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Title: The Effect of Financial Development on Environmental Quality: A Developing Country Evidence

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Abstract

Financial development is vital to enhance the inclusive growth of a country in the modern world, and environmental quality, affected by financial development, is also a highly debated topic. Thus, this study attempts to investigate the role of financial development in determining environmental quality in Sri Lanka considering other variables namely economic growth, energy consumption, trade openness, and foreign direct investments. The key econometric tool used for the purpose is the Autoregressive Distributive Lag (ARDL) approach with the data from 1992-2021. As per the findings, financial development, economic growth, energy consumption, and foreign direct investments adversely impact environmental quality in the long run and short run. Additionally, trade openness established a negative impact in the short run only. Importantly, the Environmental Kuznets' Curve hypothesis and Pollution Haven Hypothesis are established. Finally, all variables except trade openness confirmed a unidirectional causal relationship with environmental quality. This study recommends that all the modelled variables are vital to enrich the environmental quality in Sri Lanka.

Keywords: *Financial development, environmental quality, Environmental Kuznets Curve, Pollution Haven Hypothesis, Autoregressive Distributive Lag Approach, Sri Lanka.*

1. Introduction

The remarkable growth in the world population and economic activities has driven the world economies toward a major challenge of the ecological balance which inevitably hampers the livability of the planet. It is undoubtedly accepted that environmental quality is a prime necessity for human survival in this universe. However, it is obviously seen that the current phase of human activities cause a detrimental effect on the quality of the environment at an alarming rate. Given these developments, the global consensus is now converging towards the inclusive growth concept which basically aims at balancing growth and environmental quality simultaneously.

Moreover, both sustainable human development and sustainable economic growth are largely guaranteed by environmental quality (Jianping, et al., 2013). More often than not, a debate has erupted globally about whether traditional economic growth strategies should focus solely on economic profit and the material well-being of society. These accumulated facts turned the inclinations of policymakers to more environmentally friendly growth strategies. In view of mitigating unfavourable outcomes, on 25th September 2015, the 193 countries of the UN General Assembly adopted the 2030 Development Agenda titled "Transforming our world: the 2030 Agenda for Sustainable Development". The historical view of the business to the financial bottom line now expands adding people and planet, popularly known as the triple bottom line approach to development, a term coined by John Elkington in 1994. Subsequently, this concept was merged with Sustainable Development Goals (SDG) through the 2030 development agenda. These global concerns induced attention to environmental quality in the global development agenda.

Furthermore, the financial development of an economy foresees forthcoming economic advancement and it is an indication of the country's wealth creation ability which permits the transactions of financial assets. In addition, financial development is instrumental in promoting investment prospects in an economy which eventually stresses the environment as it consumes more energy sources (Baloch et al. 2021). Thus, the contemporary world petitions an economic growth mechanism along with a sound and viable financial system that is exceptional for containing ecological devastation (Asiedu & Boahen, 2022). The broad spectrum of financial and economic progress will head on the level of environmental quality since the bigger scale of economics and financial activities demand a greater level of resources as inputs which ultimately upsurges the environmental threats (Halkos & Polemis, 2017). Conversely, financial development assists sustainable investments in environmentally healthy technical innovations which uplift the environmental quality by reducing carbon emissions (Shobande & Ogbeifun, 2022).

Unarguably, financial development broadens the access to financial facilities that need to individuals, the corporate sector, and the government which promotes investments that consume more energy sources. Comparatively, both financial resources and technological advancements are not seen progressively in developing economies and those economies fulfill the saving-investment gap by promoting foreign investments which have a spillover effect on environmental protection as it facilitates the exchanging intellectual knowledge for exploring and adopting green technologies in developing economies (Shobande & Ogbeifun, 2022). Importantly, a green light is seen at the end of the tunnel as the advanced economies are much worried about environmental devastation and give their top priority to containing the environmental destruction caused by global development. These countries have given the leadership to form some important global treaties for addressing this issue. Some of the note-worthy initiatives are the Paris Agreement, Kyoto Protocol, EU climate diplomacy, Bali Road Map, etc. These are also legally binding documents agreed upon by several contracting nations on common interest. Furthermore, the International Finance Corporation (IFC) has formed Sustainable Banking Network (SBN) to promote green financing through the banking system. Under this program, the banking system begins to offer financial services to green businesses which aims at prioritizing environmentally friendly operations. In addition, advanced economies have already set up environmental regulations especially for the financial sector to facilitate sustainable finance

while developing nations are far behind the advanced economies on this front. As such, the propagation of sustainable finance practices among developing nations is a need of the hour.

In Sri Lankan context, environmental pollution got an exponential effect as a result of industrialization which began in the 1980s with the market liberalization policies implemented by the government. Recent statistics showed that the pollution index value counted 66.25 for the Sri Lankan economy and ranked at the 61st environmentally polluted country in the world. In addition, Environmental Performance Index (EPI) ranked Sri Lanka 132th place with a 32.70 EPI score and it recorded a 2.60 drop EPI score in the last ten-year period which emphasizes the importance of prioritizing the environmental issues in setting economic development policies. Therefore, the financial sector has a vital role to play in setting grounds for mobilizing financial resources, targeting some sort of improvement of environmental quality while balancing the output of the economy. Unfortunately, it is hardly seen any constructive mechanism in Sri Lankan financial sector to tackle the need for sustainable financing practices, except for some voluntary practices adopted by financial institutions. Given this neutrality, the Sri Lankan financial market has an obligatory duty in enhancing environmental quality by encouraging the corporate sector to mobilize the investment flows towards green investment projects. Thus, this study initially attempts to establish a nexus between financial development to environmental quality. The research has also considered some other relevant variables that might affect environmental quality. These variables are included as control variables. It also aims at examining whether financial development matters for environmental quality in Sri Lankan context. The research outcomes on the nexus of financial development and environmental quality in the Sri Lankan context are vital to bridge the knowledge gap in developing countries and bring the attention of policymakers to this important matter.

There has been limited evidence on the nexus of financial development and environmental quality in the Sri Lankan context. Ex-ante Sri Lankan literature has considered only one aspect of the financial market for modelling the effect of financial development on environmental quality and highly neglected the significant aspects of financial development. Thus, novel contributions of this study fall into the body of knowledge in the field of financial development and environmental quality in the Sri Lankan context. To the best of the authors' knowledge, this is the first study that captures the stock market development and banking sector development together to examine its impact on environmental quality taking into model other vital factors such as economic growth, energy consumption, foreign direct investment, and trade openness. In addition, this study tests the applicability of both the Environmental Kuznets Curve (EKC) hypothesis and the Pollution Haven Hypothesis in Sri Lanka.

The rest of this paper is organized as follows. Section 2 presents a brief review of the theoretical and empirical body of knowledge with an attempt to establish a rational ground to investigate the link between financial development and environmental quality. Section 3 discusses the methodology of the study and section 4 presents the findings of data analysis and research discussion. Finally, section 5 concludes the findings with a proposal for policy implications.

2. Key Literature

This section further scrutinizes the existing theoretical and empirical studies which relevant to this study. To begin with, the early scholarly argument of supply leading theory emerged by Patrick (1966) emphasized that the financial system of an economy must provide incentives for economic growth through efficient allocation of capital. This argument was further amplified by King and Levine (1993) establishing that financial development encourages economic growth by diverting funds for higher productive industries, mobilizing external financing for productive industries, and acting as a mechanism for diversifying the risk for maximizing the return under an uncertain business environment.

Another important fundamental hypothesis of the demand-following theory introduced by Hermes and Lensink (1996) recognized that product differentiation and broadening the market space which need progress in the financial

market for diversifying the risk and tackling the transaction cost to be revealed at the market. Therefore, it is evidenced that, a substantial body of literature is emerging to emphasize the role of financial development in enhancing environmental quality. The dialog and thereafter the empirical investigation of financial development and environmental quality began in the 1980s. In this era, financial assistance programs of the World Bank and IMF for the developing countries totally disregarded the environmental aspect and ultimately those programs led to serious social and environmental distresses in developing countries (Aufderheide & Rich, 1988).

Moreover, financial intermediaries commit to a short-term motive which is profit maximization, and totally neglect the environmental risk associated with the fund mobilization of those intermediaries (Schmidheiny & Zorraquin, 1998). Conversely, financial intermediaries play an effective role in mobilizing surplus capital to financial deficit units while ensuring economic growth and financial development. In addition, the financial system has a great potential to improve environmental quality because steady financial markets are able to finance clean energy usage which is ultimately promising environmental quality (Tamazian et al., 2009).

Notably, as a substantial element of the financial system, the stock market has a vital role in ensuring the environmental quality of a country by mobilizing capital investments toward carbon-free industries to ensure the long-term sustainability of those industries (Shobande & Ogbeifun, 2022). As such, Yue et al. (2019) revealed that the development of the stock market drives to decline the energy usage, particularly in advanced equity markets. This will result in reducing the financing costs for both public and private enterprises which supports establishing high-tech energy-saving practices that increase productivity. On the contrary, increasing the size of stock markets in high carbon-emission economies is detrimental to the environmental quality of those economies (Zhang et al., 2021). More importantly, emerging economies experience a negative linkage between stock market developments and environmental quality while developed markets established a positive linkage between equity market development and ecological quality (Paramati et al., 2017; Habiba et al., 2021).

In the contemporary world, the banking sector has turned into a fundamental necessity in economic growth and the environmental quality of an economy; especially banking sector development plays a major role as a channel of green financing services (Yang et al., 2020). Hence, Cao et al., (2021) empirically proved that banking sector development drives green growth and environmental quality by financing projects that use renewable energy sources. The empirical work of Obiora et al., (2020) discovered that a rise in domestic credit to the private sector and commercial bank lending worsens the environmental quality in developed, emerging, and developing economies.

Many scholars have empirically tested the relationship between financial development and environmental quality. However, the existing body of literature is contradictory and inconclusive. The first set of findings highlights that financial development improves environmental quality. As such, financial institutions adhere to the carbon reduction project finance (Guo,2021; Karimzadeh, et al, 2014). Rahman & Alam (2022) found that financial development reduces carbon emissions in Australia by employing the ARDL approach. Tamazian et al (2009) established similar findings for the BRIC countries over the period of 1992-2004 modelling the financial development and economic growth together. Interestingly, Shahbaz et al., (2013a); Shahbaz et al., (2013b); Shahbaz et al., (2013c) validated the effect of economic and financial variables on carbon emissions in South Africa, Malaysia, and Indonesia. The findings endorsed the fact that domestic credit to the private sector declined the level of emissions in the long-run and short run.

On the contrary, the second set of existing literature argued that financial development drives increased carbon emissions. Komal and Abbas (2015) revealed a negative relationship between financial development and environmental quality in Pakistan via the Generalized Method of Moments Approach. Similar findings are established by Sadorsky (2010); Zhang (2011); Boutabba (2014); Gokmenoglu and Ozatac (2015); Charfeddine and Kahia (2016); Abbasi and Riaz (2016); Ahmad and Khan (2018); Pata (2018); Jiang and Ma (2019); Shen et al. (2021): and Khan et al. (2021).

Briefing the above empirical studies on developed and developing contexts, it is concluded that the existing empirical findings in this regard are indecisive. Moreover, to the extent of our best understanding, the effect of financial development on environmental quality in the Sri Lankan context is investigated only by Alabi, et al., (2021) and revealed an insignificant impact of financial development to determine the environmental quality in long-run and short-run. However, it captured only banking sector indicators to measure financial development. Thus, the present study contributes to filling the enormous vacuum in the nexus between financial development and environmental quality in Sri Lanka. Thus, this paper raises an important research question which is how financial development matters for environmental quality in Sri Lanka. The generalizability of the findings of this paper is another important merit of this study.

3. Materials and Methods

Variable selection

For the econometric modeling purpose, financial sector development is considered as the independent variable, and environmental quality is used as the dependent variable. The total carbon emission of the country is used as the proxy for the environmental quality which is also extensively used by previous scholars to measure the environmental quality (Batuo et al, 2018; Ahmed et al, 2020). On the other hand, the country's environmental quality is well interconnected with the total carbon emission level prevalent in that economy. In the model, the financial development is captured via constructing an index with two indicators namely the stock market development and banking sector development. The Principal Component Analysis (PCA) is employed to generate an index for financial development (Batuo et al, 2018; Ahmed et al, 2020). More importantly, being a part of the financial system, the stock market facilitates raising funds for the corporate sector while satisfying capital allocation for investment and growth. In addition, the banking sector is the most accessible and convenient method for fundraising (Khan et al., 2018) for different agents. Thus, it is valid to employ the stock market and banking sector together to capture the financial development for the study.

It is well documented that stock market size is the most relevant variable for stock market development. Thus, stock market capitalization to GDP is used as the proxy for stock market development. It is well relevant as stock market capitalization influences carbon emission which is fundamentally hanging on the efficiency level of the financial system of the country (Azeem et al., 2023). It is believed that the financial system in developing countries is inefficient which leads to an inaccurate valuation of financial assets. As such, it is reasonable to argue that stock market development in the developing world degrades the environmental quality. In addition, economies with low economic growth and stock market development deteriorate the environmental quality (Azeem et al., 2023). On the other hand, in modern society, the banking sector plays a crucial role in mobilizing financial resources for investments and shoulders the responsibility of financing green investments (Yang et al., 2020). In practice, the credit to the private sector captures the volume of total monetary resources channelled through the banking sector to private firms and it represents the banking sector's contribution to investments in the private sector. Thus, this research used credit to the private sector relative to GDP as the proxy in measuring banking sector development. It is anticipated that credit to the private sector will be negatively related to environmental quality. It is because the banking sector brings up the industrial and manufacturing scale that increases carbon emissions. Hence, the following hypothesis is constructed for the statistically validating impact of financial development on environmental quality in Sri Lanka.

H_1: Financial development negatively impacts environmental quality in Sri Lanka.

Control Variables

In view of eliminating statistical bias and other econometrics issues, some variables were used as control variables. They are namely, economic growth, energy consumption of the economy, trade openness, urbanization, and foreign

direct investments. The theoretical validation behind the inclusion of economic growth in the model is based on Environmental Kuznets Curve (EKC) hypothesis. Grossman and Krueger (1991) highlighted the fact that environmental pollution rises at the early phase of economic growth; though, environmental quality will improve once the economy reached a certain level of economic growth based on the EKC hypothesis of Simon Kuznets (1955). In addition, an inverted U curve illustrates the nexus between economic growth and environmental pollution. Economic growth is considered as the strategic driver of environmental deprivation and it mainly affects the environmental quality through scale effect, technical effect, and composite effect (Halkos & Polemis, 2017; Grossman and Krueger, 1995). In addition, the impact of economic growth on environmental quality is extensively tested in developed and developing contexts. Although, the empirical finding in this regard is still inconclusive. The economic growth is measured with the Real Per Capita GDP of the country since it is one of the leading indicators of economic growth and the estimation model is tested with the quadratic form of Real Per Capita GDP to examine the validity of EKC in Sri Lanka.

Moreover, a greater volume of energy consumption indicates a higher usage of fossil energy and gas which subsidizes a bigger level of ecological effluence and resource deprivation (Mirza & Kanwal, 2017; Soytas et al. 2007). Conversely, green technologies and innovations drive efficient usage of energy which will aid to mitigate environmental hazards (Stern et al. 2006). However, according to the statistics of Sri Lanka Sustainable Energy Authority, as a developing country renewable energy usage is far behind in Sri Lanka. As such, it is realistic to expect a negative impact from energy consumption on environmental quality in Sri Lanka. For the statistical modeling purpose, the primary energy consumption of the country is employed as the proxy for energy consumption.

On the other hand, the effect of trade on the environment is also unavoidable in the modern world as growing trade tendencies upsurge the production scales the environmental pollution and damage are to raise (Grossman and Krueger, 1991). Further, it is believed that trade openness without a solid environmental policy drives pollution (Managi, 2004). Besides, altering the conventional trading patterns towards modern trading patterns contribute to a healthy environment (Atici, 2009). However, the absence of a sound environmental policy framework for the country causes a negative effect on the environmental quality, especially, in the open market environment in Sri Lanka. Thus, this study employed trade openness as a dimension to capture the environmental quality. The trade intensity ratio (exports plus imports divided by GNP) is used as the proxy for trade openness.

In addition, the pollution haven hypothesis theorized that industrialized economies seek for cheapest resource endowment nations for relocating their production plants. It is a publicly known fact that most developing countries are ideal locations for accessing cheap resources without complying with strict environmental regulations and policies. Thus, it will be strategically important to relocate production scales to developing nations. It is a more popular approach as the costs associated to meet environmental regulations in industrialized economies are more costly for multinational companies (Levinson & Taylor, 2008). As such, this study captured Foreign Direct Investments (FDI) as another determinant of environmental quality in Sri Lanka and expects a negative effect of FDI on environmental quality in Sri Lanka.

Empirical Model and Data

We employed the Autoregressive Distributive Lag (ARDL) bound test approach to test the hypotheses and a similar estimation technique is adopted by Rahman & Alam (2022); Mesagan & Nwachukwu (2018). It is the superior method to estimate log run and short run coefficients without concerning the lag order of the data set (Gerrard & Godfrey, 1998). Additionally, the ARDL model is adopted for small samples and derives a dynamic error correction model over a simple linear transformation. This study employed the data series covering the period from 1992 to 2021 and the following economic model is adopted following Rahman (2017).

$$CO_2 = f\left(FD_{t,}\, GDP_{t,}\, GDP_{t,}^2\, ENG_{t,}\, To_{t,}\, FDI_t\right) \quad (1)$$

Then, log transform is used to remove the exponential variances in the data set and turn the data into comparable figures. Thus, the economic model (1) can be reorganized as shown in equation (2).

$$lnCO_2 = \alpha + \beta_1 lnFD_t + \beta_2 lnGDP_t + \beta_3 lnGDP_t^2 + \beta_4 lnENG_t + \beta_5 lnTO_t + \beta_6 lnFDI_t + \varepsilon_t \quad (2)$$

Where, CO_2 is carbon emission, FD denotes the financial development, GDP and GDP^2 are real per capita GDP and quadratic form of real per capita GDP. Further, ENG, TO, and FDI denote energy consumption, trade openness, and foreign direct investment respectively. β_1, β_2, β_3, β_4, β_5, and β_6 measure the coefficient of independent variables. ε is the error term of the model and t is the time.

The estimated ARDL model presents in model 3 and the optimal lags for the cointegrating equation grounded on the Akaike Information Criterion (AIC).

$$\begin{aligned}\Delta lnCO_2 = {} & \beta_0 + \beta_1 lnFD_{t-1} + \beta_2 lnGDP_{t-1} + \beta_3 lnGDP^2{}_{t-1} + \beta_4 lnENG_{t-1} + \beta_5 lnTO_{t-1} + \beta_6 lnFDI_{t-1} \\ & + \sum_{i=1}^{p} \delta_1 \Delta lnCO_{2_{t-i}} + \sum_{i=1}^{p} \delta_2 \Delta lnFD_{t-1} + \sum_{i=1}^{p} \delta_3 \Delta lnGDP_{t-1} + \sum_{i=1}^{p} \delta_4 \Delta lnGDP^2{}_{t-1} \\ & + \sum_{i-1}^{p} \delta_5 \Delta lnENG_{t-1} + \sum_{i-1}^{p} \delta_6 \Delta lnTO_{t-1} + \sum_{i-1}^{p} \delta_7 \Delta lnFDI_{t-1} + \varepsilon_t \end{aligned} \quad (3)$$

The bound testing has been tested to observe the presence of long run association among the variables by conducting an F-test for the joint significance of the coefficients of the lagged levels of the variables (null hypothesis of H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ against alternative hypothesis of H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$). After confirming the long-run association, long run regression coefficients are tested by applying model 4 given below.

$$\begin{aligned} lnCO_2 = {} & \beta_0 + \sum_{i=1}^{p} \beta_1 lnFDI_{t-i} + \sum_{i=0}^{p} \beta_2 lnGDP_{t-i} + \sum_{i=0}^{p} \beta_3 lnGDP^2{}_{t-i} + \sum_{i=0}^{p} \beta_4 lnENG_{t-i} + \sum_{i=0}^{p} \beta_5 lnTO_{t-i} \\ & + \sum_{i=0}^{p} \beta_6 lnFDI_{t-i} + \varepsilon_t \end{aligned} \quad (4)$$

Next, the Error Correction Model (ECM) is estimated by using model 5 to establish the short-run dynamics. The negative and significant sign of the Error Correction Term (ECT) supports the existence of short-run association among the variables. The value of the ECT shows the speed of adjustment of the dependent variables (financial development, economic growth, energy consumption, trade openness, foreign direct investment) towards the equilibrium due to the changes in environmental quality. To confirm the goodness of fit of the model, serial correlation and heteroscedasticity are tested. Subsequently, a stability test is conducted by employing the cumulative sum of recursive residuals (CUSUM).

$$\begin{aligned} \Delta lnCO_2 = {} & \delta_0 + \sum_{i=1}^{p} \delta_1 \Delta lnFD_{t-i} + \sum_{i=0}^{p} \delta_2 \Delta lnGDP_{t-i} + \sum_{i=0}^{p} \delta_3 \Delta lnGDP^2{}_{t-i} \\ & + \sum_{i=0}^{p} \delta_4 \Delta lnENG_{t-i} + \sum_{i=0}^{p} \delta_5 \Delta lnTO_{t-i} + \sum_{i=0}^{p} \delta_6 \Delta lnFDI_{t-i} + \psi ECT_{t-1} + \varepsilon_t \end{aligned} \quad (5)$$

Lastly, this study applied a two-way causality test to determine the causal relationship between modelled variables because the ARDL model implies the long-run relationship does not a causal relationship among the variables. The following Granger (1969) Causality model is applied Rahman & Alam (2022);

$$Y_t = \varsigma_0 + \varrho_1 Y_{t-1} + \ldots\ldots\ldots + \varrho_k Y_{t-k} + \varepsilon_1 X_{t-1} + \ldots\ldots\ldots \varepsilon_k X_{t-k} + \omega_t \quad (6)$$

$$X_t = \zeta_0 + \vartheta_1 X_{t-1} + \ldots\ldots\ldots + \vartheta_k X_{t-k} + \xi_1 Y_{t-1} + \ldots\ldots\ldots \xi_k Y + \varphi_t \quad (7)$$

The null hypothesis of Y does not granger causes X and X does not granger cause Y is tested by using the equations 6 and 7.

Stock market development data was gathered from the Colombo Stock Exchange (CSE) database. The required data such as banking sector development, trade openness and real per capita GDP data were collected from the Central Bank's annual reports for several years. Total carbon emission, energy consumption and FDI data were gathered from the World Bank database.

4. Analysis and Discussion

A summary of descriptive statistics of all variables which were selected for the econometric model summarizes in Table 1. The key statistics shown are the mean, median, maximum value, minimum value, standard deviation, skewness, kurtosis, and Jarque-Bera test statistics. All the variables are skewed to right except the financial development index and trade openness. Financial development index and trade openness skewed to left. In addition, descriptive statistics indicate that all selected variables are normally distributed.

Table 1: Descriptive Statistics

Description	CO_2 (Mt.)	ENG (TWh)	FD (% of GDP)	FDI (% of GDP)	GDP (USD)	TO (% of GDP)
Mean	14.582	67.763	27.875	1.2545	2171.63	64.800
Median	13.447	64.020	29.365	1.1575	1533.1	69.935
Maximum	25.511	108.17	41.270	2.8496	4401.0	88.640
Minimum	5.4080	32.000	17.700	0.4298	547.05	38.620
Std. Dev.	6.1196	23.885	5.9387	0.4874	1473.4	14.807
Skewness	0.3527	0.3861	-0.0486	1.0752	0.3497	-0.1615
Kurtosis	2.0760	1.9084	2.3749	5.1069	1.3707	1.4786
Jarque-Bera	1.6894	2.2350	0.4001	11.329	3.9294	3.0236
Probability	0.4296	0.3270	0.8186	0.1234	0.1401	0.2205
Observations	30	30	30	30	30	30

Confirmation of the integrating order of the data set is a necessary condition in the time series analysis technique. Therefore, this paper confirmed the integrated order of the dataset by employing Augmented Dickey-Fuller (ADF) test by formulating the null hypothesis of H_0: $\beta = 0$ and the alternative hypothesis of H_1: $\beta < 0$. The test results are summarized in Table 2 and it indicates that Real Per Capita GDP and FDI established the order of the integration at the level while the rest of the variables confirmed the order of integration at the first difference series which pushed the analysis to the ARDL approach.

Table 2: Unit Root Test Results for the Variables

Variable	Level series	1st difference	Order of integration
CO_2	-1.5637	-6.6000**	I (1)
FD	-1.2226	-5.8284***	I (1)
GDP	-3.7249***	-8.1495***	I (0)
GDP^2	-0.8546	-3.5673***	I (1)
TO	-0.4469	-5.1880**	I (1)
ENG	-1.5052	-4.3225**	I (1)
FDI	-5.9181**	-5.0842***	I (0)

Note: ***, & ** indicates significant at 1%, 5% level respectively.

Source: Results of Analysis of Eviews.

The fitted ARDL model resulted in the optimal lag selection as 2, 2, 0, 2, 1, 1, 2 which fits the lowest Akaike Information Criterion (AIC) value. Successively, the presence of a long-run relationship is tested by conducting F-test for the joint significance of the coefficients of the lagged levels of the variables through the bound test approach. Table 3 shows the results of the ARDL bound test.

Table 3: The results of the ARDL bound test

		Critical Values	I (0)	I (1)
F-statistic	7.9542	10%	1.99	2.94
		5%	2.27	3.28
		1%	2.88	3.99

The results of the bound test prove that the F-statistic (7.9542) exceeds the upper bound at 1% significance level. Hence, the refusal of the null hypothesis of no long-run association confirms the cointegration among observed measurements. Furthermore, it shows the existence of a linear combination between the log series of carbon emission, financial development, economic growth, the square of economic growth, trade openness, energy consumption and foreign direct investments in Sri Lanka. Interestingly, it confirms that observed variables move together with environmental quality in the long run. The existence of a long-run association assures the requisite of testing long-run coefficients to scrutinize the long-run impact of financial development on environmental quality in Sri Lanka. It is because the long-run impact of observed dimensions on environmental quality can be positive or negative in Sri Lankan context.

Furthermore, estimates of the long-run coefficients present in Table 4. It shows that financial development, energy consumption, foreign direct investments and economic growth significantly determine the level of environmental quality in Sri Lanka. Interestingly, financial market development indicates a significant impact on environmental quality which means that financial development directly influences environmental quality in the long run in Sri Lanka. As an illustration, 1% upsurges in financial development, keeping other variables constant, result in to increase in carbon emission by 0.092% in Sri Lanka. Especially, this result is opposing the findings of Alabi, et al (2021) because it revealed an insignificant long-run impact of financial development on environmental quality in Sri Lanka. Besides, the findings are consistent with the studies done by Rahman & Alam (2022);Tamazian et al (2009); Shahbaz et al., (2013a); Shahbaz et al., (2013b); Shahbaz et al., (2013c).

Table 4: Estimates of Long-run Coefficients

Variable	Coefficient	Std. error	t-statistic	Prob.
LFD	0.092842	0.028015	3.314016	0.0069***
LENG	1.241028	0.327401	3.790543	0.0030***
LFDI	0.299738	0.141709	2.115166	0.0581*
LGDP	3.807499	1.498171	2.541432	0.0274**
$LGDP^2$	-0.558393	0.231223	-2.414961	0.0343**
LTO	-0.431655	0.611062	-0.706401	0.4946
C	-6.708379	2.227188	-3.012040	0.0118

Note: ***, ** & * indicates significant at 1%, 5% and 10% level respectively.

Source: Results of Analysis of Eviews.

As per the formulated hypothesis stated before, energy consumption in Sri Lanka shows a negative effect on environmental quality in the long run and our findings are consistent with the findings of Mirza & Kanwal (2017); Soytas et al. (2007). The attributable reason for the results is the higher use of non-renewable energy sources in the country during the last four decades. Surprisingly, the observed significant coefficient of FDI aligns with the formulated hypothesis of the study. It establishes a negative impact of foreign direct investments on environmental quality in Sri Lanka and the findings of this study supports the arguments of Kheder and Zugravu (2012); Rahman et al., (2019). In addition, the negative impact of FDIs on environmental quality supports establishing the pollution haven hypothesis in Sri Lanka and FDIs would be a disadvantage for Sri Lanka due to the environmental degradation and FDIs not transferring any greener technologies to Sri Lanka (Mert & Emre, 2020). Interestingly, this finding challenges the findings of Alabi, et al (2021) along with some other established literature in emerging countries.

This empirical investigation confirms a positive and significant relationship between economic growth and environmental quality in Sri Lanka. It confirms that the scale of economic activities directly impacts the increase in carbon emissions in Sri Lanka. It is true that the greater scale of economic activities will demand more inputs to be used which in turn increases the ecological hazards (Halkos & Polemis, 2017). Moreover, the non-linear form of economic growth ($LGDP^2$) shows a negative and significant impact towards the carbon emission in Sri Lanka which validates the presence of the EKC hypothesis in Sri Lanka. The observed coefficient of trade openness suggests an insignificant impact of trade openness towards the level of carbon emission in Sri Lanka. Interestingly, it further challenges the findings of Grossman and Krueger (1991) and supports the findings of Alabi, et al (2021).

The short-run regressors on environmental quality are tested using the Error Correction Model (ECM) of the ARDL approach. The findings of the short-run test are summarized in Table 5. The error correction term is negative and statistically significant which suggests that total carbon emission returns to its equilibrium after a change in financial development indicators and other tested variables at a speed of 68.61%. Further, it presents a short-run association between carbon emission and regressors. In the short run, all variables play a crucial role in determining the quality level of the environment in Sri Lanka.

Table 5: Estimates of Short-run Coefficients

Variable	Coefficient	Std. error	t-statistic	Prob.
D(LFD)	0.026556	0.007350	3.613140	0.0041***
D(LFD(-1))	0.023588	0.007552	3.123645	0.0097***
D(LENG)	0.439196	0.086604	5.071312	0.0004***
D(LFDI)	0.005974	0.019072	0.313249	0.7600
D(LFDI(-1))	0.063175	0.023806	2.653747	0.0224*
D(LGDP)	6.729837	1.239003	5.431656	0.0002**
D($LGDP^2$)	-1.000398	0.192971	-5.184201	0.0003**
D(LTO)	0.016222	0.103827	0.156237	0.8787
D(LTO(-1))	0.812539	0.118266	6.870425	0.0000***
CointEq(-1)	-0.686165	0.067243	-10.20432	0.0000***

R-squared: 0.8852, Adjusted R-squared: 0.8278, Durbin-Watson statistic: 2.0008

Note: ***,** &* indicates significant at 1%, 5% and 10% significant level respectively

More importantly, Financial development impacts carbon emissions in the short run. It illustrates, 1% improvement in the financial sector increases the carbon emission by 0.02% while other factors do not change. However, short-run elasticity for financial development is a lesser than long-run elasticity. Energy consumption also contributes to increasing the carbon emission of Sri Lanka in the short-run and the short-run impact is slightly lesser than the long-run impact. The short-run impact of energy consumption on environmental quality might indicate the increase in renewable energy in the electricity mix in 2014 and achieved the target of generating 10% of the share from renewable energy sources. In addition, the contribution of fossil fuels to the electricity mix decreased in 2015 and Asian Development Bank financed 70% of a wind power plant in Sri Lanka[1]. FDI is also statistically significant in lag one and it further validates the existence of the pollution haven hypothesis in Sri Lanka. However, the short-run adverse effect is much lesser than the long-run impact. Both short-run coefficients of linear and non-linear economic growth indicators are statistically significant and reaffirm the existence of EKC in the Sri Lankan context. Further, short-run elasticities of Real GDP and square of GDP are taking bigger values than long-run coefficients of themselves which implies the existence of inverted-U EKC in Sri Lanka. This supports establishing the empirical findings of Rahman & Vu (2021). Additionally, the R-squared value of the tested short-run model is 0.8852 indicating that 88.52% of the total variation in the environmental quality can be jointly described by the regressors which are employed in this study. Further, the R-squared value (0.8852) is less than the Durbin-Watson statistics (2.0008), confirming the fitted model is not a spurious model.

Finally, the results of the Granger causality test are presented in Table 6. The existence of cointegration of the ARDL between the modelled variables suggests that there should be at least one-way causality between the variables. By confirming that, the results support to rejection of the null hypothesis and led to accept the alternative hypothesis. That is, financial development, energy consumption, per capita GDP, the square of per capita GDP and foreign direct investments granger cause the environmental quality, reflecting unidirectional causality. However, no causality is observed between trade openness and environmental quality in Sri Lanka.

[1] Sri Lanka – Energy Sector Assessment, Strategy, and Road Map, ADB Bank, 2019

Table 6: Results of the Granger Causality Test

Null Hypothesis	F- statistic	Decision
LFD does not Granger Cause LEQ	0.90001* [0.0697]	Unidirectional causality from FD to EQ
LEQ does not Granger Cause LFD	2.99661 [0.4204]	
LENG does not Granger Cause LEQ	3.89808** [0.0348]	Unidirectional causality from ENG to EQ
LEQ does not Granger Cause LENG	0.24259 [0.7866]	
LFDI does not Granger Cause LEQ	2.80783* [0.0811]	Unidirectional causality from FDI to EQ
LEQ does not Granger Cause LFDI	0.06054 [0.9414]	
LGDP does not Granger Cause LEQ	2.21660* [0.0517]	Unidirectional causality from GDP to EQ
LEQ does not Granger Cause LGDP	0.22075 [0.8036]	
$LGDP^2$ does not Granger Cause LEQ	2.24560* [0.0686]	Unidirectional causality from GDP^2 to EQ
LEQ does not Granger Cause $LGDP^2$	0.22550 [0.7999]	
LTO does not Granger Cause LEQ	4.44477 [0.1233]	No causality
LEQ does not Granger Cause LTO	1.97588 [0.1615]	

Note: ** & * denote that sataistical significant at 5% and 10%, respectively.
Parenthesis "[.]" indicates the probability values

The results of Diagpnotic tests

Breusch-Godfrey Serial Correlation LM test Heteroskedasticity Test: Breusch-Pagan-Godfrey, normality test and CUSUM test are done and test results summarize in Table 7. The respective probability value of the Breusch-Godfrey Serial Correlation LM test surpasses the 5% critical value and it proved that no serial correlation in the residuals of the fitted model. Besides, heteroskedasticity test statistics showed statistically insignificant outcomes which indicate that the heteroskedasticity is nonexistent in the fitted model and the residual series is homoscedastic. Moreover, Jarque-Bera statistics verify that the residuals in the model are normally distributed. The CUSUM test (Figure 1) and CUSUMSQ test (Figure 2) show that the CUSUM statistic falls within the critical bounds at 5% by confirming that the selected time series investigation is steady over the long run and short run. The statistics of all the above diagnostic tests show that the model specifications are very well constructed.

Table 7: The results of diagonostic tests

Breusch-Godfrey Serial Correlation LM Test	0.278491 [0.7632]
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.662133 [0.7799]
Jarque-Bera	0.731020 [0.6938]

Parenthesis "[.]" indicates the probability values

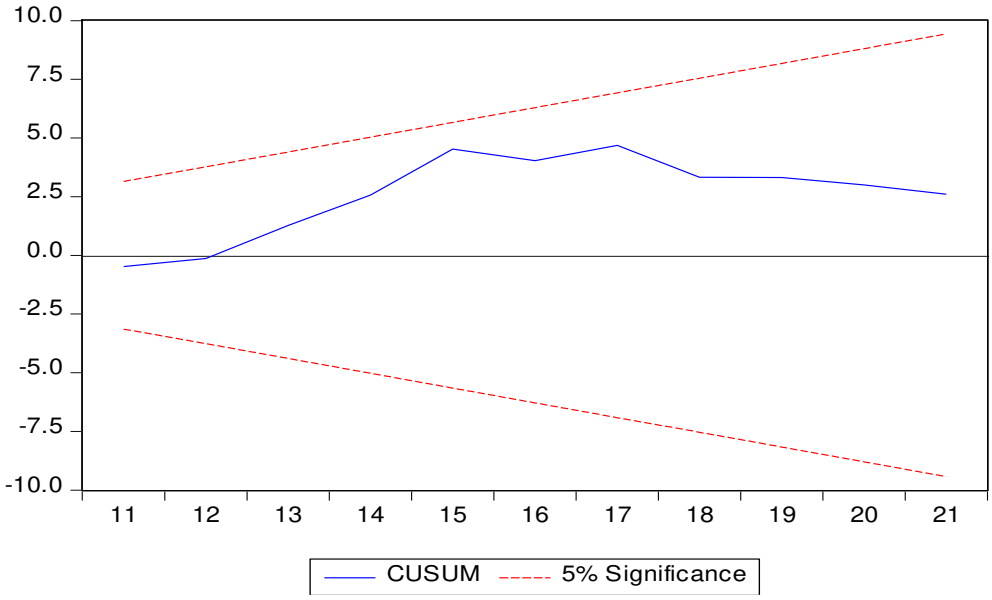

Figure 1: Plots of CUSUM Test

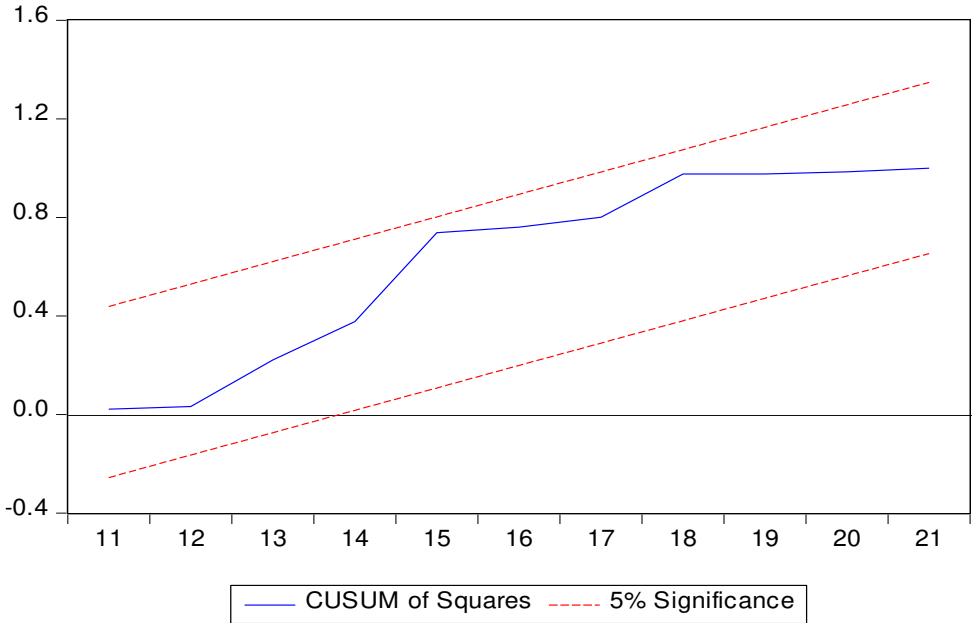

Figure 2: Plots of CUSUMQ Test

5. Conclusion and Policy Implications

Currently, the entire world is extremely challenged by climate change which is obviously happening now in the world. There are clear evidences that a decrease in the quality of the environment is directly attributable to climate change. As such, this study attempted to figure out how financial development affects the environmental quality in one of the developing economies. As per the study findings, financial development adversely impacts environmental quality in Sri Lanka in the long-run and short-run. Moreover, economic growth, energy consumption and FDI adversely affected the environmental quality in the long run and short-run. However, the role of trade openness is insignificant in the long-run and it adversely impacts the environmental quality in the short-run. More importantly,

the study findings established the existence of inverted-U EKC in Sri Lanka. Furthermore, foreign direct investments deteriorate the ecological quality in the long run and short run and it does not pass greener technologies to the economy. Therefore, it validates the presence of the Pollution Haven Hypothesis (PHH) in the host country of Sri Lanka.

As per the findings, numerous policies may be recommended to the government for promoting environmental quality in Sri Lanka. First, the results imply that financial development positively impacts carbon emissions. Thus, the entire financial system should have a prime responsibility for allocating capital to green activities which promotes a green inclusive financial system in the country. Especially, financial intermediaries should promote carbon-zero project financing and financial governing bodies should come up with a clear policy framework to implement and govern the green financing mechanism of financial intermediaries. Secondly, government should promote green growth by initiating inclusive growth strategies and implementing emission regulations, especially on trade including both domestic and foreign trade. Thirdly, policymakers should set up long-term strategies for promoting sustainable energy sources which protect the environmental quality in the country. More importantly, a well-established policy framework is needed to attract environmentally healthy FDI to Sri Lanka which will bring innovative production and service facilities that assist to reduce the total carbon emission in Sri Lanka. In addition, we recommend establishing a strong environment regulations to monitor and control the existing foreign investment projects which damage the environment in Sri Lanka.

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