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Intertemporal relationship between tourism demand and environmental quality in Sri Lanka

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Abstract

The aim of this study is to investigate the intertemporal relationship between tourism demand and environmental quality in Sri Lanka for the period of 1970-2018. In this study, both exploratory data analysis and inferential data analysis tools were employed. The exploratory data analysis technique involves the tools of scatter plots with confidence ellipse, whereas the inferential data analysis technique consists of the ADF unit root test, the autoregressive distributed lag (ARDL) Bounds cointegration technique, the Pairwise Granger Causality test, and the variance decomposition test. The test result of exploratory data analysis confirms that tourism demand has a positive relationship with environmental degradation. The ADF unit root test result indicates that the variables used in this study are in mixed order. The ARDL Bounds cointegration test result confirms that tourism demand in Sri Lanka causes s the environmental quality to decline in both the long-run and the short-run. Further, the causality test result reveals that tourism demand leads to environmental degradation. The variance decomposition analysis finds that innovation in tourism demand increasingly step by step contributes to forecasting error variance in the environmental quality till the 10^{th} period.

Keywords: ARDL Bounds test, Ganger causality, Variance decomposition, Environmental quality, tourism demand, Sri Lanka.

1. INTRODUCTION

In the past eight consecutive years, the contribution of tourism to global Gross Domestic Product (GDP) is increasing (Aslam, 2016; Aslan et al., 2020; Balli, et. al.,2019; Balsalobre-Lorente et. al., 2020). Accordingly, the total contribution of the tourism sector to the world GDP was US$ 8.8 trillion (10.4% in GDP) in 2018. Tourism demand for the worth of nearly 1.5 billion was recorded in 2019 which was an increase of 4.4% compared to the previous year. Based on the statistics published by the world tourism organisation, the tourism demand in almost all the regions in the world shows an increasing trend. The United Nations tourism travels Secretary-General for the year 2020 states that tourism is a consistent economic sector due to being the heart of global development. In fact, the tourism sector affords the best remedy for less income countries for uplifting their economies by generating income and job-opportunities, thereby enabling these countries to modernise remote areas and also speed up cultural development (Aslan et al., 2020; Balli, et. al.,2019; Balsalobre-Lorente et. al., 2020).

By creating job opportunities and other positive attitudes, the tourism sector helps to attain all sustainable development goals (SDGs) introduced by the United Nation (Danish, & Wang, 2018; Haseeb et al., 2018; Dogan et al., 2017; Eyuboglu

& Uzar, 2020). Notably, the first two goals of SGDs are no poverty and zero hunger may be overcome by tourism development. However, in spite of creating better jobs and other positive attitudes, the tourism sector consumes high energy which causes environmental degradation through pollution (Katircioglu, et al., 2014; Khan, et al.,2020; Koçak, et. al., 2020; Kumail, et al., 2020; Liu, et al.,2019; Paramati, et. al., 2017). Although the tourism demand does not directly consume the energy, the tourism demand indirectly causes at an average 55% of carbon dioxide emission every year. Demand for energy is an important concept that needs to be taken into consideration when studying the tourism sector's impact. The International Energy Agency notes that world energy demand induced by the tourism sector may be increased by 28% until 2060, which may have a negative influence on the environment owing to the emission of carbon dioxide to the atmosphere. This negative impact on the environment may result in economic imperfection. Thus, the development policymakers now stress the necessity of environmental protection for achieving sustainable economic development [Khan, et al.,2020; Koçak, et. al., 2020; Kumail, et al., 2020; Liu, et al.,2019; Paramati, et. al., 2017].

Sri Lanka is a developing country which has a number of places of tourist attraction. Because of these tourist spots and other positive perceptions, the tourism demand in Sri Lanka has rapidly grown in the last few decades. However, one of the important findings of tourism-related studies is that tourism demand is a factor that causes environmental degradation. I In the case of Sri Lanka, there is no valid empirical study that investigates whether tourism demand is a factor for environmental degradation. Therefore, this remains an unresolved issue empirically in Sri Lanka. The main motivation of this study is to find the answer to the research question of whether tourism demand is a factor that accounts for the degradation of the environment in Sri Lanka. The objective of this study is to examine the intertemporal relationship between tourism demand and environmental quality in Sri Lanka. Further, no research so far has considered the relationship between tourism demand and environmental quality in the Sri Lankan context. By investigating this relationship, it is hoped that this study will contribute more information to the existing literature.

The remaining of this study is structured as follows: Section 2 provides the literature review carried out, section 3 discusses the research methods employed in this study, section 4 presents empirical results and discussion, and section 5 is the conclusion which also states the policy recommendation.

2. LITERATURE REVIEW

When studying the impact of tourism on economic development, testing the relationship between tourism demand and environmental quality is an absolutely important for the tourism policy development framework. As a consequence of the growing importance of this topic, many works of literature have empirically investigated this relationship in different countries by using macro-level data. In this respect, this study reviews the previous literature related to the present study. In the previous literature, Singha, (2012) analyses the nexus between tourism and environment in Bhutan, which finds that tourism causes the decline of the environment. Katircioglu, et al., (2014) investigate the long-run equilibrium relationship among international tourism, energy consumption, and carbon dioxide emissions. This study confirms that international tourism increases carbon dioxide emissions in such countries. Solarin, (2014) investigates the factors that cause carbon dioxide emission with special emphasis on tourism development in Malaysia; this study asserts that tourist inflow leads to a drastic increase in pollution. Işik, et al., (2012) investigate the dynamic causalities between economic growth, financial development, international trade, tourism expenditure and the CO_2 emissions in Greece over the period of 1970–2014. This study confirms that tourism engenders CO_2 emission in Greece. Eyuboglu & Uzar (2020) investigate the impact of tourism on CO_2 emission in Turkey. This study concludes that the tourism arrivals induce CO_2 emission in the long-run and the short-run over the study period. Kumail, et al., (2020) investigate the relationship between tourist arrivals and CO_2 emissions in Pakistan over the

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period of 1990 – 2017. This study concludes that tourism sector causes the decline of the quality of the environment.

Further, Dogan, et al., (2017) analyse the impact of tourism on CO_2 emissions in Organisation for Economic Co-operation and Development OECD countries. This study finds that tourism sector in focal countries increase CO_2 emissions. Paramati, et al., (2017) comparatively examine in both developed and developing countries, the dynamic relationships among tourism, economic growth, and CO_2 emissions. This study reveals that tourism reduces the quality of environment much faster in developed economies than in developing economies. Danish & Wang (2018) examine the dynamic relationship between tourism, economic growth, and CO_2 emissions from 1995 to 2014 in the context of BRICS economies. In this study, the empirical findings reveal that tourism sector significantly contributes to economic growth, but degrades the quality of the environment. Haseeb, et al., (2018) empirically investigates the linkages among corruption, democracy, tourism, and CO_2 emissions for selected disaggregate and aggregate panel data over the period 1995-2015. This study indicates that the corruption and tourism at disaggregate and aggregate levels are substantial contributors of CO_2 emissions. Balli, et al., (2019) examine the impact of tourism on Co_2 in Mediterranean countries; this study finds that tourism causes the CO_2 emission to rise in such countries.

Satrovic & Muslija (2019) investigate the relationship between tourism and environmental quality in the top 10 tourist destinations over the period 1995-2016. This study finds that tourism is one of the important factors that causes low environmental quality. Khan, et al., (2020) test the relationship between tourism and CO_2 emission in Belt & Road Initiative (BRI) countries over 1990–2016. This study concludes that the tourism sector increases environmental degradation. Sherafatian-Jahromi, et al., (2017) investigate the impact of tourism development, renewable energy and the real GDP on CO_2 emissions for G20 economies for the period of 1995-2015. This study confirms that tourism sector promotes the environmental degradation in such countries. Aslan, et al., (2020) examine the impact of tourism development on CO_2 emissions over the 1995 to 2014. In this study, empirical results indicate that tourism arrivals have an adverse effect on CO_2 emissions. One of the works with a slightly different finding is Liu, et al., (2010) which studies the dynamic relationship between international tourist receipts, economic growth, energy and carbon dioxide (CO_2) emissions in Pakistan over the period 1980-2016 and concludes that tourism have no significant impact on environmental quality.

Based on the literature reviewed in this study, it can be concluded that almost all works in the literature have mixed conclusion regarding the relationship between tourism demand and environmental quality. However, in the case of Sri Lanka, there is not sufficient evidence in terms of scholarly works to conclude that tourism demand in Sri Lanka decreases environmental quality. Thus, it is hoped that the findings of the study will help fill the existing research gap.

3. RESEARCH METHOD

3.1 EMPIRICAL MODEL SPECIFICATION

Empirical literatures reviewed in this study, notably (Katircioglu, et al., (2014), Sherafatian-Jahromi, et al., 2017; Satrovic & Muslija, 2019; Koçak, et al., 2020) have used a number of variables to examine the relationship between tourism demand and environmental quality. However, after carefully reviewing the literature discussed above, this study has communicated the following mathematical function to investigate the relationship between tourism demand and the environmental quality in the Sri Lankan context. Thus, the mathematical function of the empirical model of this study can be written as:

(1)

$$Co_{2t} = f(TD_t, GDP_t, Econ_t)$$

where Co_{2t} is carbon dioxide emission per-capital in metric tons which is a proxy variable for environmental degradation; TD_t represents tourism arrivals which is a proxy variable for tourism demand; GDP_t denotes gross domestic

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product; and $Econ_t$ is electric power consumption per-capita in kilowatts which is proxy for energy consumption.

Based on the mathematical function (1), the empirical model specification of this study can be written in natural logarithmic form as follows:

(2)

$$lnCo_{2t} = \beta_0 + \beta_1 lnTD_t + \beta_2 lnGDP_t + \beta_3 lnEcon_t + u_t$$

where β_0 is the constant term, $\beta_1 - \beta_3$ are coefficients of variables used in this study, ln is the notation of natural logarithmic, while u_t is the error term.

3.2 DATA

In this study, we used the time series data for the variables of carbon dioxide emission per-capital in metric tons, tourism arrivals which is a proxy variable for tourism demand, gross domestic product and electric power consumption per-capita in kilowatts which is proxy for energy consumption over the period of 1970-2019. The data for tourism demand were collected from the annual statistical reports published by the Sri Lanka tourism development authority (SLTDA) in different years. Further, the data for the variables of carbon dioxide emission, gross domestic product and electricity consumption were gathered from the databases of the World Bank. In addition, the variables of carbon dioxide emission were considered the dependent variable and others: tourism demand, gross domestic product and electric power consumption were independent variables. All the data for the variables used in this study were converted into natural logarithms for transforming the series into linearity.

3.3 ANALYTICAL APPROACHES

In order to achieve the objective of this study, we employed both exploratory data analysis (EDA) and inferential data analysis (IDA) techniques. The EDA consists of scatter plots, confidence with ellipse, whereas the IDA has three types of analytical techniques such as the cointegration technique; the Pairwise Granger Causality test, and variance decomposition analysis.

3.3.1 UNIT ROOT TEST

Since this study uses time series data, testing the order of integration of the variables used in this study is essential [1-3]. In that respect, the Augmented Dickey-fuller (ADF) unit root test was employed to test the order of integration of the variables used in this study.

3.3.2 LAG SELECTION PROCEDURE

Once the order of integration of the variables used in this study has been determined, the next step is the selection of the optimal lag length under the vector auto regression (VAR) environment. In order to select the optimal lag length, a number of lag selection criteria have been employed in the empirical studies, of which the Akaike Information Criterion (AIC) is the widely used lag selection criterion in the empirical studies. Thus, this study employed the Akaike Information Criterion (AIC) to select the optimal lag-length model.

3.3.3 COINTEGRATION TEST

Having confirmed the order of integration of the variables and the optimal lag-length, we tested the long-run relationship between the variables. To examine this relationship, there are a number of cointegration tests such as the Johansen Juselius likelihood cointegration, and the autoregressive distributed Bounds test used in the empirical studies examining the relationship between tourism demand and environmental degradation. Both cointegration techniques will be used in different situations, respectively. However, in the case of this study, as the variables used in this study given in Table 1 are in mixed order, we selected the autoregressive distributed Bounds cointegration technique to test the relationship between tourism demand and environmental degradation. Satrovic & Muslija (2019) point out that the ARDL Bounds cointegration test has the following advantages compared to the Johansen Juselius likelihood cointegration, which are: (a) while the Johansen Juselius likelihood cointegration method accepts the same order variables, the ARDL method admits the mixed order variables either $I(0)$ or $I(1)$, fractionally integrated variables, but does not allow $I(2)$ or higher-order variables; (b) the ARDL method tolerates the small and finite sample but other cointegration methods need a big sample in order for the examination to be applied; (c) while other cointegration methods individually apply the long-run and short-run estimation, the ARDL cointegration method help estimate both the long-run and short-run estimation in a single reduced form of the equation.

The ARDL cointegration method used the following unrestricted error correction model (UECM):

(3)

$$\Delta lnCo_{2t} = \beta_0 + \sum_{i=1}^{m} \beta_1 \Delta lnCo_{2t-1} + \sum_{i=0}^{m} \beta_2 \Delta lnTD_{t-1} + \sum_{i=0}^{m} \beta_3 \Delta lnGDP_{t-1} + \sum_{i=0}^{m} \beta_4 \Delta lnEcon_{t-1} + \delta_1 lnCo_{2t-1} + \delta_2 lnTD_{t-1} + \delta_3 lnGDP_{t-1} + \delta_4 lnEcon_{t-1} + u_t$$

where Δ denotes the 1^{st} difference operator, m is the optimal lag length, β_0 is the drift component, $\beta_1 - \beta_4$ indicate the short-run coefficient, $\delta_1 - \delta_4$ illustrate the long-run coefficients of the variables used in this study.

Based on the UECM given in equation (3), the joint null hypothesis that there is no long-run relationship between the variables used in this study $[H_0: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0]$ was tested against the alternative hypothesis that there exits a long-run relationship between the variables used in this study $[H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0]$. There are two sets of alternative critical values at different significance levels that were used in this study to arrive at the conclusion about the long-run relationship between the variables. The first set of critical values represent the lower Bounds critical values that assume that all the regressors are $I(0)$ and the second set of critical values denote the upper Bounds critical values that assume that the regressors used in this study are $I(1)$. By comparing the calculated F-statistic with Bounds critical values, three conclusions can be taken: (1) if the calculated F-statistic is greater than the upper Bounds critical values at any significance level, it can be assumed/concluded that the variables used in this study are cointegrated among them; (2) if the calculated F-statistic is less than the lower Bounds critical values at any significance levels, it can be concluded that the variables used in this study are not cointegrated among them; (3) in case the calculated F-statistic lies between the upper and lower Bounds critical values at any significance levels, the decision about the long-run relationship between the variables used in this study cannot be taken.

In case the long-run relationship between tourism demand and environmental degradation is confirmed, the next step of this study is to test the short-run dynamics of the variables used in this study. In order to do that, the following error correction model (ECM) was employed:

(4)

$$\Delta lnCo_{2t} = \beta_0 + \sum_{i=1}^{m} \beta_1 \Delta lnCo_{2t-1} + \sum_{i=0}^{m} \beta_2 \Delta lnTD_{t-1} + \sum_{i=0}^{m} \beta_3 \Delta lnGDP_{t-1} + \sum_{i=0}^{m} \beta_4 \Delta lnEcon_{t-1} + \pi ECT_{t-1} + u_t$$

where: π is the coefficient of speed of adjustment parameter, which is expected to be negative, less than one, and statistically significant. If the coefficient of speed of adjustment fulfil all the expectations, it may be concluded that the response variable of this study (environmental degradation) returns to the long-run equilibrium.

Having confirmed the long-run relationship between the variables used in this study, it is necessary to test the robustness of the estimated ARDL model given in Equation (3). . In order to validate the estimated ARDL model, this study considered the following tests: (1) the Breusch-Godfrey serial correlation LM test; (2) the heteroskedasticity ARCH test; and (3) the Jarque-Bera normality test. Furthermore, the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of square recursive residuals (CUSUMSQ) tests were also employed to confirm the stability of the estimated model of this study.

3.3.4 CAUSALITY TEST

Testing the shot-run and long-run causality between the variables is the next step in this study. In order to examine the direction of causality between the variables used in this study, both Pairwise Granger Causality test for testing the short-run causal relationship and the error correction term given in Equation (2) for examining the long-run causal relationship were performed.

The pairwise Granger causality is defined as X_t is said not to Granger cause as Y_t if

(5)

$$E(Y_{t+h}|J_t, X_t) = E(Y_{t+h}|J_t)$$

Where J_t denotes the information is sets considering the past observation of X_t and Y_t up to and including time (t).

Therefore, by using equation (5), the short-run causal direction between the variables used in this study was examined. However, by employing the error correction term given in equation (2), the long-run causal relationship between the variables used in this study was tested.

3.3.5 VARIANCE DECOMPOSITION TEST

Examining the variance decomposition analysis is the next step of this study. The variance decomposition test or forecast error variance decomposition test of multivariate dynamic system shows the relative importance of shock to each innovation in affecting the forecast error variances of all variables in the system.

The general form of the variance decomposition of y_{kt} (variable k) m periods into the future, attributable to a one-standard deviation innovation shock to y_{jt} is:

(6)

$$y_{mjk} = \frac{\sum_{t=0}^{m-1}\left(e'_k C_t e_j\right)^2}{\sum_{t=0}^{m-1} e'_k \emptyset_t \sum \emptyset'_t \, e_k}$$

where e_j is a selection vector of length member of series containing a 1 in element j and zero elsewhere; for orthogonalized variance decompositions $C_m = \emptyset_m P$, where P is the lower triangular factor in the Cholesky factorisation of Σ, for generalized variance compositions $C_m = \sigma_j^{-1}\emptyset_m\Sigma$, where σ_j is the standard deviation of innovation j, the numerator id the contribution shock to variable j to the forecast error variance of the m- step ahead forecast variable k. the denominator is the mean square error (MSE) of the m-step-ahead forecast of variable k.

4. EMPIRICAL FINDINGS

In this section, we present the test results of analytical tools such as exploratory data analysis (EDA) and inferential data analysis (IDA) that have already been discussed in the research methods section of this study.

Figure 1 shows the visual inspection of the relationship between tourism demand and

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environmental degradation in Sri Lanka by using scatter plots with confidence ellipse, which confirms that when tourism demand increases the environmental quality continuously degrades.

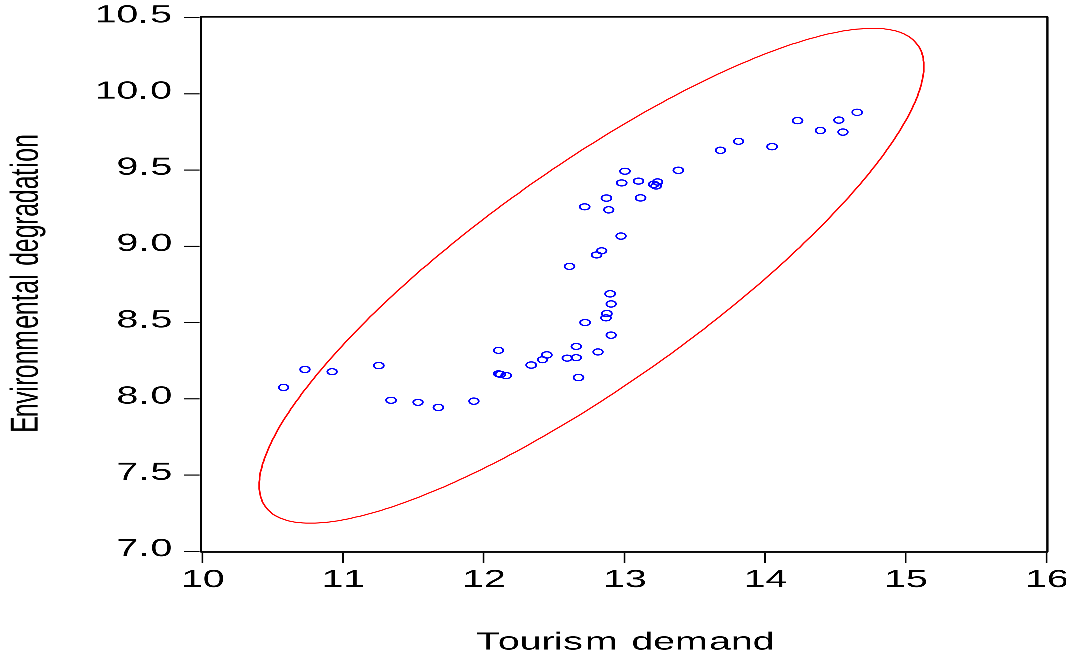

Figure 1. Association between tourism demand and environmental degradation
Source: EViews software

Illustrated in Table 1 are the unit root test results which indicate that the variables used in this study are in mixed order. The variables of carbon dioxide, gross domestic product, and tourism demand are non-stationary at their level as the corresponding *p*-value of these variables are greater than 5% significance level, on the other hand, the particular variables are stationary at their 1st difference as the corresponding p-value is less than 5% significance level. Further, the variable of electricity consumption is stationary at its level as the corresponding p-value is less than 5% significance level. Further, the unit root test results informs us that the variables used in this study are not *I*(2) or higher order.

Table 2 shows the test results of optimal lag length. As stated in the research method section, the Akaike Information Criterion (AIC) is used to select the optimal lag length of this study. In the case of this study, as the 6th lag has optimal value, this lag is selected to find the appropriate ARDL model of this study.

Shown in Figure 2 is the graph of 20 appropriate ARDL models that have been produced by the 6th lag under Akaike Information Criterion in which, the ARDL (6, 3, 5, 2) model has the optimal lag length compared to others. As the ARDL (6, 3, 5, 2) model has the optimal lag-length, this study utilized the ARDL model to test the long-run relationship between tourism demand and the environmental quality in Sri Lanka.

Table 3 presents the cointegration test results of this study. The calculated F-statistic given in Table 3 is 5.27 which is greater than the upper bound critical value of 4.35 at 5% significance level. Thus, the null hypothesis that there is no long-run relationship between the variables used in this study is rejected, implying that there is a long-run relationship between the variables used in this study.

Table 1. ADF unit root test results

Variable	Augmented Dickey-Fuller (ADF) test		Decision
	At level	1st difference	
$lnCO_{2t}$	-2.421 (0.363)	-2.971 (0.045)	$I(1)$
$lnTD_t$	-0.896 (0.781)	-4.816 (0.000)	$I(1)$
$lnGDP_t$	-2.033 (0.568)	-7.404 (0.000)	$I(1)$
$lnECon_t$	-3.746 (0.028)	-7.531 (0.000)	$I(0)$

Source: EViews software

Table 2. VAR lag selection criteria

Lag	Lag selection criteria		
	AIC	SC	HQ
0	1.181227	1.345060	1.241644
1	-7.866414	-7.047251*	-7.564332*
2	-7.734909	-9.260415	-7.191161
3	-7.799765	-5.669942	-7.014352
4	-7.769139	-4.983986	-6.742061
5	-8.313516	-4.873032	-7.044772
6	-8.789962*	-4.694148	-7.279552

Source: EViews software

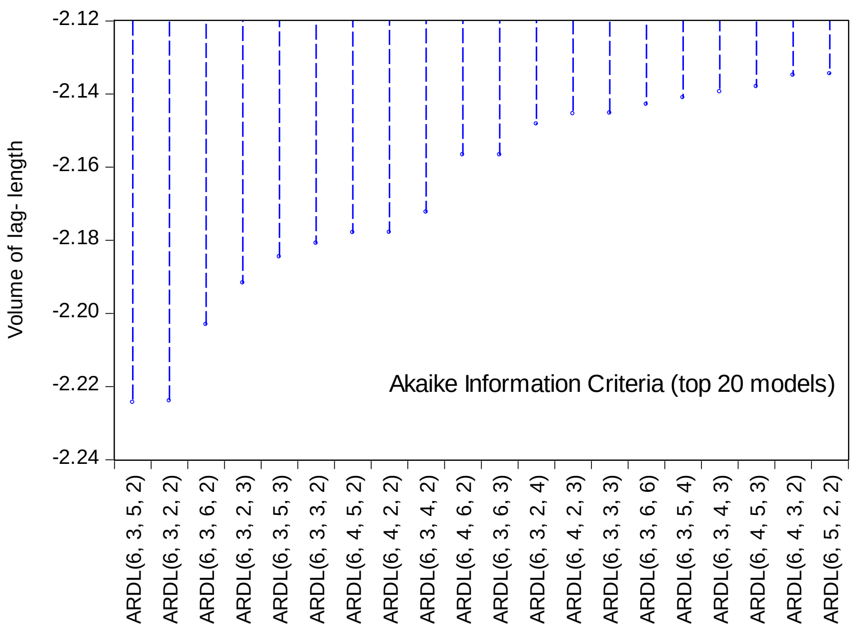

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Figure 2. Graph of AIC model selection criterion (Source: EViews software)

Table 3. ARDL Bounds test results

Test statistic	Value	
F- Statistic	**5.27**	
K	3	
Significance	*I*(0) Bound	*I*(1) Bound
10%	2.72	3.77
5%	3.23	**4.35**
2.5%	3.69	4.89
1%	4.29	5.61

Source: EViews software

Presented in Table 4 are the long-run coefficients of the variables used in this study. In this study, the key independent variable is tourism demand which is noted by the proxy variables of tourists' arrivals. This variable positively influences the carbon dioxide at 5% significance level. The estimated coefficient of tourism demand explains that 1% increase in tourism demand raises the carbon dioxide by 0.36% which shows that the environment is degraded by 0.36%. This is empirically true because if the tourism demand increases, the subordinate industries may be induced. Under this circumstance, the polluted actives on the environment may increase. Therefore, environmental degradation may increase in Sri Lanka induced by the increase in tourism demand. This finding is in line with studies of (Singha, 2012; Solarin, 2014; Paramati, et al., 2017; Sherafatian-Jahromi, et al., 2017; Satrovic & Muslija, 2019; Shi, et al., 2020). The variable of GDP is one of the policy variables used in this study which positively affects the carbon dioxide at 1% significance level. In that respect, the estimated coefficient indicates 1% increases in GDP increases the carbon dioxide by 0.45%. This finding is theoretically accepted because if GDP increases, the wealth of the nation will also increase. If so, this will led to the emergence of many factories in Sri Lanka as being induced by GDP. Therefore, a huge number of factories may emit more carbon dioxide. Therefore, it may be assumed that increasing GDP in Sri Lanka may cause environmental degradation. This finding confirms studies of (Liu, et al., 2019; Satrovic & Muslija, 2019; Shi, et al., 2020). The variable of energy consumption has a positive influence on the carbon dioxide at 1% significance level. The estimated coefficient of energy consumption indicates that 1% upsurges in energy consumption increases carbon dioxide by 0.48%. This finding is also theoretically true because if energy consumption increases the wastages too may increase. If so, the quantity of carbon dioxide emitted to the environment increases which results in an increase in environmental pollution. This finding is consistent with studies of (Liu, et al.,2019; Katircioglu, et al., 2014; Khan, et al., 2020; Koçak, et al., 2020; Kumail, et al., 2020).

The short-run dynamics of the variables including the error correction term used in this study are presented in Table 5. The estimated coefficient of error correction term (ECTt-1) given in Table 5 shows a negative sign, and is statistically significant at 1% level. The negative sign indicates that the response variable of carbon dioxide (CO_2) moves towards the long-run equilibrium path. The estimated coefficient of error correction term is -0.395 denoting that 39.5% of disequilibrium will be adjusted every year. Further, the estimated coefficients of the variables used in this study statistically affect the carbon dioxide in different lag periods. Accordingly, the variable of tourism demand positively affects the variable of carbon dioxide at 1% significance level in one period lag. Moreover, the variable of gross domestic product has a positive relationship with the dependent variable at 10% significance level. In the meantime, the energy consumption positively affects the carbon dioxide at 5% significance level in one period lag. The finding of this study in the

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case of tourism demand in the short-run is practically true because when tourism demand increases in the short-run, there is an increase in tourism related industries which causes the decline of the quality of the environment.

Table 6 shows the diagnostic test results of the Breusch-Godfrey serial correlation LM test and the heteroskedasticity ARCH test. The results indicate that the corresponding p-value of the estimated *F*-statistic of both tests are greater than 0.05. Therefore, since the corresponding *p*-values are greater than at 5% significance level, this study concludes that the estimated ARDL (6, 3, 5, 2) model does not suffer from the serial correlation issue and is homoscedasticity.

The normality test results of the residuals for the estimated ARDL (6, 3, 5, 2) model are given in Table 6. The results indicate that the corresponding *p*-value of normality test is greater than 0.05. Therefore, as the corresponding *p*-value is greater than at 5% significance level, the null hypothesis that the residuals are normally distributed is not rejected. Thus, this study concludes that the residuals of the estimated ARDL (6, 3, 5, 2) model is normally distributed.

Figure 3 and Figure 4 show the plot of cumulative sum of recursive residuals and the plot of cumulative sum of recursive residuals squared for the estimated ARDL (6, 3, 5, 2) model, respectively. Due to the fact that the CUSUM and CUSUMSQ lines locate within the critical bounds at 5% significance level, the null hypothesis that the parameter coefficient constancy is not rejected. Therefore, the estimated ARDL (6, 3, 5, 2) model is stable under the study period.

Table 8 shows the Pairwise Granger causality test results. Based on the results, the null hypothesis that the tourism demand does not Granger Cause carbon dioxide in Sri Lanka is rejected at 10% significant level because the corresponding p-value of the null hypothesis is less than 0.1. By contrast, the null hypothesis that the carbon dioxide does not Granger Cause the tourism demand in Sri Lanka is not rejected at 5% significance level as the corresponding p-value of the null hypothesis is greater than 0.05. Further, as the estimated coefficient of error correction term given in Table 5 is significant at 1% level; thus, it can be concluded that there is a long-run causality between the variables used in this study (see Table 5).

The test results of variance decomposition for the amount/quantity of carbon dioxide in Sri Lanka are presented in Table 9. Based on this test results, the changes in carbon dioxide in the 1st period explains absolutely its own shock. However, in the 2nd period 96.2% of error variance in carbon dioxide indicates its own shock, while 2.54% of error variances in carbon dioxide decomposes by shock of tourism demand. Further, 93.88% of error variance in carbon dioxide in the 5th period is accounted for by its own shock, while 3.81% of error variance in carbon dioxide is explained by the shock of tourism demand. Finally, 89.82% of error variance in carbon dioxide is due to its own shock in the 10th period, whereas 3.10% of error variance in carbon dioxide is explained by the shock of tourism demand. Therefore, the findings of error variance in carbon dioxide shows that the contribution of tourism demand shock to the error variances in carbon dioxide slightly increase from the 1st period to 10th period.

5. CONCLUSION AND POLICY RECOMMENDATION

Intertemporal relationship between tourism demand and environmental pollution resulting from the emission of carbon dioxide over the period of 1970 -2019 has been discussed in this study. Accordingly, the EDA visual inspection shows that there is a positive relationship between tourism demand and carbon dioxide in Sri Lanka. The ADF unit root test confirms that the variables used in this study are in mixed order. The ARDL Bounds cointegration test results indicate that tourism demand induces the emission of carbon dioxide in both the long-run and short-run. Further, the estimated coefficient of error correction term shows that the response variable of carbon dioxide moves towards the long-run equilibrium path. All the diagnostic tests used in this study inform that the estimated model is robust over the study period. Furthermore, the Pairwise Granger Causality test results demonstrate that there is unidirectional (one-way) causality from tourism demand to carbon dioxide in Sri Lanka in short-run. Moreover, the estimated error correction term indicates the long-run causality between the variables. The variance decomposition test result indicates that a shock to tourism demand accounts for the error variance in carbon dioxide in different percentage. Based on the findings of this study, we can safely conclude that tourism demand in Sri Lanka helps increase the carbon dioxide emission, that is, the tourism demand causes environmental degradation in Sri Lanka. Therefore, this study recommends that the policymakers in Sri Lanka should introduce the low-carbon green technology in the tourism sector.

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Table 3. ARDL Bounds test results

Test statistic	Value	
F- Statistic	**5.27**	
K	3	
Significance	*I*(0) Bound	*I*(1) Bound
10%	2.72	3.77
5%	3.23	**4.35**
2.5%	3.69	4.89
1%	4.29	5.61

Source: EViews software

Table 4. Long – run coefficient of the variables

Dependent Variables: $lnCO_{2t}$			
Variable	Coefficient	*t*- statistic	*p-value*
$lnTD_t$	0.364	2.113	0.046**
$lnGDP_t$	0.451	5.038	0.000*
$lnECon_t$	0.481	5.178	0.000*
C	8.001	2.353	0.027**

Source: EViews software Note: * p<0.01, and ** p<0.05

Table 5. The short-run dynamics of the variables

Dependent Variables: $\Delta lnCO_{2t}$			
Variable	Coefficient	*t*- statistic	*p-value*
$\Delta lnTA_t$	0.181	1.607	0.121
$\Delta lnTA_{t-1}$	0.481	3.704	0.001*
$\Delta lnGDP_t$	0.285	2.067	0.050***
$\Delta lnGDP_{t-1}$	0.501	3.094	0.005*
$\Delta lnGDP_{t-2}$	0.338	2.760	0.011**
$\Delta lnECon_t$	0.408	1.014	0.321
$\Delta lnECon_{t-1}$	1.049	2.491	0.020**
$\Delta lnECon_{t-2}$	0.061	0.160	0.874
$\Delta lnECon_{t-3}$	0.102	0.266	0.792
$\Delta lnECon_{t-4}$	0.697	1.544	0.136
ECT_{t-1}	-0.395	-3.970	0.000*

Source: EViews software Note: * p<0.01, ** p<0.05, *** p<0.1

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Table 6. Diagnostic Tests results

Model	Test statistic			
	Breusch-Godfrey Serial Correlation LM Test		Heteroskedasticity ARCH Test	
	F-statistic	Prob.F(2, 21)	F-statistic	Prob.F(1,40)
ARDL (6, 3, 5, 2)	0.380	0.688	0.030	0.861

Source: EViews software

Table 7. Normality Tests results

Model	J-B test statistic Chi-square	p-value
ARDL (6, 3, 5, 2)	1.503	0.741

Source: EViews software

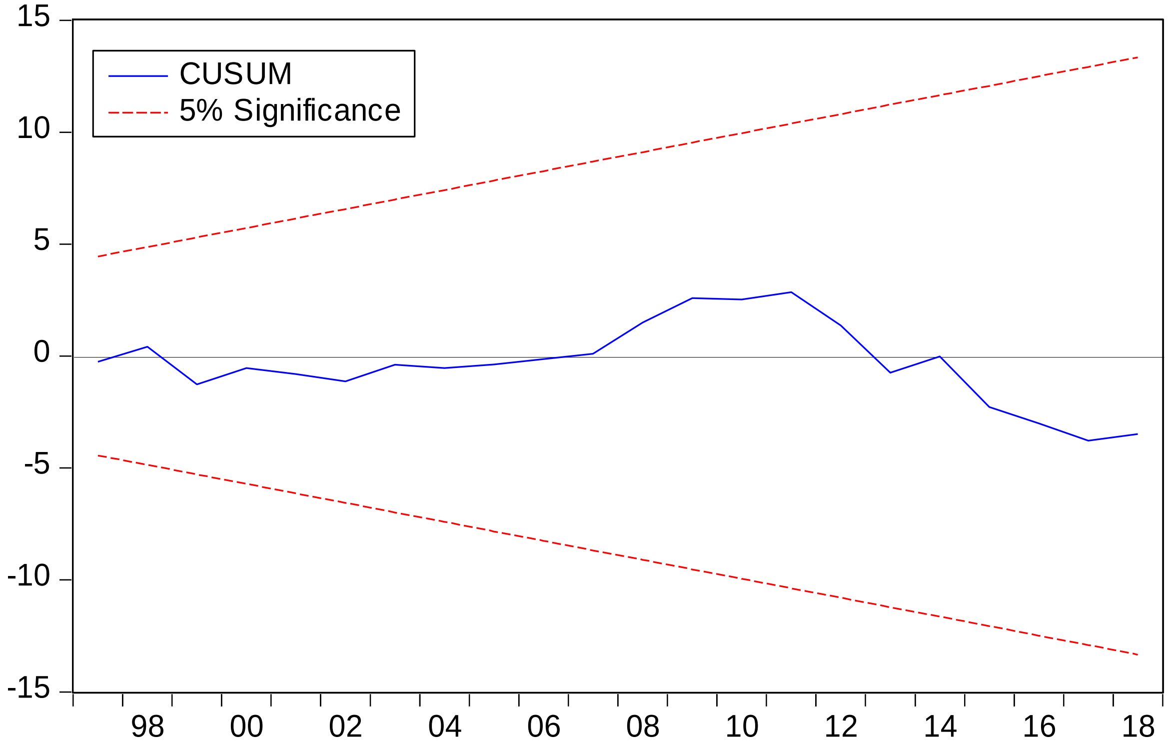

Figure 3. The CUSUM plot for the ARDL (6, 3, 5, 2) model
Source: EViews software

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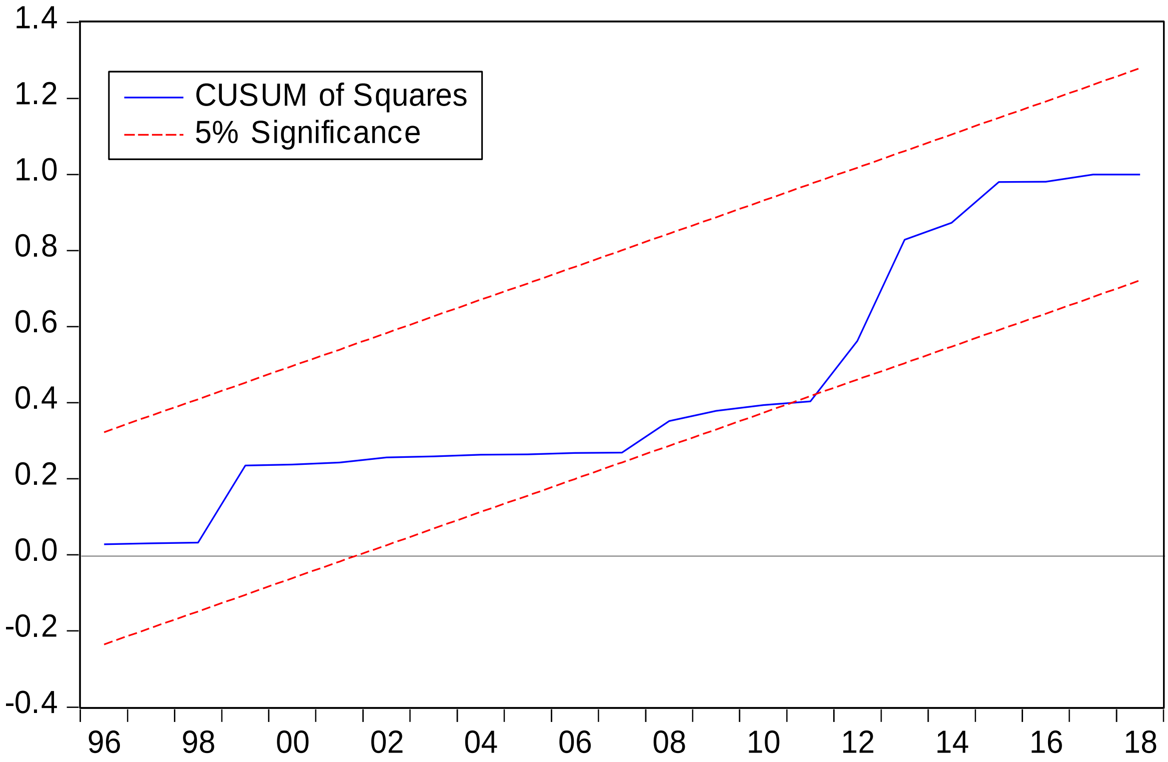

Figure 4. The CUSUMSQ plot for the ARDL (6, 3, 5, 2) model
Source: EViews software

Table 8. Pairwise Granger Causality Test Results

Null Hypothesis	Obs	F – Statistic	Prob.
$\Delta \boldsymbol{lnTD_t}$ does not Granger Cause $\Delta \boldsymbol{lnCO_{2t}}$	42	2.026	0.094*
$\Delta \boldsymbol{lnCO_{2t}}$ does not Granger Cause $\Delta \boldsymbol{lnTD_t}$	42	0.879	0.522^{ns}

Source: EViews software Note: * p<0.1, ^{ns}: not significant

Table 9. Result of variance decomposition for financial development

Forecast error in	Forecast horizon (period)	Proportions of Forecast error variance $\boldsymbol{h}$ periods ahead accounted for by innovations in			
		$lnCo_{2t}$	$lnGDP_t$	$lnEcon_t$	$lnTA_t$
	1	100.00	0.00	0.00	0.00
	2	96.24	0.46	0.74	2.54
	3	94.87	0.61	0.91	3.59
	4	94.25	0.57	1.29	3.87
	5	93.88	0.53	1.77	3.81
$\boldsymbol{lnCo_{2t}}$	6	93.39	0.50	2.44	3.65
	7	92.72	0.50	3.26	3.49
	8	91.88	0.51	4.25	3.34
	9	90.90	0.51	5.36	3.21
	10	89.82	0.51	6.55	3.10

Source: EViews software

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