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Exploring the Correlation and the Causality between Carbon Emission and Inbound Tourism Growth in Maldives

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The purpose of this study is to empirically explore the relationship between inbound tourism growth and carbon emission in Maldives. Ordinary Least Square method was used to investigate the correlation, and Granger Causality test was performed to test the long run relationship. Secondary data from 1984-2010 for Maldives have been used to carry out empirical tests. The study results) suggest statistically significant positive relationship between inbound tourism growth and carbon emission. The three individual models for indicators of inbound tourism growth and combination model of three indicators also show positive upward relationship. Studied data sets show no statistical evidence of long term relationship between inbound tourism growth and carbon emission.

Key Words: Inbound Tourism, Carbon Emission, Maldives, Growth, Causality

Introduction

Maldives is an ocean archipelago consisting of 1192 islands in the Indian Ocean. The Country is famous for its coral reefs, sandy beaches and luxury resorts. The population of Maldives is estimated to be 336,220 people living in 190 islands (DNP, Maldives at a glance - July, 2013). The Maldives has more territorial sea than land. Marine resources have played a vital role in shaping the contours of economic development with nature-based tourism and fishing being the main drivers of economic growth.

Since the world tourism has grown from twenty five million tourists to one in the last 60 years, it is proven that tourism has become an important tool for development in many parts of the world. Likewise inbound tourism is the main power house of Maldives for the last three decades. Unexploited natural beauty of small island nation opened opportunities for economic growth and development. Like any other industry tourism is a “business transaction, a commodity for sale in the world market” (Maximiliano, E.Korstanje, & Babu George, 2012).Tourism mainly provides two goods; a) Accommodation, b) Food, and two services; a) Transportation, b) Entertainment services. Production of all the goods and provision of all services have its costs, economic cost, social cost as well as environmental cost.

Most literature on economic development today focuses on the environmental cost of the development. Environmental data from Maldives shows very sharp increase in carbon emission year on year. Maldives has a fully service-oriented economy. Hence, understanding the relationship between emissions in small country like Maldives is very significant in promoting economic development and reducing carbon emission. The main scope of this paper is to explore the relationship between Carbon Emissions (CE) and Inbound Tourism Growth (ITG).

It is very important to understand the causal relationship between these two variables as it will give concrete statistical information for the relevant policy making. Maldives government has announced its target of achieving carbon neutral in the year 2020. Understanding the nature of carbon emission and inbound tourism growth relationship will not only help to understand the long term relationship but it will give vital information for policy makers to make appropriate policies to grow the industry beyond its current growth while being environment friendly. When the direction of causality runs from ITG to CE, it explains that inbound tourism growth is the driver for carbon emission. On the contrary if the causality runs from CE to ITG implies that ITG is not responsible for rapid increase in CE.

Most specifically this paper aims to empirically investigate below four questions.

1- Whether there is a long run relationship between inbound tourism growth and carbon emission in Maldives.
2- Whether the statistical relationship between inbound tourism growth and carbon emission in Maldives is bi-directional.

3- Whether there is a long run relationship between each inbound tourism growth and carbon emission in Maldives.
4- Whether the statistical relationship between each inbound tourism growth indicator and carbon emission in Maldives is bi-directional.

This paper is going to use three indicators; 1- Inbound Tourist Arrivals (TA), 2- Inbound Tourism Gross Domestic Product (TGDP) and 3- Inbound Tourism Bed Nights (TBN) to represent the ITG. The first section of the paper deals with the introduction. While in the second section conceptual model is further developed and back ground to Maldives tourism development and carbon emission has been revised in section 3. Section 4 is comprised of literature review followed by models, variables and data collection in section 5. Estimation methods are explained in section 6. Statistical tests and results are given in section 7. In section 8 results were analyzed. The 9th section concludes the paper.

Conceptual Model

Inbound tourism growth and carbon emission are the main variables discussed in this paper. Three indicators, TA, TGDP and TBN are used to represent the inbound tourism growth. Hence total four variables are analyzed in this paper. They are as follow:-

1- Carbon Emission –CE
2- Tourist Arrivals –TA
3- Gross Domestic Product from Inbound Tourism –TGDP
4- Number of Bed Nights tourist spend in Maldives –TBN

Conceptual model for the relationship between inbound tourism growth and carbon emission of Maldives is illustrated in the figure 1. Inbound Tourism growth is a function of inbound tourism growth indicators. The relationship between each inbound tourism growth indicator is explained in 4 hypothesis. H_1: ITG stimulates the CE. H_2: CE drives ITG.H_3: ITG impact on CE and CE impact ITG, that is to say that the relationship is directional. Last hypothesis $H_4$was ITG and CE has no relationship or uni-directional relationship. These four hypotheses were extended to the three indicators of ITG. Similar hypotheses were drawn for the relationship between inbound tourism growth and carbon emission.

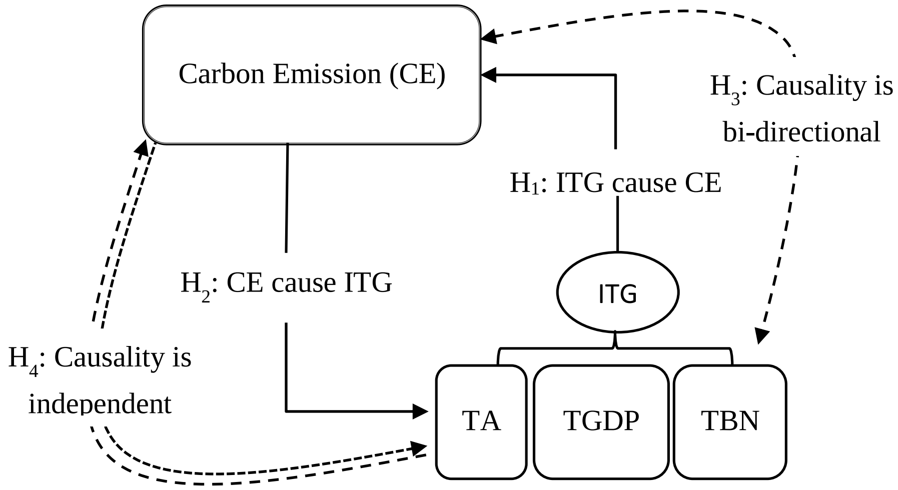
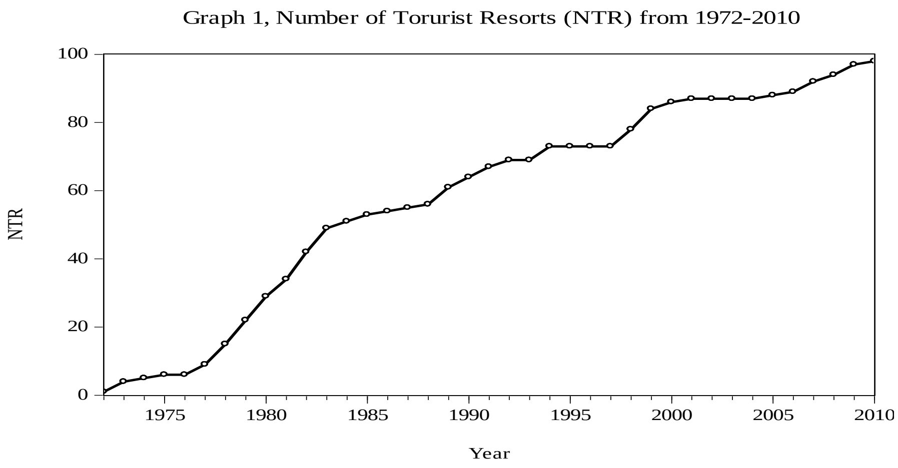


Figure 1. Conceptual Model

Inbound Tourism Growth and Carbon Emission in Maldives

Maldives is a small nation in the Indian Ocean heavily depending on tourism as its main economic industry. Tourism industry is accounted for one third of the Gross Domestic Product (GDP) of the Maldives (DNP, Publications, 2014). In the past three decades government has been allocating most of its resources and efforts to grow the tourism industry. Foreign Direct Investments (FDI) are encouraged with lots of incentives to develop the tourism industry. Tourism was introduced to Maldives in 1972 by private entrepreneurs with the help of the government.

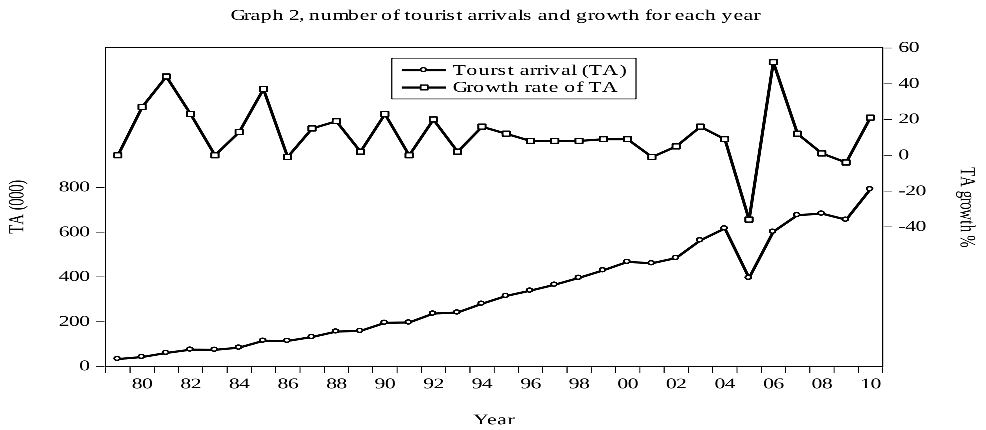


Within 5 years after the first tourist establishment in 1972, 10 resorts were opened for business under unique model of "one island – one resort". In the end of first ten years of the tourism industry a total of forty two resorts were built and were in operation. Graph 1 shows the progress in building tourist resorts in Maldives from 1972 to 2010. In the end of 2010, records show 98 resorts are in operation in 98 islands. In addition to that, 17 city hotels, 25 guest houses and 156 registered safari vessels are also providing accommodation to the tourists (Ministry of Tourism, Arts and Culture, Tourism Yea book 2011, 2011). Increase in number of resorts is an indicator of tourism development in Maldives. Inbound tourist arrival, GDP from tourism and tourist bed nights are main indicator of growth in inbound tourism for which data are available.

Inbound tourism growth

Inbound tourism in Maldives is growing at a rapid rate. In 2010 the world enjoyed tourist arrival growth of 6.7 percent, but Maldives experienced healthy growth of 20 percent. In 2010 Government achieved its goal of receiving 700,000 tourists. In 2013 the goal was to receive 1 million tourists. This is 11percent growth than that of 2012 growth. Due to the political unrest in 2012 overall growth was decreased to nearly 3 percent. Maldives achieved the target of 2013 with more than 1million tourist arrivals in 2013.

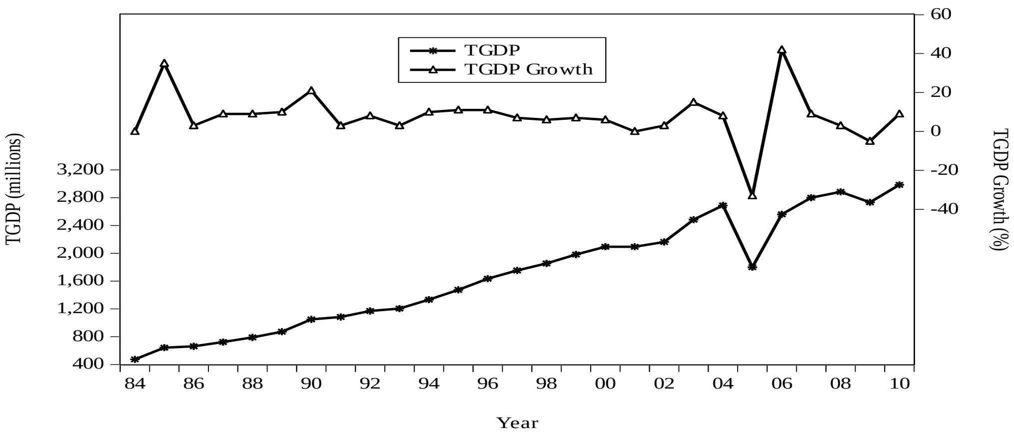
From 1979 to 1989 the average growth of the tourist arrival was 17 percent. In 1983 and 1986 there was slight dropped in the tourist arrival. From 1989 to 1999 the average growth rate was 10 percent. Compare to first 10 years, there was slight decrease in the growth rate. From 2000 to 2010 the average growth rate dropped to 7 percent even though the number of arrivals increased year on year. In 2001, 2005 and 2009 the growth was recovered with stability of government. Most of the time the decrease in the growth rate was associated with either bad weather conditions, political unrest in the country or global financial problems. Graph 2 shows the actual number of tourist arrival and growth for each year respectively.



Gross Domestic Product from tourism (TGDP) also increased with the increase in tourist arrivals. GDP of the Maldives prior to tourism in 1972 was growing lower than average of 5% per year. GDP of 1970 was equivalent to 4 million USD. Ten years after introducing tourism to Maldives, particularly;

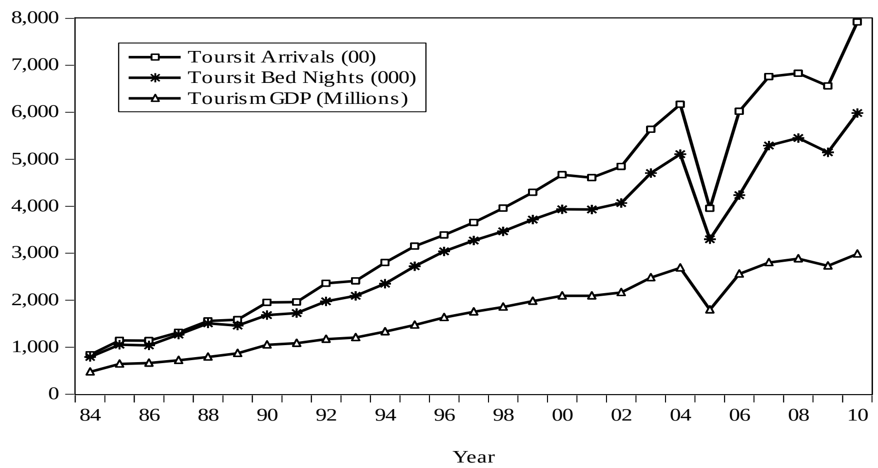
in 1980 GDP growth was 17% compared to that of the previous year's GDP (Kushnir, 2014). This implies the GDP of the country started increasing in parallel to with the tourism industry. Statistics of 2013 shows one third of the Maldives GDP comes from tourism sector. From 1984 to 2010 TGDP was growing at an average growth of 8%. TGDP for 2005 decreased by 33 percent due to the tsunami that hit most of the South Asian countries. In 2009 the TGDP decreased by 33 percent due to political turmoil in 2008. Apart from these two years TGDP shows a healthy upward growth with slight ups and downs. Figure 3 shows the actual amounts of TGDP and growth rate in each year from 1984 – 2010.

Graph 3, TGDP and TGDP growth from 1984-2010



Tourist bed nights (TBN) refers to how many nights each tourist stay in Maldives. In average, tourists spend 7-9 nights in Maldives. Tourist bed nights increase with the increase in the number of tourist arrivals. Figure 4 shows the growth of three indicators representing the growth of the tourism industry from 1984-2010. The graph shows very sharp increase in all three indicators except for 2005.

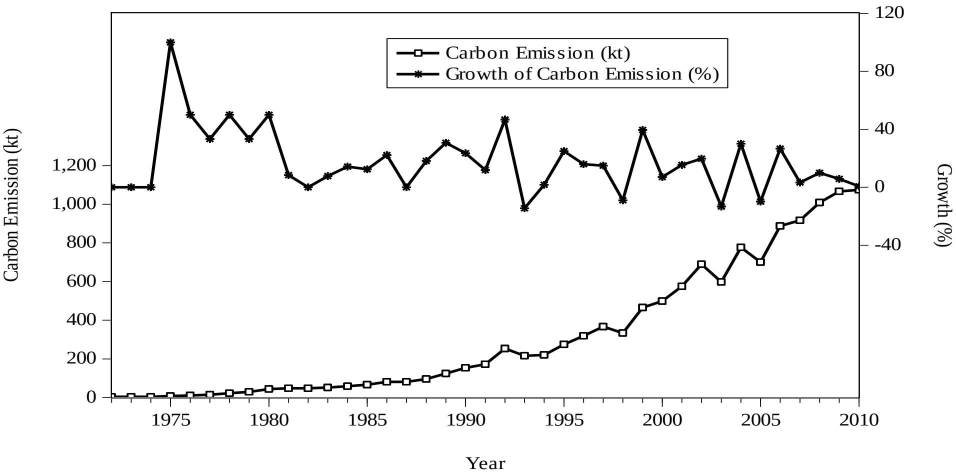
Graph 4, Growth of Inbound Tourism Growth Indicators from 1984-2010



Carbon emission growth

Reported data of (CDIAC, 2011)World Bank shows that carbon emission in Maldives is increasing at an alarming rate. First carbon audit report of Maldives indicates tourism industry is accounted for nearly one fourth of the total carbon emission (Flora, Khelil, Pichon, & Tissot, 2010). Carbon emission figures for Maldives are estimated figures calculated by analyzing the consumption of the fossil fuel. Total carobon emssion of Maldives in 1972 was estimated around 3.6 kt. After 10 years, this amount increased by 13 folds. Twenty years later the mount increased by means of a hundred to 253 kt, this is 68% increase comparing to 1972. Carbon emission of Maldives in 2010 is estimated to be 1074 kt. Figure 5 shows the carbon emission and growth percentage for each year from 1972-2010.

Graph 5, Carbon Emsission and its growth from 1972-2010



At the same time we also assume that inbound tourism growth and carbon emission should have a causal relationship. Most probably inbound tourism growth will be driving the carbon emission in the Maldives. On the other hand; we assume it is very unlikely that carbon emission drives the growth of inbound tourism in the Maldives.

Literature Review

Litrature on tourism growth evolves mainly around three theories. Tourism led economic growth is the most videly accepted theory in tourism based economies. (Akinboade & L. Braimoh, 2010), (Mashra, Rout, & Mohapatra, 2011), (Çağlar, 2012), and others support this theory that causal relationship is from tourism growth to economic development. Other studies, such like; (Lanza, Temple, & Urga, 2003), (Lee & C. Chang, 2008), (Nayaran, S. Nayaran, & Prasad) support ecoomic growth driven tourism theory. In this theory tourism is caused by economic growth and development. Bi-directional theory of economic growth and tourism promotes each other gathered much evidences from empirical studies. (Dritsakis, 2004), (Chen & Song, 2009) provide evidence to this theory while (Caglayan, Karymshakov, & Sak, 2012)study supports these three theories.

Tourism industry across the globe has developed at a very rapid rate in the last few decades. Resent forcast shows that tourism will enjoy at an everage growth of 3.8 percent annualy between 2012 and 2020 (UNWTO, 2013). Tourism based economies are achieving comparetively higher average economic growth compared to other economies (Brau, A. Lanza, & F. Pigliaru, 2003).

The impact of tourism from different prospective has been reasonably well researched, particularly from the environmental and economic prospective. However empirical support to show the relationship between tourism and carbon emission has mainly based either on direct observation of the data or on some parallel based analysis. Such approaches are clearly insufficient to classify the nature of the underlying linkage between carbon emission and tourism development (Zaman, Khan, & Ahmad, 2011). Tourism is a service business that involves lots of economic activities. Airport, planes, ports, boats, ships, sea-planes, as well as powerhouses are required to give services to tourists who visit the country. Most of the carbon emission is generated indirectly from indirect services (Lenzen, 1998; Becken, Frampton, & Simmons, 2001; Castellani & Salsa, 2008).

United Nations World Tourism Organization has observed that tourism is a significant contributor to climate change and global warming. (Bob, Bruce, Catherine, & Rob, 2009). A substantial volume of research has identified tourism as a major source of greenhouse gas emissions, primarily (but not exclusively) from air transport. On the other hand, tourism industry is one of the victims of the global climate change. It is estimated that tourism contributes 5 percent of the total Carbon Dioxide (CO_2) emission and up to 14% of all emission when other greenhouse gases are considered (Scott, et al., 2008). In spite of these figures, some people still believe that tourism industry is emission free or a less emission industry (Salah & John, 2005).

Tourism often uses fossil fuel to meet the energy demand of the industry. Unlike other countries, due to the unique nature of the country, each resort has to have its own power house to provide electricity. Researches like, (Bode, Hapke, & Zisler, 2003) & (Scott, et al., 2010) provide statistica evidence that tourism related energy cosumption cause environmental issues and carbon emission. All these researches does give enough evidences to conclude tourist arrivals, the time a tourist spends in the destiation must cause the growth of the carbon emission. The main contuributers to the Tourism GDP are driven by the number of tourists and length their stay.

Models, Variables and Data

In this study we explore the causal relationship between the carbon emission and inbound tourism growth. Tourism development indicators are used to denote the growth of the inbound tourism. Research of (Ahmed & Laijun, 2012) shows Maldives carbon emission is led by the economic development. Hence we use carbon emission as the dependent variable and tourism development indicators as independent variables. Non-linear models to test the causal relationship between carbon emission and inbound tourism growth for observation period from 1984-2010 are specified below in equation 1-3.

$$\log[CE_t] = \alpha_1 + \alpha_2 \log[TA_t] + \varepsilon \quad (1)$$

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$$\log[CE_t] = \beta_1 + \beta_2 \log[TGDP_t] + \varepsilon \quad (2)$$

$$\log[CE_t] = \varphi_1 + \varphi_2 \log[TBN_t] + \varepsilon \quad (3)$$

$$\log[CE_t] = \gamma_1 + \gamma_2 \log[TA_t] + \gamma_3 \log[TGDP_t] + \gamma_4 \log[TBN_t] + \varepsilon \quad (4)$$

Where;

CE_t denotes carbon emission in given year in kilo

TA_t denotes inbound tourist arrivals in a given year

$TGDP_t$ denotes total amount of GDP (in Rufiyya) generated from tourism in a given year.

TBN_t denotes the total number of nights inbound tourists stayed in Maldives in a given year.

t denotes the observed year.

εdenotes disturbance term and *log* denotes natural logarithm.

To understand the relationship between inbound tourism growth and carbon emission, combined model was created. In the combined model, all inbound tourism indicators used as the independent variables. The dependent variables do not change. Carbon emission was used as the dependent variable. We assumed that if the inbound tourism growth indicators cannot independently explain the causal relationship with carbon emission, the indicators can explain the relationship when they are combined. If the combined model fits better than the individual models, then combined model can be used to estimate the carbon footprint from inbound tourism. The Combined model to test the relationship between inbound tourism growth and carbon emission is given in equation (4).

It was challenging to collect data for carbon emission as well as data for tourism development indicators for Maldives. Tourism being the most important industry of the economy, government has either not kept clear records of the data or has not published the recorded data. This study uses annual observations for the period starting from 1984 to 2010. Carbon emission data used in this study is taken from the data published by the World Bank (Bank, 2014). Inbound tourism growth data was collected from the data published by the Department of National Planning (DNP, Publications, 2014). Most of the data was extracted from "25 years of statistics" (DNP, The 25 Years of Statistics, 2005) published online by the Department of National Planning in 2005. Data for 2005 to 2010 was reconciled from year statistical year books of 2005 to 2012. Tourism year books; (Ministry of Tourism, Arts and Culture, Tourism Yea book 2011, 2011 & Ministry of Tourism, Arts and Culture, Tourism Year Book 2013, 2013) was also used to reconcile and cross double check the data for other indicators as well. Monthly statistics issued by Maldives Monetary Authority (MMA, Monthly Statistics 2014, 2014) was also used to confirm the data.

Estimation methods

All four variables, CE, TA, TGDP and TBN was tested for hetroscedaticity before moving to other statistical tests. In the next step data for the variables were checked for stationary status using ADF test. At last Granger causality (Granger, 1969) test was performed to test the four hypotheses.

Unit root test

Non-stationary time series data has often been regarded as a common problem in empirical analysis. Working with non-stationary variables lead to spurious results from which further inference is meaningless when these variables are estimated in their original form. In order to overcome this problem there is a necessity for testing the stationary of these variables.

The unit root tests on all the variables are to determine the time series characteristics. Unit root test is important as it shows the number of time the variables have to be differentiated to clear the unit roots and make the data stationary. In general variables which are stationary are called I (0) series. Those data which needs to be differentiated once in order to obtain stationary are called I (1) series. In testing for stationary, the standard Augmented Dickey-Fuller (Dickey & Fuller, 1979) (ADF) test was performed to test whether or not unit root exists in the data. The regression is estimated by equation (4) as follows:

$$\Delta Y_{t-1} = \alpha + \beta Y_{t-1} \sum_{j=1}^{k} \gamma_i \Delta Y_{t-k} + \varepsilon_t \quad (5)$$

Where delta is the difference operator, Y is the series being tested, K is the number of lagged differences and ε is the error term. The null hypothesis is that series has a unit root and the alternative hypothesis is that it is stationary. The number of augmentation terms for the ADF tests were determined by using the Schwarz information criterion (Schwarz, 1978).

Causality

Engle and Granger developed a model to test if one time variable $X(t)$ is being caused by another times variable $Y(t)$ even if they are not correlated. In classical approach, the regression formulation of Granger causality states that a variable X is the cause of another variable Y if the past values of X are helpful in estimating the future values of Y. When using maximum time lag, if the model in equation (7) is significantly better than model in equation (6) then X Granger cause time series Y (Liu & Bahadori, 2012)

$$Y(t) = \sum_{l=1}^{L} a_1 Y(t-l) + \varepsilon_1 \quad (6)$$

$$Y(t) = \sum_{l=1}^{L} a_1 Y(t-l) + \sum_{l=1}^{L} b_1 X(t-l) + \varepsilon_2 \quad (7)$$

Statistical tests and results

Data for dependent variable and independent variables were converted into log form to eliminate hetrocedasticity. When the difference between maximum and minimum observation is very large, observations are hetrocedastic. Maximum and minimum observation of the variables are shown in table 01. Unit root test shows the variable contains unit root at level. The original time series data was not stationary in its original form. Intercept and trend and intercept models of ADF tests show the time series data for dependent and independent variables contain unit roots. Calculated *t* values are smaller than the critical values obtained for 5% critical values. Calculated *p* values were also greater than 5%, hence at level the null hypothesis, data contains unit root, could not be rejected. In order to run the cointegration tests the series must be I(1) series.

Table 1, Maximum and minimum observation for the variables

Variable	Maximum observation	Minimum Observation
Carbon Emission (CE)	1074.431	58.67
Tourist Arrivals (TA)	791,917	83,814
Tourism GDP (TGDP)	2,987.70	475
Tourist Bed Nights (TBN)	5,985,951	79,846

ADF results at first difference shows the series are stationary. Calculated t values were greater than the 5 percent critical values and all the p values are greater than 5 percent. At first difference, the null hypothesis was rejected to conclude that observations do not have unit root. ADF tests results for variables are given in table 02. The order of the series, CE, TA, TBN and TGDP are I(1). Relationship between carbon emission and inbound tourism growth indicators were tested using Ordinary Least Square method using the equations 1-3. Correlation results are given in table 03. ADF test results for residuals of the Model are given in Table 04. Causality test results are given in table 05. Time lags used for all the models were 2 lags.

Table 2, ADF unit root test results

Variables	Level		First Difference		Decision
	Intercept	Trend and Intercept	Intercept	Trend and Intercept	
log[CE]	2.61112	1.2939	-9.7260*	-4.6091*	Not stationary at level
	(1.000)	(0.866)	(0.000)	(0.007)	Stationary at First Difference
log [TA]	1.5216	-4.4828*	-5.9892*	-6.4962*	Not stationary at level
	(0.998)	(0.007)	(0.000)	(0.000)	Stationary at First Difference
log [TGDP]	0.1757	-5.1601*	-6.2853*	-6.1471*	Not stationary at level
	(0.964)	(0.001)	(0.000)	(0.000)	Stationary at First Difference
log [TBN]	0.2026	-4.5021*	-6.9054*	-6.8065*	Not stationary at level
	(0.966)	(0.007)	(0.000)	(0.000)	Stationary at First Difference

Carbon emission and Tourist arrivals

Time series observation from 1984 to 2101 for model 1; shows positive correlation between carbon emission and inbound tourist arrivals. Adjusted R^2 of 0.9689 shows the relationship is very significant. Drubon-Watson statistics concludes the model is fit to explain the dependent variable. Coefficient of the independent variable is significant at 5% level.

Table 3. Correlation tests of the models

Models	Model (1)	Model (2)	Model (3)	Model (4)
R-Squared	0.9701	0.9555	0.9671	09748
Adjusted R-Squared	0.9689	0.9537	0.9658	0.9716
Prob(F-statistics)	0.0000	0.0000	0.000	0.0000
Durbin-Watson Stat	1.7495	1.3061	1.6105	2.2316
Akaike Information Criteria	-0.7190	-0.3207	-0.6213	-0.7430

ADF test results of the residual for model one shows they are stationary at level. P values are higher than 5%. Hence we can statistically conclude that the carbon emission and tourist arrivals are cointegrated. Granger causality test results shows that the tourist arrivals do not Granger cause carbon. P value of 36.34% is higher than 5% critical level. Result is not significant to reject null hypothesis that TA does Granger cause CE. The other null hypothesis, CE does not Granger causes TA, was rejected as the p value is less than 5% critical level. The causal relationship between CE and TA is uni-Directional.

Carbon emission and Tourist bed nights

The relationship between carbon emission and tourist bed nights are also positively correlated. As expected, the correlation strength is trivial than that of tourist arrivals. Adjusted correlation coefficient of the model is 0.9537. *t* statistics are significant at 5% level. Probability of that the coefficient of the independent variable happening in random manner is nearly zero, showing statistical significant that the coefficient can explain the dependent variable. Other statistical results show the model is fit to explain the dependent variable.

Engle-Granger cointegration results show the variables are cointegrated. Residuals of the model is I(0) series. Carbon emission and tourist bed nights do have long term relationship. Granger causality shows CE does not Granger cause TBN and TBN does not Granger cause CE. This results suggests increase in tourist bed nights do not cause any significant increase in carbon emission.

Carbon emission and Tourism GDP

Correlation between carbon emission and GDP from tourism was also positively correlated. Increase in TGDP will result in increase in carbon emission. The R-squared shows very strong relationship of 0.9671. t statistics are statistically significant to give evidence that the coefficient of the model is suitable to estimate the dependent variable. P value of the coefficient of the model is close to zero. Durbin Watson statistics shows the model is fit to explain the dependent variable.

Residuals are stationary at level in intercept criteria as well as trend and intercept criteria. ADF tests results are significant at 5% level. Two variables have long term cointegration. Granger causality results shows TGDP does not granger cause CE. Tourism GDP does not cause carbon emission. Results also show evidence that CE does not granger cause TGDP.

Combined model

Combined model was used to test the combined relationship between carbon emission and inbound tourism indicators. Correlation test results shows combined model is fit to explain the emission from inbound tourism growth. Combined relationship between carbon emission and tourism growth is stronger than the individual indicators relationship with carbon emission. Coefficients of the model are significant at 5% level, except TGDP.

Cointegration of the model shows that variables do have long term relationship between them. ADF test results conclude the residual series is I(0) series.

Table 4, ADF unit root test results of the residuals at level

Model	Intercept	Trend and Intercept	Decision
Model (1)	-4.6082	-4.8323	
	(2.9810)	(0.0034)	Series is stationary at level, I(0)
	-0.9100	*-0.9633*	
Model (2)	-3.6173	-3.8520	
	(0.0124)	(0.0296)	Series is stationary at level, I(0)
	-0.6783	*-0.7321*	
Model (3)	-4.555	-4.9648	
	(0.0013)	(0.0025)	Series is stationary at level, I(0)
	-0.8656	-0.9243	
Model (4)	-5.9200	-5.2797	
	(0.000)	(0.000)	Series is stationary at level, I(0)
	-1.1617	*-1.6484*	

First value is calculated t statistics, probability is given in parenthesis and coefficient of the residuals(-1) is given below the probability in italics.

Analysis of results

Empirical studies reveal that inbound tourism growth and carbon emission are positively correlated in Maldives. There exists an upward growing relationship between these two variables. Growth in inbound tourism will increase the carbon emission. According to statistical results an increase or decrease in 1% tourist arrival would result in increase or decrease in carbon emission by 1.4%. Government of the Maldives should consider these results before setting the target for tourist arrivals. According to Draft 1 of Fourth Tourism Master Plan 2013-2017 (Ministry of tourism Arts and Culture, 2012), tourist arrivals will grow 16.2% in 2014 compare to arrivals of 2012. This amount of significant growth in arrivals will cause the carbon emission to grow by not less than 22%. Same master plan estimates, by year 2020 tourist arrivals will grow from 1 million to 2.3 million. This single fold in the tourist arrival growth would double fold the carbon emission in the year 2020.

However, the correlation between tourist stay and carbon emission is slightly weaker than tourist arrivals. Though the correlation is weaker than that of tourist arrivals, it is statistically very significant. But the coefficient of the trend suggests an increase or decrease of 1% in tourist stay would increase the carbon emission by 1.5%. This percentage of increase is more than the percentage increase of tourist arrivals. Longer tourist stay does not Granger cause emission. Hence we can conclude increase in tourist stay in Maldives will help to reduce the total carbon emission as other studies (Simpson, Gossling, Scott, Hall, & Gladin, 2008) suggest that the longer tourists stay in one place would decrease the carbon emission.

According to Empirical test results economic growth contribution from tourism sector contributes to more carbon emission. This is mainly due to the emission from infrastructure and horizontal indirect services of the tourism industry. Every one percent growth in tourism related GDP, carbon emission would grow by 1.7 percent. Granger causality does not show any causal relationship for the data used in this empirical tests. But results from all the indicators suggest tourism does significantly contribute to carbon emission, but no evidence to conclude they have long term causal relationship. The test results failed reject all the null hypothesis in the conceptual model.

Table 5, Granger causality test results

Null Hypothesis	F-statistics	Probability	Decisions
TA does not Granger Cause CE	1.06515	0.3634	Accepted
CE does not Granger cause TA	4.0441	0.0335	Rejected
TBN does not Granger Cause CE	0.8777	0.4311	Accepted
CE does not Granger cause TA	3.1790	0.0633	Accepted
TGDP does not Granger Cause CE	0.9071	0.4197	Accepted
CE does not Granger cause TGDP	3.0835	0.0680	Accepted

From the four models used in this study, the combined model is best fit to explain the carbon emission in Maldives. Below is the representation of the model derived from the time series data for Maldives from 1984-2010.

$$logCE = 2.4334logTA - 1.5361logTBN + 0.4630log\,TGDP - 5.10266$$

The standard deviation of the difference between actual carbon emission and estimated carbon emission from the models shows the lowest standard deviation is that of combined model. The coefficients of TA and TBN are significant at 5% level and co efficient of TGDP is significant at 10% level. This model is suitable to estimate the carbon foot print from the inbound tourism in the future using TA, TBN and TGDP as independent variables.

Conclusion

This study investigated the relationship between inbound tourism growth (ITG) and carbon emission (CE). Three indicators; Tourist arrivals in a given year (TA), Tourist bed nights in a given year (TBN) and Gross Domestic Product from inbound tourism for a given year (TGDP) were used to represent the inbound tourism growth. Three models were used to test the relationship between carbon emission and each indicator. One combined model was used to test the combined relationship, which shows relationship between inbound tourism growth and carbon emission. Ordinary Least Square method was applied to check the correlation and Granger causality test was used to test the long term Granger causality relationship. Secondary data from 1984 to 2010 were used to carry out the empirical tests. All the data were collected from online sources.

The test results show there exists statistically significant positive correlation between each inbound tourism growth indicators. Each tourism growth indicators have more than 96 percent information to estimate the carbon emission. Combined model test results suggest that the tourism growth indicators together can explain the carbon emission from inbound tourism more efficiently. Causality test results suggest that there were no statistical evidence to support the long term relationship between inbound tourism growth and carbon emission. This study provides combined model to estimate the carbon foot print of inbound tourism growth using the most important three inbound tourism indicators.

This study suggests policy makers to rethink setting goals to attract more tourists each year. Inbound tourism is an important industry for the country's economy. Increasing tourism related activities for the tourist to stay longer in the country is more beneficial than increasing the number of tourists. This conclusion paves the road for future researches on this subject.

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