Tasmanian School of Business and Economics
University of Tasmania

Discussion Paper Series N 2018-10

Tourist Arrivals, Energy Consumption and Pollutant Emissions in a Developing Economy–Implications for Sustainable Tourism

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ISBN 978-1-925646-66-5

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Abstract:

Sustainable tourism management policies should aim at maximising economic benefits from tourist arrivals while minimizing associated adverse impacts on the environment. This study assesses the short-run and long-run relationships between tourist arrivals, per capita economic output, emissions, energy consumption and capital formation, citing Nepal as a specific case study. We developed four hypotheses and tested them using time-series econometrics based on the autoregressive distributed lag model and Granger causality tests. The results provide strong evidence of an economy driven tourism sector where expansion in economic output leads to expansion in tourist arrivals. More tourist arrivals, in turn, generate positive impacts on gross capital formation. Energy consumption negatively affects tourist arrivals, calling for increased attention towards improving energy efficiency and energy diversity. We conclude that national policies to increase tourist arrivals should be integrated with national energy and environmental policies in order to facilitate the transition towards a sustainable tourism sector.

Keywords: sustainable tourism; Autoregressive distributed lag (ARDL); Granger causality; energy consumption; climate change

JEL Classification: Z32; Z38; C32

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1. Introduction

Tourism is one of the world's largest economic sectors; its importance to the global economy is undeniable. Tourism creates employment, promotes exports and embodies tremendous cultural, environmental and heritage value. WTTC (2017) reports global tourism contributed to 10.2 percent of the Gross Domestic Product (GDP), created 292 million jobs, and accounted for 6.6 percent of total global exports in 2016. Tourism is a driver of wealth and employment creation worldwide, although there are concerns about increasing socio-economic inequities and environmental costs. The United Nations (UN) designated the year 2017 as the *International Year for Sustainable Tourism for Development,* making it timely to reconsider the impacts of tourism, and support policies for making tourism an important contributor to the United Nation's Sustainable Development Goals (SDGs).

Much has been discussed about sustainable tourism during the last two decades (e.g. Saarinen, 2006; Hughes, Weaver & Pforr, 2015). More recently, critics have called into question its practicalities given the expanding global economy which demands increased production and consumption of material resources (Nepal et al., 2015). Ophuls (2011) states the impossibility of achieving sustainability, given that we live in a period of a limitless materialistic and consumptive culture, rapidly depleting stocks of fossil hydrocarbons in an era of ecological scarcity and irreplaceable biological and geological resources. The 17 distinct Sustainable Development Goals (SDGs) ratified by the UN has renewed a sense of urgency in the tourism sector to address, among others, elimination poverty (SDG 1), ending hunger and achieving food security (SDG 2), and combating climate change (SDG 13)(UN, 2017) . Specific to SDG 13, managing tourism sustainably requires reducing the impact of the sector on climate change and curbing excessive dependency on energy consumption such as fossil fuels since tourism-related use of it has detrimental environmental consequences (Becken et al., 2003; Gössling, 2000; Nepal, 2008). The proper understanding of the interrelationships between tourism, the underlying economy, and the natural environment is critical in formulating effective sustainable tourism policies. However, empirical studies demonstrating these linkages are limited in the tourism literature (Shakouri et al. 2017). This is particularly so in the context of mountain economies despite the critical role these economies play towards sustainable development as enablers of green growth. Our study aims to fill this gap in the literature.

Mountain destinations are climatically vulnerable but naturally attractive for developing and expanding adventure and nature-based tourism opportunities. Mountainous countries like Nepal have become popular destinations for international tourism, however, serious socioeconomic and environmental consequences undermine the development potential associated with tourism (Nepal, 2000). It is argued that tourism, and particularly recreational tourism, may contribute considerably to a country's energy and environmental costs (Becken et al., 2003). Mountain destinations are also essential for global sustainable development as bearers of crucial ecosystem goods and services. The world's mountains regions are home to about 800 million people and serve as water towers for billions while providing ecosystem services for the entire globe (Kohler et al., 2010). Mountain economies are essential building blocks for long-term sustainable global development, poverty alleviation and the global transition to a green economy (FAO, 2011). It is, critically important to understand the influence and implications of tourism on the economy and the environment if tourism is to be established as a low-impact, non-consumptive development option in mountainous economies.

The focus of this study is Nepal, a mountainous and developing South Asian economy where tourism is one of the largest industries and source of foreign exchange and revenue receipts. Nepal is home to eight of the ten tallest mountains in the world, while mountains and rugged hills cover almost 75% of its land area. The Nepal Tourism Policy identifies tourism sector as an important vehicle for economic and social development (MCTCA, 2018). In 2016, the direct contribution of tourism to the national economy was 3.6 percent of the GDP[1], supporting 6.4 percent of total employment, generating visitor exports of 450 million USD and attracting 3 percent of total capital investment (WTTC, 2017).

The private sector in Nepal is the primary beneficiary of tourism as in other developing economies, however, the environmental and social costs associated with tourism are mostly borne by the State (or the citizens at large) in Nepal, suggesting a need for intervention strategies and policies (Heredge, 2005). Evidence elsewhere suggests more than two-thirds of the revenue from international tourism never reaches the local economy because of high leakage (Pleumarom, 1999). Nepal lacks laws that seek to mitigate or offset negative

[1] The contribution (both direct and indirect) was 7.5 percent of GDP in 2016.

environmental costs associated with the development of tourism (Gotame, 2017). However, exploring the different policy options for sustainable tourism necessitates a critical understanding of tourism-environment trajectories, supported with rigorous scientific research. This paper fulfils that goal, as it analyses the short-run and long-run relationships between tourist arrivals, per capita income, emissions, energy consumption and capital formation.

This study explores long run and short-run causal relationships of tourism in a multivariate framework with income and capital investment (as measures of economic indicators), and pollutant emissions and energy consumption (as measures of environmental indicators). A multivariate model reduces the possibilities of biased results arising from variables omissions. We include energy consumption in our analysis since earlier studies have excluded the use of energy and its environmental consequences from the discussion on sustainable tourism development (Gössling, 2000). The interface between tourism and energy use also remains less explored despite growing awareness of environmental issues related to tourism (Becken et al., 2003). This is one of the first time-series study analysing the inter-relationships between tourism, the underlying economy and the environment using data for Nepal. We take a country-specific case study by focussing only on Nepal, as studies conducted at the regional level cannot capture and account for the economic, environmental and institutional complexities at a larger scale.

The study is significant, as findings would allow policymakers in identifying economic strategies that seek to balance economic growth while reducing pollutant emissions and curbing energy usage. The policy implications of this study's findings would be relevant to other mountainous economies where tourism sector plays an important role in fostering economic and environmental development.

2. Literature Review

Since the original study by Pigliaru and Lanza (2000), who tested the *tourist-led growth* (TLG) hypothesis, the methods used in econometric studies are quite variable including applications based on time-series, panel data and cross-section data. In this section, we discuss the previous literature that examines the relationship between tourism, economic growth, carbon emissions, energy consumption and capital formation based on time-series data and time-series econometrics. In general, tourism studies focusing on time-series econometric analysis are somewhat limited. Empirical results reported in the majority of studies are also sensitive to the selection of model specifications and to the econometric techniques used (Pablo-Romero and Molina, 2013).

2.1. Tourism and Economic Growth

Literature on the causal relationship between tourism and economic growth has increased since 2002, and is well summarised by Pablo-Romero and Molina (2013). The causality relationships between tourism and economic growth include a mix of four different scenarios, namely: tourism-led growth; economy-driven tourism; bidirectional causality or no causality (Antonakakis et al., 2016). The lack of a clear consensus on the exact nature of relationships between tourism and economic growth indicates that this area of research is inconclusive and is still open to discussion. There are several studies which tend to indicate supports for the TLG hypothesis in South-Asian economies like Pakistan (Adnan Hye and Ali Khan, 2013; Khalil et al., 2007) and Sri Lanka (Srinivasan et al., 2012), based on a bivariate framework of GDP and tourism receipts. Likewise, Mishra et al. (2011) and Malik et al. (2010) also found that tourism granger causes GDP based on a trivariate model using GDP, tourism receipts and exchange rate respectively in the context of India and Pakistan.

On the other hand, Oh (2005) supported the case for an economy-driven tourism for South Korea based on a bivariate framework of GDP and tourism receipts. Tang (2011) also found evidence of growth led tourism for Malaysia, based on a trivariate framework of GDP, tourism receipts and exchange rate. In the case of Nepal, Gautam (2011) provided evidence of a bidirectional causality between tourism and economy both in the short-run and long-run, based on a bivariate model using foreign exchange earnings and GDP. Tourism receipts were also found to have a bi-directional relationship with GDP in Nepal (Paudyal, 2012). Summarising the findings from the existing literature; we hypothesise that there is a positive relationship between tourism and economic output (*Hypothesis 1*).

2.2. Tourism and Emissions

Tourism is a significant contributor to global greenhouse gas (GHG) emissions but very few studies have looked at tourism's impact on national emissions (Gössling, 2013). At a global level, the impact of tourism on CO_2 emissions is reducing much faster in developed than in developing economies providing evidence of the environmental Kuznets curve (EKC) hypothesis on the link between tourism growth and CO_2 emissions (Paramati et al., 2017). The EKC hypothesis implies that the impact of tourism on CO_2 emissions diminishes as national income increases. Time-series analysis on the underlying relationship between tourism and GHG emissions are limited (Chen et al., 2018).

Kuo et al. (2012) showed that an increase in tourism receipts led to only limited increase in CO_2 emissions in China as compared to much larger impacts of number of tourist arrivals in CO_2 emissions. Solarin (2014) established a unidirectional long-run causality between tourist arrivals to pollution within a multivariate framework, which included real GDP, energy consumption, financial development and urbanization in Malaysia. The result implied that an increase in tourist arrivals led to an increase in pollution in Malaysia. In the case of Singapore, tourist arrivals produced negatively significant effects on CO_2 levels both in the long-term and the short-term periods (Katircioglu, 2014b). Results of the Granger causality tests revealed a unidirectional causality between tourism developments to carbon emission growth in the long-term confirming the tourism-induced EKC hypothesis as in Paramati et al. (2017). International tourism was also found to be catalyst for an increase in the level of CO_2 emissions in Cyprus using a trivariate framework of international tourist arrivals, energy consumption and emissions (Katircioglu et al., 2014). Katircioglu (2014a) found a similar evidence for Turkey where tourism development not only contributed to an increase in energy use but also considerable increases in GHG emissions. Based on the results of these studies, we propose our second hypothesis that there is a positive relationship between tourism and GHG emissions (*Hypothesis 2*).

2.3. Tourism and Energy Consumption

Globally, tourism has been described as fossil fuel-dependent industry and a large emitter of GHG (Becken and Simmons, 2005; Gössling, 2013). Gössling (2000) showed that tourism-related use of fossil fuels was significant in small island states and had detrimental environmental consequences. Similarly, Nepal (2008) documented that tourism contributed to increasing consumption of primary energy sources such as wood and kerosene in rural Nepal. Tourism induced energy-related vulnerabilities are considerably present in many countries (Gössling, 2013).

Only a few time-series econometric studies exist that examine this relationship. Based on a trivariate framework of tourism, energy consumption, and environmental degradation, Katircioglu (2014a) showed that the number of tourist arrivals in Turkey considerably increased long-run energy use. Similarly, Katircioglu et al. (2014) revealed that international tourist arrivals had long-run positive, statistically significant, and inelastic impacts on the level of energy consumption in Cyprus. Solarin (2014) established a unidirectional long-run causality between tourist arrivals to energy consumption in Malaysia. In the Indian context, based on a trivariate framework using tourism, economic growth and energy consumption, Tang et al. (2016) showed that tourism strongly affected energy consumption in the long-run. Based on these findings, we propose our third hypothesis that there is a positive relationship between tourism and energy consumption (*Hypothesis 3*).

2.4. Tourism and Capital Investments

Not many studies have assessed the causal linkage between tourism and capital investments in a time-series setting. Khoshnevis Yazdi et al. (2017), in their study in Iran, found no causal relationship among these variables, based on the autoregressive distributed lag and the error correction model under a multivariate framework. However, based on a bivariate analysis conducted in Saudi Arabia, Alam et al. (2016) found that there is a positive relationship between tourism receipt and numbers of tourist with Foreign Direct Investment (FDI) in the short term and long-term. The study also confirmed a bidirectional causality between tourism expenditure and foreign direct investment (FDI). Similarly Alam et al. (2015) found a positive relationship between foreign direct investment and total number of tourist arrivals in Malaysia. The study recommended increasing tourist arrivals as an instrument to drive FDI in Malaysia. Based on these studies, we propose our fourth hypothesis that there is a positive relationship between tourism and capital investment (*Hypothesis 4*).

3. Methodology and Data

This section outlines the methodology and describes the data used in the paper. The choice of the econometric methodology and data (including its availability) are the main basis for testing all four hypotheses stated above.

3.1. Methodology

The primary question we answer in this study is: “What is the nature of the relationship between tourism, energy consumption and pollutant emissions in developing mountainous economy when time-series analysis generally show that increased tourist arrivals leads to an expansion in economic output”? We specify the models for gross domestic product (GDP), tourist arrival (tourism), gross fixed capital formation (capital), energy use (energy), and carbon dioxide emissions (CO_2) as follows:

$$GDP_t = f(Tourism_t, Capital_t, Energy_t, CO_{2_t}) \tag{1}$$

$$Tourism_t = f(GDP_t, Capital_t, Energy_t, CO_{2_t}) \tag{2}$$

$$Capital_t = f(GDP_t, Tourism_t, Energy_t, CO_{2_t}) \tag{3}$$

$$Energy_t = f(GDP_t, Tourism_t, Capital_t, CO_{2_t}) \tag{4}$$

$$CO_{2_t} = f(GDP_t, Tourism_t, Capital_t, Energy_t) \tag{5}$$

The Augmented Dickey-Fuller unit root test (Dickey and Fuller, 1981) is applied to examine the order of the integration of the series. We then employ the bound test for cointegration to ensure the validity of long-run relationships of the models (Pesaran and Shin, 1998; Pesaran et al., 2001). The bound test for cointegration is more practical than other cointegration tests when the data series are integrated of varying orders such as I(0) (i.e. integrated of order 0) and I(1) (i.e. integrated of order 1) in the unit root tests. The bound test is basically a test of coefficient by performing Wald test (Wald, 1943) on following unrestricted error correction model (ECM):

$$\Delta Y_t = a_0 + \sum_{i=1}^{n} a_{1i}\Delta Y_{t-i} + \sum_{i=1}^{n} a_{2i}\Delta X_{1,t-i} + \sum_{i=1}^{n} a_{3i}\Delta X_{2,t-i} + \sum_{i=1}^{n} a_{4i}\Delta\, X_{3,t-i} + \sum_{i=1}^{n} a_{5i}\Delta\, X_{4,t-i} + a_7 Y_{t-1} + a_8 X_{1,t-1} + a_9 X_{2,t-1} + a_{10} X_{3,t-1} + a_{11} X_{4,t-1} \tag{6}$$

Where Y is the dependent variable and X is the independent variable. Co-integration exists if the Wald test rejects $H_0\colon a_7 = a_8 = a_9 = a_{10} = a_{11} = 0$. Once the co-integration is confirmed, we estimate the long run and short-run relationships of Equation 1 to 5 by using following autoregressive distributed lag (ARDL) (p_1, q_1, q_2, q_3, q_4) model:

$$Y_t = b_0 + \sum_{i=1}^{p_1} b_{1i} Y_{t-i} + \sum_{i=0}^{q1} b_{2i} X_{1,t-i} + \sum_{i=0}^{q2} b_{3i} X_{2,t-i} + \sum_{i=0}^{q3} b_{4i}\, X_{3,t-i} + \sum_{i=0}^{q4} b_{5i}\, X_{4,t-i}$$

(7)

ARDL estimation in Equation 7 is used to calculate the long run multiplier in Equation 1 to 5 by using following formula:

$$a_0 = \frac{b_0}{1-\sum_{i=1}^{p_i} b_{1,i}} \tag{8}$$

$$a_j = \frac{b_m}{1-\sum_{i=1}^{p_i} b_{1,i}} \tag{9}$$

where j = 1, …, 4 and m = 2, …, 5.

We test the hypotheses in the cointegrating relationship by using Granger causality test based on the vector error correction model (VECM). The VECM in Equation 10 estimates short run dynamic coefficients for the co-integrated model. The stability of the ECM model is tested using cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) test based on Page (1954). We also apply standard diagnostic tests, i.e. serial correlation test, normality test, heteroscedasticity test, and misspecification test.

$$\Delta Y_t = d_0 + \sum_{i=1}^{n} a_{1i}\Delta Y_{t-i} + \sum_{i=1}^{n} a_{2i}\Delta X_{1,t-i} + \sum_{i=1}^{n} a_{3i}\Delta X_{2,t-i} + \sum_{i=1}^{n} a_{4i}\Delta\, X_{3,t-i} + \sum_{i=1}^{n} a_{5i}\Delta\, X_{4,t-i} + \sum_{i=1}^{n} a_6\, ECT_{t-1} + e_t \tag{10}$$

We use Granger causality test based on the vector autoregression (VAR) model to test the hypotheses in the absence of any cointegration.

3.2. Data

The sample is restricted to the annual time-series data covering a 40 years period from 1975 to 2014. Data on tourist arrivals was obtained from Nepal Tourism Statistics (MCTCA, 2016) while other data were retrieved from World Development Indicators (WDI) (WB, 2017). Table 1 summarises the statistics of the series while Figure 1 shows the results of data transformation into natural logarithm form.

(Insert Table 1 here)

Tourism (T) is measured by total tourist arrivals by both air and land for various purposes such as holiday/pleasure, pilgrimage, trekking and mountaineering, official and business. Tourist arrivals is an important indicator to measure the well-being of the tourism sector in the Nepalese economy since increasing the number of tourist arrivals is one of the objectives of the national tourism policy. The length of tourists stay can vary from short-term to longer term. Tourist arrivals in Nepal show a positive trend as shown in Figure 1. Tourist numbers increased from the lowest (92,440) in 1976 to its peak (803,092) in 2014. Some major events have disrupted the trend, such as earthquake in 1987 and political turmoil in 2001. Since 2006, after the end of the civil war, tourist arrivals have increased dramatically, with the exception in 2015 when numbers declined due to the earthquake.

(Insert Figure 1 here)

The Gross domestic product or GDP (G) and Gross fixed capital formation (K) also show positive trends. The GDP is in constant 2010 Nepalese rupee (NPR) and is a per capita measure. The real per capita GDP of Nepal has doubled during the period 1975 – 2014, from NRP 10,896 to NRP 26,118 and the mean per capita GDP is NRP 16,207.4 during that period, as shown on Table 1. The capital formation is also stated in per capita constant 2010 NPR and has several deviations in the short run.

Similarly, energy consumption (E) and CO_2 emission (CO_2) exhibit growing trends. Energy consumption is stated in kg of oil equivalent per capita and has relatively exponential trend especially after 1999, with a temporary decrease in 2012 (see Figure1). The high growth is mainly influenced by energy consumption in residential sectors (IEA, 2017). CO_2 emission is measured in kg CO_{2e} per capita; a fluctuating trend can be observed in Figure 1. Per capita emission in Nepal is considerably lower than 2012 world average of 7.6 tCO_{2e} per capita, however, minimising the emission is important in the context of climate change impacts in sensitive ecoregions such as mountains (JRC, 2018; Pepin et al., 2015).

4. Results

Table 2 displays the results of Spearman correlation test between the variables used in this study. All explanatory variables are positively and highly correlated implying that multicollinearity may exist and require further testing. However, before the estimations, we conduct the unit root tests with results in Table 3, implying that the variables are integrated order one (I(1)). The ADF unit tests results conclude the presence of a mix of *I(0)* and *I(1)* data series but not *I(2)* series which allow us to apply the bound test for the cointegration. Cointegration relationship is found in all models except the model for capital formation. Table 4 shows the results of the co-integration tests for the selected models. We ensure that the models do not have serial correlation problem which may cause invalid results of the bound test.

(Insert Table 2 here)

(Insert Table 3 here)

(Insert Table 4 here)

We estimate the long-run relationship of the models in Table 5. None of the explanatory variables has significant influence on energy consumption, however; energy consumption has significant negative influence on tourist arrivals. This finding contradicts earlier evidences on tourism led energy consumption hypothesis and the insignificant impact that energy consumption has on tourist arrivals (Katircioglu et al., 2014; Tang et al., 2016). Capital formation has significant positive influence on GDP and tourist arrivals in the long run, indicating capital is an important factor input in economic growth in line with the neoclassical growth theory (Solow, 1956). GDP and tourist arrivals also have significant positive influences on tourist arrivals and CO_2 respectively. Meanwhile, CO_2 effect is insignificant across all models. The standard diagnostic tests conclude that models for GDP and tourist arrivals violate one of the assumptions of classical linear regressions model (CLRM). The results of Jarque-Bera test unsurprisingly suggest a non-normal distribution as expected with finite sample sizes and hence is not problematic since the results are unbiased (Thadewald and Büning, 2007).

(Insert Table 5 here)

Based on the results of the bound test (see Table 4), Granger causality test is conducted by using VAR for the model for capital formation, and using ECM for other models. Table 6 shows the results of Granger causality tests. In the short run, energy consumption Granger causes GDP and tourist arrivals. Moreover, GDP and tourist arrivals have bidirectional causality in the short run while income (i.e. per capita GDP) significantly influences tourist arrivals in the long-run. In contrast, CO_2 emission does not have any causality relationship with other variables in the short run. The lagged error correction term (ECT), the long-run component, is negative and significant as expected. Deviations in long-run relationship models for energy consumption, GDP, CO_2 emissions and tourist arrivals are corrected for 8%, 46%, 52% and 74% respectively in a year. We also confirm the stability of the CO_2 emissions model by using CUSUM and CUSUMQ test with results in Figure 2. We highlight the following key causality results which provides a foundation to discuss the policy implications under Section 5:

- There is a bidirectional causality of tourist arrivals and per capita GDP in the short-run, similar to earlier studies including Gautam (2011) and Paudyal (2012). Growth in tourist arrivals contributes to economic growth through employment creation, foreign exchange earnings, government revenues, multiplier effects and infrastructure development. In the long-run, GDP per capita has significant positive influences on tourist arrivals supporting the economy driven tourism hypothesis as discussed by Oh (2005) in the South Korean context.
- There exists a unidirectional causality where tourist arrivals affect emissions in the long-run, similar to the studies reported by Solarin (2014) and Katircioglu et al. (2014). We find no causality between tourist arrivals and emissions in the short-run.
- There is a unidirectional causality between energy consumption and tourism, both in short and long-run. Unlike previous studies such as Solarin (2014) for Malaysia, Katircioglu et al. (2014) for Cyprus and Katircioglu (2014a) for Turkey , the results from our study suggests that more tourist arrivals lead to a decrease in per capita energy consumption in the short-run, which well highlights the energy scarcity scenario facing the economy.
- We confirm a unidirectional causality between capital investment and tourism in long-run relationships, which is similar to the findings from the study conducted by Alam et al. (2015) that capital formation causes tourist arrivals. The transition to a more capital intensive tourism sector may lead to more tourist arrivals in the long run.

(Insert Table 6 here)

(Insert Figure 2 here)

(Insert Figure 3 here)

(Insert Figure 4 here)

(Insert Figure 5 here)

5. Discussion

This paper makes three main contributions to the literature examining the short-run and long-run relationship between tourism, economic growth, CO_2 emissions, capital formation and energy consumption. First, this research gathers data from disparate sources to examine the relationship in Nepal using unit root tests and cointegration tests based on ARDL bounds testing for the period between 1975 and 2014. Second, we show the causal interactions between tourism and energy consumption, which have been ignored in previous studies given the lack of quality time-series data. The results from a country specific time-series multivariate regression models add new insights to the existing literature focused on examining tourism-energy relationship. Third, our study is the first multivariate framework analysis for estimating the inter-relationships between tourism, economic growth and energy for Nepal. Mountain economies like Nepal contribute less to the GHG emissions but bear disproportionate amount of costs in terms of adverse climate change impacts (Pepin et al., 2015). This study is one of the few attempts to use time-series data to inform tourism policy decisions explicitly aimed at mountain economies. In this section, we briefly discuss policy implications for sustainable tourism development drawing inferences based on the results.

5.1 GDP Influences on Tourist Arrivals

A significant and positive long-run effect of GDP on tourist arrivals indicate that a 1% increase in GDP increases tourist arrivals by 1.56%, thus supporting the economy driven tourism hypothesis. It is rational to assume that tourism is strongly affected by economic expansion since international trade is closely tied to growth in economic outputs (Oh, 2005). This finding lends support to the notion that a developing country like Nepal has not maximised the economic benefits of the tourism sector yet. The total contribution of tourism to Nepal's economy is relatively small, less than 4 %. Some aspect of the low contribution of tourism sector to the national economy could be due to revenue leakages, an issue that is recognized widely in tourism literature and merits further research. The government can strengthen the contribution of tourism to the national economy by maintaining economic and political stability and encouraging new businesses, especially tourism-related service businesses. However, the government cannot expect high economic return from it at least in the short-run.

5.2 Tourist Arrivals and CO_2 Emissions

A unidirectional long-run causality between tourism and emissions implies that a 1% increase in tourist arrivals increases CO_2 emissions by 0.98%. The result is unsurprising as more tourist arrivals creates more demand for energy which translates to significant emissions, even though overall tourism induced energy consumption is insignificant. As the tourism sector in Nepal is fossil fuel intensive (Nepal, 2008), burning of fossil fuels such as firewood and kerosene leads to more CO_2 emissions. This finding should alert the government to push for a green tourism agenda and avoid the business-as-usual strategy associated with tourism, which encourages consumption of fossil fuels. The tourism sector in Nepal should include efforts in energy-efficient buildings, green urban parks, promoting socially-aware entrepreneurship models, and environmentally responsible practices in service quality and management. Raising awareness among tourists to act in environmentally friendly ways is also essential. Introducing fiscally attractive environmental conservation taxes may be desirable in the long run.

5.3 Energy Consumption and Tourist Arrivals

Our results show there is a unidirectional causality between energy consumption and tourism where a 1% increase in energy consumption decreases tourist arrivals by 3.84%. Firewood is the primary energy source in Nepal including in many tourist establishments (Chapagain, 2017). Energy consumption in Nepal is dominated by biomass such as firewood. For instance, the share of biomass on total energy consumption was 82% in 2015 (IEA, 2017). Therefore, higher energy consumption will increase deforestation, which has been causing environmental problems, natural hazard, and social unrest in Nepal (Metz, 1991). Nevertheless, such negative impacts may only occur in short-run. At the same time, the overreliance of the tourism sector on solely imported petroleum products also induces energy shortage as demand increases. Energy shortage leading to the non-availability of kerosene, diesel and cooking gas due to increasing demand in mountainous economies is capable of warding off the potential inflow of tourists especially interested in adventure tourism including mountaineering and trekking. This is because tourists perceive access to energy as an essential component of safe and hygienic accommodation in Nepal as evidenced in an earlier study by Dhakal (2015). Hence, efforts must focus on large-scale development of hydropower at the national level to alleviate energy shortage. Also, opportunities to electrify remote and mountainous areas through accelerated adoption of decentralised off-grid renewable and clean energy sources such as solar, wind and micro hydro needs to be prioritised. Earlier studies such as Gross et al. (2017) has also emphasized that sustainable tourism in Nepal should call for strategies to gradually reduce the dependence on firewood as a source for energy, and promote the availability of and access to alternative fuel energy sources in encouraging tourist arrivals.

5.4 Capital Formation and Tourist Arrivals

A long-run positive relationship between capital formation and tourism indicates that a 1% increase in capital formation increases tourist arrivals by 0.72%. This impact is higher than the one of capital formation on economic output. Tourism related investments in Nepal were only 3% of the total capital investments in 2016 (WTTC, 2017). Therefore, increased government expenditures on public infrastructure such as road networks, and foreign direct investment (FDI) in tourism sectors such as hotels, restaurants and recreational centres are essential for continued growth of tourist arrivals.

Overall, our results suggest that economy-dependent tourism sector of tourism-dependent economy of Nepal needs to advocate for climate-sensitive tourism policies. The significant long-run impacts of tourist arrivals on energy consumption and CO_2 emissions suggest tourism policies in Nepal needs to be harmonized with the national energy and environmental policies in the transition towards a sustainable tourism sector. An integrated policy framework on energy, environment and tourism would reorient the tourism sector to be in tune with the SDGs. An integrated policy framework on energy, environment and tourism

Is especially desirable in mountain economies as they play a central role towards the pursuit of global sustainable development by providing key environmental services such as freshwater, biodiversity conservation and hydropower.

6. Conclusions

Using data specific to Nepal, this study examined the causality relationships between tourist arrivals, economic growth, CO_2 emissions, capital formation, and energy consumption. Time-series econometric methods based on cointegration tests and Granger causality tests were applied to test four hypotheses relevant to the Nepalese economy. The application of the concepts and methods of the cointegration and Granger causality test further allowed us to explore short-term dynamic relations among the variables. The empirical analysis rested on the assumption that adverse economic and environmental impacts can be minimized if tourism development is thoroughly well planned and controlled in line with the principles of sustainable tourism.

We suggest that sustainable tourism agenda in mountainous economies like Nepal should incorporate findings from this study. While increases in tourist arrivals may not significantly contribute to economic growth, as there would be revenue leakages due to payments for imports of goods and services, lack of national level support for climate-sensitive sustainable tourism policies would be detrimental to the industry in the long-run. While it is difficult to state if increased pollution, i.e., due to burning of fuelwood of fossil fuels, would deter tourists from visiting Nepal, it could be argued that tourists are likely to shorten the duration of their trip if pollution levels become critical. Existing energy sources in Nepal's tourism sector should be used more efficiently while making efforts to diversify the energy mix, which is, by reducing firewood consumption, lessening dependence on fossil fuels, and increasing availability of renewable energy sources. Developing mountain economies like Nepal are generally over-dependent on fossil fuels and bear greater risks of being adversely affected by the associated emissions. As such, tourism industry stakeholders need to take environmental pollution seriously if they want to realize the full potential of tourism to aid in environmentally friendly economic development strategies. The most recent statistics in Nepal indicate to a strong growth in tourism – foreign exchange earnings during 2017-18 fiscal year show significant increases, from last fiscal year's NRs 58. 5 billion to 67 billion (roughly US$ 597 million) foreign exchange earnings (The Kathmandu Post, 2018). This growth can only be sustained if energy sources in tourism are diversified, and dependency on fossil fuels are greatly reduced.

Moreover, the orientation of government budgets towards green infrastructure development (green walls, tree health mapping) is important since these spending not only support the tourism sector but also resolve the negative impacts of urbanisation. Redirecting appropriate tourism policies towards meeting the demand created by the increase in tourist arrivals for tourism-related industries is also necessary. The relationship between energy consumption and tourist arrivals is not as straignforward as what the policyamkers think and the results suggest. Tourists may not use the fact of the rising energy consumption to decide their visits to Nepal. However, such negative impacts may only occur in short-run and therefore, further researches are required for re-estimating the nexus by using other methods and social-physiological factors. We conclude that incorporating energy consumption in the economic thinking of the tourist arrivals is critical in facilitating a sustainable tourism sector.

Our results also indicate there is a need for additional research in tourism-related sectors. First, important variables like tourism receipts and exchange rates can be included as longer timer-series are available to study the possibility of tourism revenue 'leakage' in developing economies like Nepal. Second, direct time-series econometric impacts of mountain adventure tourism on energy consumption can be studied to measure the true impact of adventure tourism on the environment. Third, studies like ours would be relevant to other developing countries where tourism is a significant contributor to the national economy. Last, but not least, availability of reliable long-term trend data is critical to projecting future perspectives on tourism and the environment. The lack of accurate, timely, disaggregated and accessible data is a hindering and retarding the economic development and sustainable tourism policy initiatives across many developing economies like Nepal.

Acknowledgements:

We are grateful to the efforts of the editor-in-chief and the two anonymous reviewers in improving this research work. We also acknowledge the helpful comments received from the participants at the 2018 Australian Conference of Economists Conference held in Canberra (10-13 July).

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Table 1 Summary statistics of the series

	E	G	CO_2	K	T
Maximum	412.7	26,118.3	312.5	10,752.3	803,092.0
Mean	329.8	16,207.4	102.9	4,125.9	251,148.8
Minimum	300.9	10,896.5	22.8	1,579.5	92,440.0
Standard Deviation	30.8	4,439.4	71.4	2,357.6	194,971.7

Table 2: Spearman Correlations

Correlation	E	G	CO_2	K	T
E	1.00				
G	0.96	1.00			
CO_2	0.93	0.94	1.00		
K	0.95	0.97	0.94	1.00	
T	0.93	0.94	0.93	0.96	1.00

Table 3: The results of unit root tests

Tests	E	G	CO_2	K	Tourism (T)
ADF	I(1)	I(1)	I(1)	I(1)	I(0)/I(1)
I(0)-1	2.17	1.51	-0.30	0.26	-1.36
I(0)-2	-1.09	-2.24	-2.96	-2.13	-3.35***
I(0)-3	2.39	5.89	-2.06	3.09	2.47
I(1)-1	-7.47*	-7.36*	-6.93*	-7.38*	-8.16*
I(1)-2	-8.42*	-8.17*	-6.83*	-7.43*	-8.07*
I(1)-3	-6.40*	-0.16	-6.11*	-5.89*	-7.25*

Note: The asterisks (*), (**) and (***) indicate the rejection of the null hypothesis of unit root at 1%, 5%, and 10%. I(0)-i, I(1)-i and I(2)-i indicate that unit root tests are conducted in level, first differences and second differences, respectively. The identifier i represents test's assumptions, which are a constant for 1, a constant with a trend for 2 and no constant for 3.

Table 4: The results of the bound test for co-integration

ARDL models (and the lags of explanatory variables)	Critical value bounds		
	1%	5%	10%
$F_E(E\|G, CO_2, K, T)$= 3.63***. ARDL (3,1,0,4,4)	3.74-5.06	2.86-4.01	2.45-3.52
$F_G(G\|E, CO_2, K, T)$= 5.25*. ARDL (3,0,0,1,0)	3.81-4.92	3.05-3.97	2.68-3.53
$F_{CO2}(CO_2\|E, G, K, T)$= 4.25**. ARDL (1,0,0,0,1)	3.29-4.37	2.56-3.49	2.20-3.09
$F_K(K\|E, G, CO_2, T)$= 2.44. ARDL (2,0,2,2,2)	3.29-4.37	2.56-3.49	2.20-3.09
$F_T(T\|E, G, CO_2, K)$= 5.03*. ARDL (1,1,0,0,0)	3.29-4.37	2.56-3.49	2.20-3.09

Note: Model for energy uses assumption of unrestricted constant, model for GDP uses assumption of trend, and other models use assumption of restricted constant. The asterisks (*), (**) and (***) indicate the co-integration significant at 1%, 5%, and 10%.

Table 5: Long-run relationship of the models and the results of diagnostic tests

Variables	Energy		GDP		CO_2		Tourism	
	Coefficients	**t-stat**	**Coefficients**	**t-stat**	**Coefficients**	**t-stat**	**Coefficients**	**t-stat**
Energy			0.17	0.66	0.30	0.17	-3.84*	-3.09
GDP	-0.02	-0.01			0.22	0.18	1.56**	2.14
CO_2	0.28	0.35	-0.01	-0.38			0.06	0.37
Capital	0.71	0.50	0.18***	1.93	0.21	0.46	0.72**	2.39
Tourism	-0.44	-0.56	0.05	1.15	0.98**	2.70		
Constanta	4.81	0.67			-13.55	-2.00	13.63*	2.99
Trend			0.01*	0.00				
A (2)	0.25 [0.59]		1.67 [0.11]		0.81 [0.37]		0.87 [0.34]	
A (4)	0.14 [0.85]		0.78 [0.35]		1.11 [0.25]		0.79 [0.41]	
B	4.28 [0.12]		9.03 [0.01]		4.69 [0.08]		9.13 [0.01]	
C (2)	1.49 [0.22]		0.27 [0.74]		0.03 [0.97]		0.34 [0.70]	
D (1)	0.26 [0.80]		1.86 [0.07]		0.69 [0.49]		0.83 [0.45]	

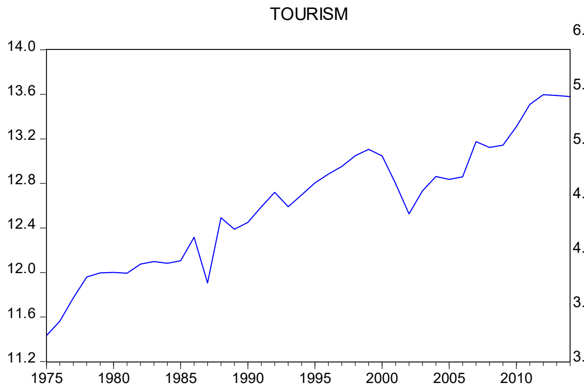
Note: (SE)/ [t-stat]; *significant at 1%, **significant at 5%, and ***significant at 10%. A: Breusch-Godfrey Serial Correlation LM Stat (lags) [its probability]; B: Jarque-Bera Stat [its probability]; C: ARCH LM tests (lags) [its probability]; D: Ramsey RESET F-stat (lags) [its probability].

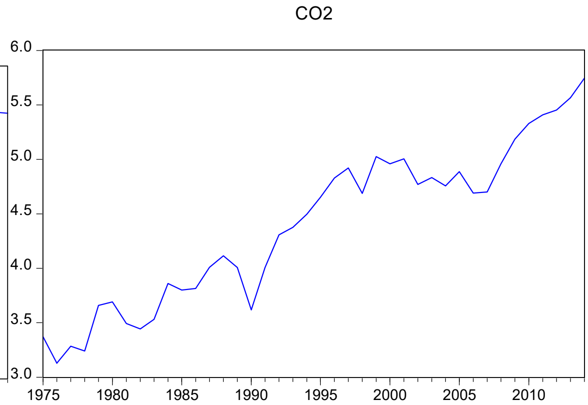
Table 6: Results of the Granger causality test

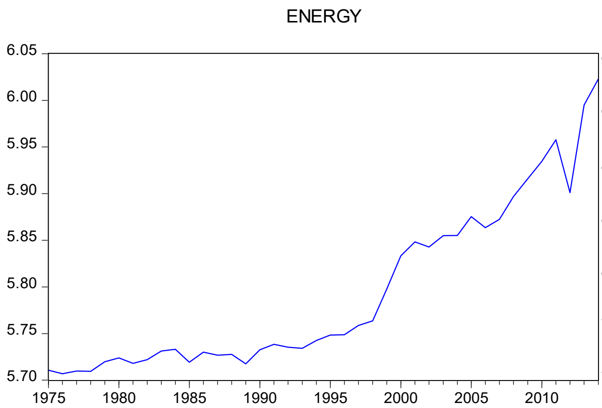
Dependent Variables	Short-run results χ^2 statistics	Long-run results

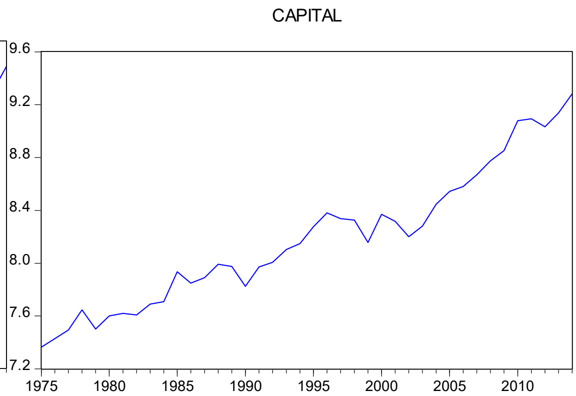
	$\Delta Energy_t$	ΔGDP_t	ΔCO_{2t}	$\Delta Capital_t$	$\Delta Tourism_t$	ECT (t-statistic)
$\Delta Energy_t$	-	-0.26***	0.03	0.03	-0.04**	-0.08*
		(-2.00)	(1.67)	(0.86)	(-2.11)	(-4.80)
ΔGDP_t	0.09	-	0.0003	0.03	0.03***	-0.46*
	(0.63)		(0.02)	(0.96)	(1.73)	(-5.60)
ΔCO_{2t}	0.76	0.22	-	0.17	0.17	-0.52*
	(0.64)	(0.25)		(0.69)	(1.10)	(-4.58)
$\Delta Capital_t$	0.72	0.90	0.05	-	0.19	-
	(0.93)	(1.30)	(0.59)		(1.91)	
$\Delta Tourism_t$	-0.41	1.35***	0.13	0.31	-	-0.74*
	(-0.43)	(0.05)	(0.25)	(1.57)		(-5.69)

Note: (SE)/ [t-stat]; *significant at 1%, **significant at 5%, and ***significant at 10%.









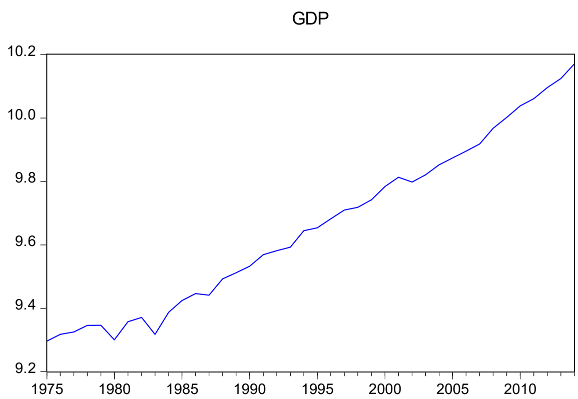


Figure 1 Trends in the transformed variables

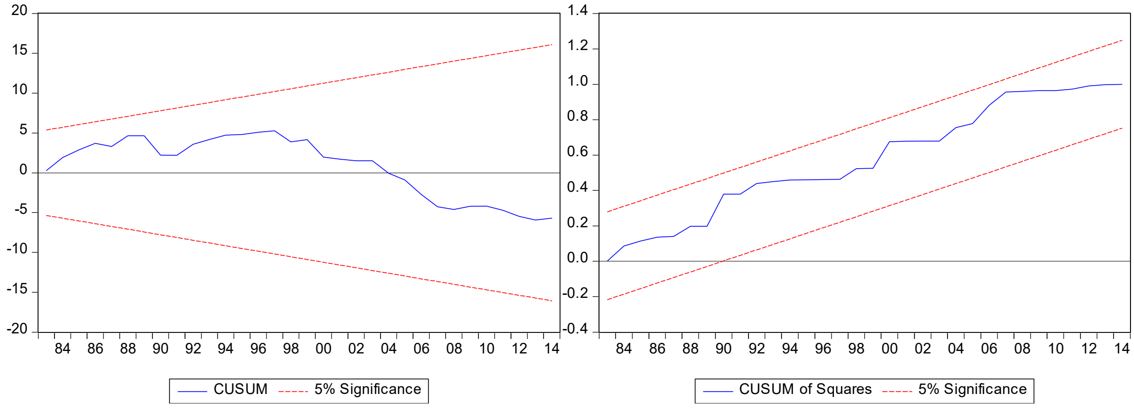


Figure 2 Stability test for model CO_2 emissions

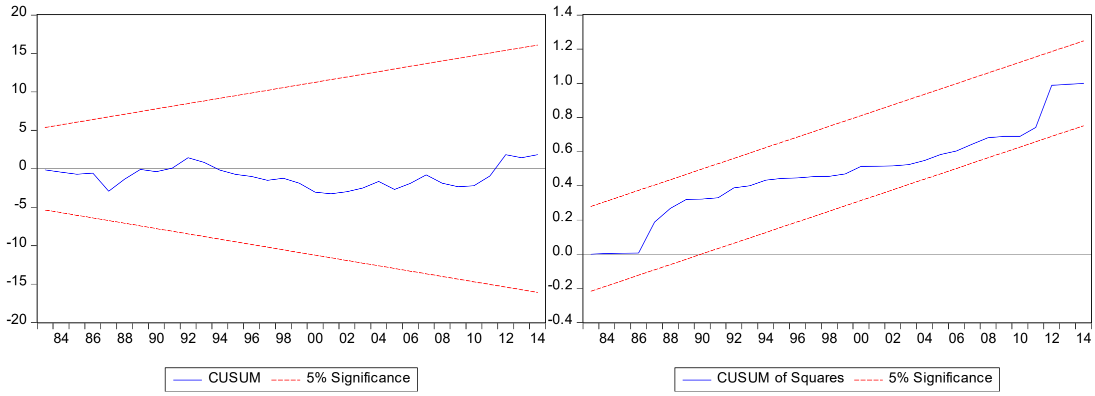


Figure 3 Stability test for model tourist arrivals

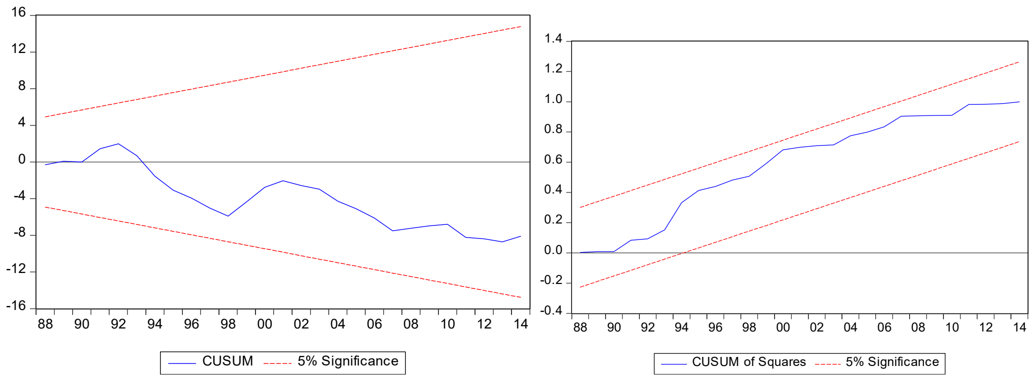


Figure 4 Stability test for model GDP

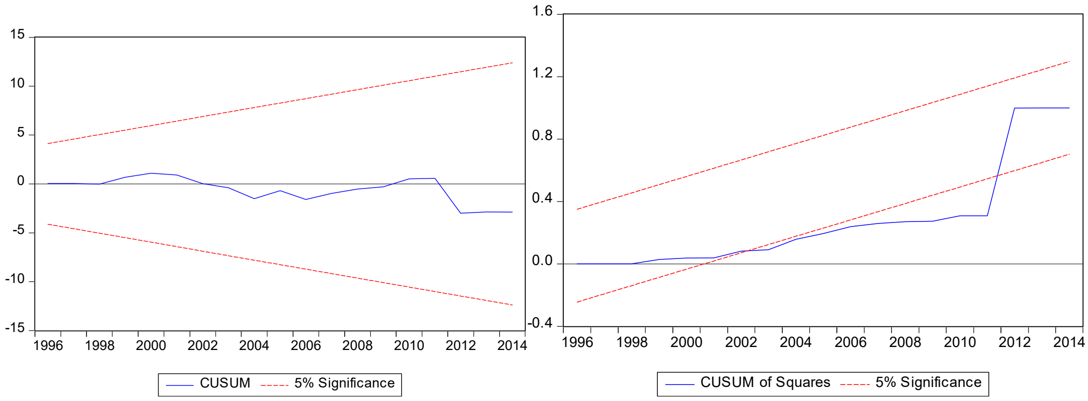


Figure 5 Stability test for model Energy Consumption