it means that the residuals do not have heteroscedasticity and it is homoscedastic. In the time-series analysis, understanding the autocorrelation or serial correlation is crucial in the fitted model. Therefore, this study employed the Breusch-Godfrey serial correlation LM test to check the autocorrelation among residuals. Considering the p-value of F-statistic (0.8856), it can be summarized that, there is no presence of serial correlation at up to two lags because the p-value is greater than the 5% significant level of this model.

Figure 2: CUSUM test results

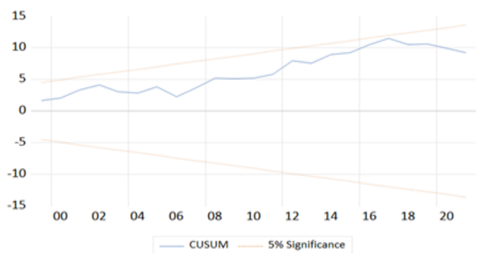
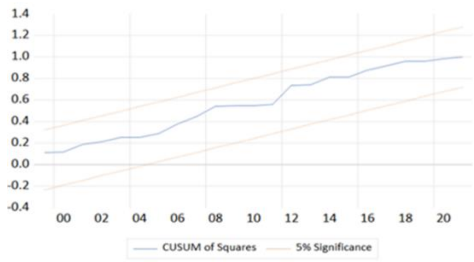


Figure 3: CUSUMQ test results



Source: Results of analysis of EViews, 2024

In the ARDL estimation process, the last step is the verification of the steadiness of the model in the long run and the short run. Thus, the study employed the CUSUM method and CUSUMQ method. The outcomes of CUSUM and CUSUMQ are illustrated in the above figures of 2 and 3 The results demonstrate that the CUSUM and CUSUMQ statistics graphs stay inside of the critical value region at the 5% threshold, confirming that the model's coefficients are stable.

4.5: Results Discussion

This discussion addresses the interaction among FD, EG, EC, TO, and EQ in the context of Sri Lanka, utilizing the ARDL approach. By addressing this, this discussion expects to convey a complete understanding of how FD and other factors influence and interact with EQ in the country. The ARDL established the availability of long-run and short-run interconnection among these engaged variables in the model.

Considering the previous experimental works, FD has a significant positive influence on emissions in several studies. Such as Musah et al (2022), Xu et al (2022), Qayyum et al (2021), and Fitriyah et al (2021). In addition, some studies discovered it has an important negative influence such as Shahbaz et al (2016), Hung et al (2022), and Rjoub et al (2021) on emissions while another set of works assessed insignificant outcomes such as Dogan & Turkekul (2016). When it comes to the Sri Lankan context, the FID and FMD indexes of IMF still pose in minimum rates, which means financial institutions and financial markets are in the early stages. According to the EKC, in the early stages it can promote environmental degradation. This situation proves the empirical results that both FID and FMD can reduce the EQ in the country. However, institutional-based financial development does not show a significant impact on EQ and it does not hold the validity of the H1 hypothesis in the methodological section. The association shows it can degrade the EQ but data does not provide enough evidence to prove the impact with high confidence.

Alongside that FMD has a significant positive influence on CO2 emissions. It points out that the FMD can also increase the CO2 emissions which results in reducing the EQ in the country. Thus, it validates the H2 hypothesis. To minimize this impact the policymakers can implement green financing initiatives such as green bonds, renewable energy projects loans, and tax breaks and subsidies for investments that promote environmentally sustainable projects. Further, regulate in the financial markets by mandating environmental reports and standards for the listed companies, including reporting CO2 emissions, usage of water, waste management, etc. Also, they can implement ESG (Environmental, Social, and government) criteria into regulation in financial markets. Finally, providing training programs and capacity-building initiatives for professionals in the financial market on environmental sustainability principles and management in risk related to environmental factors also can mitigate the environmental impacts of FMD.

The outcomes of the influence of EG on CO2 emissions discovered a significant negative impact that, means EG can decline the CO2 emissions while it can improve the EQ in the country. These outcomes validate the H3 hypothesis which EG has a significant impact on EQ. Therefore, Sri Lanka does not need to lower its income levels to decline emissions. This outcome aligns with the outcomes of the previous experimental works of Narayan & Narayan (2010) Ozcan (2013), and Moghadam & Dehbashi (2017). The following policies are here to address this scenario to boost the EQ further. Policymakers can develop green growth strategies to promote EG while reducing environmental pollution. Implementing environmental impact assessment (EIA) regulations can enforce new development proposals to reduce impacts on the environment by highlighting issues including air, and water pollution, habitat destruction, etc. Promoting government, private, and local community collaborations can also mitigate the environmental challenges in the country. Additionally, promoting urban development to boost the EQ, while reducing the CO2 emissions in urban areas. These urban development recommendations can be included in encouraging investments in public transportation systems, introducing and promoting green building codes to promote energy-efficient designs and usage of sustainable materials, etc. In addition, the government can encourage sustainable agriculture implementations like organic farming to enhance the EQ and food security.

EC outcomes revealed a significant positive influence on CO2 emissions. in other words, EC can lead to higher CO2 emissions while reducing EQ. This outcome confirms the H4 hypothesis which, EC has a significant impact on EQ. The finding aligns with the outcomes of Moghadam & Dehbashi (2017) for Iran, Farhani & Ozturk (2015) for Tunisia, Gamage et al (2017) for Sri Lanka, Shahbaz et al (2015) for India, Dogan et al (2017) for OECD nations, Zaman et al (2016) for 34 developed and developing countries, Alam et al (2007) for Pakistan, and Phong et al (2018) for Vietnam on the environmental consequences of EC.As an underdeveloped country, Sri Lanka is still heavily reliant on non-renewable energies which contribute to higher CO2 emissions. Based on this outcome, Policymakers can promote energy-saving programs, promote energy conservation practices, public awareness campaigns. Further, they can establish emission-pricing schemes like carbon taxes and carbon credits, smart grid infrastructure to capture the energy distribution and coordinate renewable energies, increase funding in R&D to innovate clean energy technologies, and energy storage solutions while improving the participation of industry, academic, and government sectors.

Finally, the outcomes of TO and EQ explored that TO has no significance environmental consequences on CO2 emissions. This could arise due to country's economic structure. Thus, it not fully transforms to industrial economy and trade might not enough to effect on EQ. Also, it does not hold the validity of H5 hypothesis. This environmental impacts of TO align with the findings of previous experimental work of Jalil & Muhmud (2009), from the Chinese perspective. However, if it is insignificant, it has negative impact on CO2 emission and positive impact on EQ. Considering EKC, in the early stages of economic development, TO can reduce the EQ, but in the higher level of the economic development trade can decline the environmental degradation with the adoption of cleaner technologies.

Table 8: Summary of the key findings

Variable	Long-run impact on CO_2 emissions		Short-run impact on CO_2 emissions		Variables Impact on EQ
	Significant or not	Sign	Significant or not	Sign	
FID	×	positive	×	positive	FID has no impact on EQ
FMD	✓	positive	✓	positive	FMD reduces the EQ

EG	✓	negative	✓	negative	EG increases the EQ
EC	✓	positive	✓	positive	EC reduces the EQ
TO	×	Negative	×	negative	TO Has no impact on EQ

✓ is denoting statistically significant,

× is denoting statistically insignificant.

Source: Developed by the author based on the outcomes of the analysis, 2024

CONCLUSION

The influence of FD on EQ has drawn a significant consideration among energy economics in the modern world. The empirical studies still have the debate on whether FD can enhance, worsen, or have no impact on EQ. Hence, the major objective of this current study is to determine the impact of FD on EQ in the Sri Lankan setting. Thus, to explore the environmental effects of FD, the model incorporates EG, EC, and TO as supplementary factors. FD is captured using financial intuitional-based and financial market-based factors. In contrast, the EQ is captured through the CO2 emission. In this study researcher, employed the ARDL procedure to identify the impact of FD on EQ in Sri Lanka for 1990-2021.

With the view of solving the stated research problem, mainly two specific research questions were developed to capture the environmental effect of FD. The first question focuses on addressing to what is the impact of FID on EQ in Sri Lanka. The second question focuses on addressing to what is the impact of FMD on EQ in Sri Lanka. The ARDL model is applied to answer these both questions. The ARDL results confirm the availability of long and short-term associations among FID, FMD, EG, EC, and TO with CO2 emissions in the country. The key findings of the study reveal that market-based FD and EC lead to reduce the EQ in the country. However, EG can improve the EQ in the country. Finally, study expects the findings will contribute to the debates of scholars, policymakers, investors, and industry experts.

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