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ENERGY TRAILS OF TOURISM: ANALYZING THE RELATIONSHIP BETWEEN TOURIST ARRIVALS AND ENERGY CONSUMPTION IN MALAYSIA

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Abstract: This study aims to investigate the long-term relationship between Malaysian tourism, energy consumption, and their association with economic growth, and financial development, using the Autoregressive Distributed Lag (ARDL) method. Utilizing annual data spanning from 1990 to 2020, this research examines how increased international tourist arrivals, economic growth, and financial development contribute to energy consumption in Malaysia. The study's findings reveal that growing tourism escalates energy demands for transportation, accommodation, and leisure activities. Furthermore, economic expansion drives energy usage through business expansion and increased industrial activities. Financial progress facilitates capital accessibility, leading to investments in energy-intensive sectors. In conclusion, to ensure sustainable future energy demand, this study underscores the importance of eco-friendly tourism practices that stimulate economic growth while minimizing emissions. Sustainable economic and financial strategies are also essential.

Key words: Energy use; Tourist arrivals; Economic growth; Financial development; Sustainable tourism; Climate change

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INTRODUCTION

Energy is the main wheel of the rising Malaysian economy, and it is essential to find out which factors are related to energy demand (Begum et al., 2023). In Malaysia, rising tourism sectors, increasing income, and spreading financial development might be correlated with energy demand (Raihan and Tuspekova, 2022a). The general thinking is that tourism is one of the most noticeable service industries, making it an extremely important international industry (Nocca et al., 2023). According to the World Travel and Tourism Council's latest findings, the tourism industry contributed 10.3% of the world's total gross domestic product (GDP) in 2019 and brought in 8.9 trillion dollars worldwide in income (WTTC, 2022). Even amid an economic downturn, tourism can help a nation's economy recover and thrive because it can help create jobs and generate money (such as earnings in a foreign currency), both of which are important contributors to economic growth (Jahanger et al., 2023).

Nevertheless, tourism remains Malaysia's most important source of overseas revenue and a major factor in the country's overall development. In 2019, Malaysia welcomed 26 million international tourists (World Bank, 2022), nearly the country's total population. In the year 2020, the tourism industry in Malaysia contributed 14.1% to the country's GDP. In addition, Malaysia's growing tourism industry was responsible for providing 11.4% of all jobs in the country. This tourism business

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employed around 1.5 million people directly or indirectly. Since 2012, China surpassed Thailand as Malaysia's third-largest tourist source, with over 2 million annual Chinese visitors by 2016, peaking at 2.94 million in 2018 (Tourism Malaysia, 2020). Tourism Malaysia, under the Ministry of Tourism, promotes the country internationally (Musa et al., 2023). COVID-19 caused a drastic 83.4% drop in 2020's international tourist arrivals to 4.3 million (Tourism Malaysia, 2020). However, Malaysia reopened its borders in 2021, leading to a positive resurgence in the tourism industry's growth (Shaari et al., 2022b).

Tourism's growth boosts income but escalates energy use (Kumail et al., 2023; Liu et al., 2023; Ventura et al., 2023), driven by increased hotel stays and transit use (Dogan and Aslan, 2017). Particularly, aviation exacerbates energy consumption and emissions. Malaysia's National Tourism Policy (2020-2030) emphasizes balancing income with sustainable transformation, competitiveness, and environmental protection. Stagnation in Malaysia's tourism industry stems from lacking innovation, government reliance, and unsustainable practices. To remain competitive and eco-friendly, the industry must pivot towards responsible consumption, supporting Net Zero Emission (NZE) goals and decarbonization. Energy consumption is vital for economic progress but must be balanced to mitigate negative impacts (Selvanathan et al., 2021). While driving technological advancement and growth, excessive energy use harms the environment, increasing carbon dioxide (CO_2) concentrations and driving climate change (Nocca et al., 2023). This harms ecosystems and human well-being (Pan et al., 2021). Tourism contributes almost 5% of global emissions, mainly from transport (75%) and lodgings (20%). Malaysia's energy sector faces emission challenges (Shaari et al., 2022a; Ridzuan et al., 2022), alongside natural disasters. Over three decades, Malaysia's tourism and energy consumption surged, necessitating sustainable practices for environmental resilience.

The intricate interplay of energy, emissions, and tourism captivates scholars, as does the nexus of globalization, energy sources, economic growth, and usage (Işik et al., 2020a). Recent research highlights factors like technological evolution, economic status, urbanization, regional environmental policies, and industry composition influencing travel (Pan et al., 2021; Thang, 2022). Rural tourism success hinges on rural business engagement, while "entertainment tourism" success entails quality services, logistics, marketing, and safety (Luo et al., 2021). Evolving travel trends alter these dynamics. Countries promote agricultural, rural, and medical tourism interchangeably (Cham et al., 2021). Many nations explore tourism's CO_2 impact tied to energy (Shi et al., 2022). Tourism wields both positive and negative pollution effects, explored through empirical studies (Dogru et al., 2019a; Işik et al., 2020b). Scarce research examines this link in a single, expanding upper-middle-income nation like Malaysia. Thus, this study delves into how Malaysia's tourism affects its energy consumption.

This study explores how tourism affects energy use in Malaysia, revealing a lasting connection. By predicting energy changes tied to tourism, economic growth, and development, the study fills an important gap. Since tourism is crucial for Malaysia's economy (Solarin, 2014), it's vital to understand its energy impact for effective carbon emission rules. The research focuses on sustainability, looking at environmental, economic, and socio-cultural aspects. Recommendations aim at creating jobs, preserving local culture, and balancing socio-cultural, economic, and environmental aspects. This approach ensures Malaysia's tourism lasts long and follows global trends. For policymakers in Malaysia and similar developing nations relying on tourism, the study suggests considering energy efficiency and clean technologies. This aligns with Sustainable Development Goal 7. It also emphasizes reducing pollution, managing waste, and supporting cultural sites, contributing to Goals 8, 12, and 14 for sustainable growth and resource use. In the post-COVID-19 world, where tourism helps economic recovery, this study guides national policies in line with Malaysia's Paris Agreement goals. The article comprises five sections: an introduction, a literature review, a methodology, findings and discussion, and a conclusion with policy implications.

LITERATURE REVIEW

Rising energy demand is a concern and there is a link between growing economies, trade, FDI, industrialization, GDP growth, urbanization, and rising energy use. Tourism has a significant impact on the economy, but its effect on CO_2 emissions has been neglected. Some research has found a connection between tourism and energy consumption, but more investigation is needed to understand the impact of tourism on the environment. For example, tourism activity can lead to increased emissions in Mediterranean countries (Gao et al., 2021; Alola and Alola, 2018), high-income countries within the OECD (Balsalobre-Lorente et al., 2023), Golf member countries (Farooq et al., 2023), Middle Eastern nations (Onifade et al., 2023), emerging countries (Nathaniel et al., 2023). Katircioglu (2014) found that tourism is a major factor in the rise of energy consumption, similar to Zhang and Gao (2016) who found that tourism has a substantial impact on GDP growth and CO_2 emissions in China. However, a few studies have suggested the opposite, such as certain Middle Eastern regions (Voumik et al., 2023a), G7 nations (Ahmad et al., 2022), top tourist destinations (Ansari and Villanthenkodath, 2022), and countries involved in the Belt and Road initiative (Umurzakov et al., 2023).

Jebli and Hadhri (2018) used the feedback hypothesis to confirm short-run Granger causality between touristic zone development and energy consumption. They found only one path of long-term causation between energy use and international travel using a vector error correction model (VECM). Tang et al. (2016) investigated dynamic causal and inter-relationships between India's tourist sector, GDP growth, and energy use, finding only roughly 9 per cent of the GDP-tourism gap could be attributed to energy use. The growth in tourism and the economy significantly impacted the total amount of energy consumed. Ali et al. (2018) found a strong correlation between renewable energy use and tourism in nations with higher GDP, suggesting a feedback loop between the two industries.

Nepal et al. (2019) found a one-way causal relationship between energy use and the number of visitors, demonstrating how the consumption of firewood and reduced reliance on fossil fuels affected tourism in Nepal and other developing countries. Dogan and Aslan (2017) discovered no correlation between the quantity of tourists visiting European Union member states and candidate nations and overall energy consumption. Gamage et al. (2017) found that an increase in tourism

in Sri Lanka would not substantially influence the country's ecological system. Raihan (2023) used the DOLS approach to report that recent investigations found that tourism increases CO_2 emissions in the Philippines, Thailand, and Chile.

Recently, research has focused on the relationship between tourism and energy consumption. Gokmenoglu and Eren (2020) analyzed 55 years of data (1960-2015) to determine the impact of tourists from other countries on Turkey's energy use. They found a one-way causal relationship between the number of tourists and energy consumption, using the bootstrap method to adjust for multiple correlations. The study concluded that Turkey's high energy consumption is largely due to its large number of visitors from other countries. Amin et al. (2020) found a long-term, unidirectional causal link between the rise in the number of visitors and energy use. Selvanathan et al. (2021) evaluated the correlations between tourism, energy consumption, carbon emissions, and GDP for South Asian countries and found that tourism positively affects energy consumption in Bangladesh, India, Nepal, and Pakistan. However, the expansion of the tourist industry in South Asia poses a significant risk to the environment due to growing CO_2 emissions, which could harm the quality of the environment.

Tourism's impact on the natural world is a concern due to the increasing energy demand for activities like transportation, housing, and retail services (Ali et al., 2020). High-middle-income nations' primary energy consumption has a one-way causal relationship with visitors' expenditures and the net inflow of international tourists over the long run (Shi et al., 2020). The primary energy use of high-income nations is causally associated with the per-capita expenditure of foreign tourists in a short-run, one-way relationship. Tourism's impact on energy use varies based on the countries' GNP. The article examines the link between carbon emissions and tourism's impact on energy consumption. Raihan et al. (2022c) found that a 1% increase in tourism results in a 0.04% rise in CO_2 emissions. A paired Granger causality test revealed that tourism is a primary sector responsible for CO_2 emissions.

Tourism expansion and economic growth are shown to go hand in hand in Germany by Isik et al. (2018), while in China and Turkey, it is the reverse. Dogru et al. (2019b), employing the ARDL method, reported that a depreciation of the local currency improves the balance of US tourism trade with Canada, Mexico, and the UK, but the results were inconclusive overall. Isik et al. (2020a) confirmed the validity of the tourism-driven EKC theory in the French context and confirm that countries like France, Italy, the UK, and the US can benefit from a decrease in their CO_2 emissions if they increase their use of renewable energy sources. However, a rise in the country's foreign tourist arrivals has a net positive effect on Italy's carbon footprint. For the top 10 most visited countries, Isik et al. (2017a) found evidence of causality between tourist arrivals, tourism receipts, energy consumption, and economic growth. Isik et al. (2017b) demonstrated that rising GDP, improved financial markets, increased exports and imports, and higher tourism spending all contributed to rising CO_2 emissions in Greece. From 1996Q3 to 2015Q1, Ongan et al. (2017) looked into how changes in real exchange rates and revenue affected demand for international travel to the US from selected EU countries finding that visitors to the US are more responsive to shifts in the actual exchange rate than they are to shifts in GDP. More recent studies by Voumik et al. (2023b) explored the impact of tourism, GDP, renewable energy, and fossil fuel towards environmental degradation at top ten most attraction tourist destinations at Africa. The main outcome showed that higher renewable energy reduced the carbon emissions, while higher number tourist arrivals and fossil fuels lead towards higher releases of carbon emissions.

Research conducted by Irfan et al. (2023) on China's tourism industry from 2001 to 2019 reveals that tourism related activities (i.e., food and beverage, shopping and entertainment) significantly contribute to greenhouse gas emissions. In the long run, the tourism-traveling sector is one of the primary contributor to CO_2 emissions. Xiong et al. (2022) used the ARDL method to investigate the influence of tourism on environmental quality in the USA. Their findings highlight a significant connection between tourism and both greenhouse gas emissions and air pollution, indicating an adverse impact on people's lives. Yıldırım et al. (2023) found that by analyzing tourism revenues alongside variables such as trade openness, financial development, urbanization, and energy consumption in Mediterranean countries, it was observed that an increase in tourism revenue was correlated with a rise in CO_2 emissions. Other studies in the Middle East have found similar findings (Al Fahmawee and Jawabreh, 2023). Recently, groundbreaking econometric techniques have been employed to investigate the GDP- CO_2 nexus, yielding novel insights. The study conducted by Jiang and Yu (2023) investigated the relationship between greenhouse gas emissions and economic activity in China, revealing significant trade-offs between rapid economic growth and environmental quality. This research highlights the increasing difficulties that economies face in pursuing the SDGs through rapidly expanding sectors such as tourism. In accordance with Ghosh et al. (2023), who utilize innovative quantile regression techniques, economic advancement is of paramount importance. This is evidenced by the strong positive relationship between GDP growth and carbon dioxide emissions, particularly in developing nations such as the BRICS group. The findings of Usman et al. (2023) suggest that the use of ARDL bound testing reveals that economic growth, non-renewable energy utilization, and trade openness have a detrimental effect on environmental quality and an increase in carbon emissions in Pakistan.

The adverse impacts of tourism on CO_2 emissions have been thoroughly documented and widely recognized across the globe. Guo et al. (2023) find that initial growth in manufacturing and services increases fossil fuel consumption and CO_2 emissions, but long-term expansion in the tourism service sector in Asian developing countries is expected to mitigate environmental degradation. This supports the tourism growth hypothesis, predicting increased inbound arrivals in Asia. Raihan (2023) explores interdependent effects in the Philippines, indicating that a 1% increase in economic growth, urbanization, industrialization, and tourism corresponds to CO_2 emission increases of 0.16%, 1.25%, 0.06%, and 0.02%, respectively. Farooq et al. (2023) reveal positive correlations between economic growth, foreign investment, tourism investment, electricity production, and population density with CO_2 emissions in the Gulf region. Azam and Raza (2022) analyze global data (1990-2018), showing positive correlations between economic growth, foreign investment, tourism investment, electricity production, and population density with CO2 emissions.

Research on the ecological consequences of financial growth and trade openness, aimed at acquiring advanced technologies for reducing CO_2 emissions, has been explored. Habiba et al. (2023) find that financial development contributes to increased CO_2 emissions and environmental degradation, but when combined with renewable energy, the impact can be mitigated. Ren et al. (2023) show that the link between financial development and CO2 emissions is more pronounced in areas with lower poverty levels, with structural factors playing a role in mitigating this association. However, financial development has both positive and negative effects on CO_2 emissions at the regional level, leading to spatial spillover effects. Foreign investment's environmental impact varies across countries with differing income levels. Huang and Guo (2023) discover that in the Europe & Central Asia region, financial development tends to separate carbon emissions from economic growth, while in the Eastern Partnership, Sub-Saharan Africa, and Middle East and North Africa regions, financial development correlates with increased carbon emissions.

Several studies suggest that energy consumption affects economic growth and environmental quality (Amin et al., 2020; Isik et al., 2021), but there is limited research on tourism's impact on energy use, particularly in Malaysia. This study aimed to address this knowledge gap by investigating the relationship between tourism, energy consumption, GDP growth, and the financial sector using country-specific time series data.

METHODOLOGY

1. Data

This study analyzed annual time-series data from 1990 to 2020, which included data from the Visit Malaysia campaign's launch in the 1990s. The study aimed to evaluate the campaign's impact on energy use since its inception. The Malaysia Tourism Promotion Board (MTPB) website provided tourism statistics, while the World Development Indicator (WDI) provided data on energy consumption, economic growth, and financial development. To reduce variance, logarithmic forms were used for the variable of interest. Definitions, units of measurement, and data sources for each variable are listed in Table 1.

Table 1. Description of the variables and data sources (Source: WDI and MTPB)

Variables	Description	Logarithmic structures	Measurement units	Sources
EU	Energy use	LEU	Kg of oil equivalent per capita	WDI
TR	International tourism	LTR	Number of tourist arrivals	MTPB
GDP	Economic growth	LGDP	GDP per capita (constant Malaysian Ringgit)	WDI
FD	Financial development	LFD	Domestic credit to the private sector (% of GDP)	WDI

2. Empirical framework

The Cobb-Douglas production function is a reasonable fit if we assume a market-clearing scenario in which energy demand is proportional to tourist arrivals, GDP, and financial growth.

$$EU_t = f\ (TR_t; GDP_t; FD_t) \quad (1)$$

Where EU_t represents energy use, TR_t is employed as a proxy for tourism, GDP_t is the proxy for income growth, and FD_t represents financial development. The subscript t represents 'time'

In this empirical analysis, the exogenous variables are TR, GDP, and FD; and the endogenous variable is EU. Theoretically, increasing tourist arrivals is anticipated to contribute to the surge in energy use. Therefore, TR is expected to increase EU. Prior studies established that economic growth enhances energy use. Therefore, GDP is expected to increase EU. As per previous studies, financial institutions offer funding for economic activities (low-cost loans to consumers and enterprises), which encourages energy demand. Therefore, FD is expected to contribute to boosting the EU.

Although the number of tourist arrivals was the primary variable of interest for this study, the researchers also consider other important control variables, such as economic growth and financial development, which are known to influence the amount of energy consumed, according to the previous research (Begum et al., 2020; Akan, 2023). The number of visitors from other countries and Malaysia's overall demand for energy is formulated as:

$$LEU_t = \tau_0 + \tau_1 LTR_t + \tau_2 LGDP_t + \tau_3 LFD_t + \varepsilon_t \quad (2)$$

where τ_1, τ_2, and τ_3 are the coefficients of the regressors. Besides, ε_t represents an error term.

The empirical model was subjected to several innovative econometric procedures. Firstly, the stationarity property of the data was analyzed using three-unit root tests, including the Augmented Dickey-Fuller (ADF), Dickey-Fuller generalized least squares (DF-GLS), and Phillips-Perron (P-P) tests. The study verified the long-term relationship between the specified model and certainty once the integration order of the series was determined. Next, the ARDL bounds test, developed by Pesaran et al. (2001), was employed to test for the presence of cointegration between Malaysia's energy consumption and other variables used to explain it. Compared to alternative one-time integer procedures, the ARDL bounds test for cointegration valuation provides several advantages, such as providing higher reliability for even small sample sizes (Ridzuan et al., 2022). It can also be used to test for mixed order of integration, as long as all variables are included in the same order. The Akaike information criterion (AIC) was used to select the most effective model order. The following Equation represents the ARDL model for the estimation:

$$\Delta LEU_t = \tau_0 + \tau_1 LEU_{t-1} + \tau_2 LTR_{t-1} + \tau_3 LGDP_{t-1} + \tau_4 LFD_{t-1} + \sum {}^{q}{}_{i=1}\gamma_1 LEU_{t-1} + \sum {}^{q}{}_{i=1}\gamma_2 LTR_{t-1} + \sum {}^{q}{}_{i=1}\gamma_3 LGDP_{t-1} + \sum {}^{q}{}_{i=1}\gamma_4 LFD_{t-1} + \varepsilon_t \quad (3)$$

The study investigated the long-term and short-term associations between the variables using the ARDL bounds testing equation to obtain the F-statistic result. The ARDL model was used to determine the long-run relationship and short-run dynamics of a single model's variables in case cointegration was discovered. The ARDL method is suitable for studies where variables are kept the same, either at level, first differences, or a combination of the two (Ansari and Villanthenkodath, 2022). It is also straightforward to understand and requires only one equation to be set up. The long-term relationship between the series was determined, and the short-run coefficients were calculated. The error-correction model was evaluated, and the short-run coefficients were obtained as shown in Equation (4).

$$\Delta LEU_t = \tau_0 + \tau_1 LEU_{t-1} + \tau_2 LTR_{t-1} + \tau_3 LGDP_{t-1} + \tau_4 LFD_{t-1} + \sum {}^{q}{}_{i=1}\gamma_1 LEU_{t-1} + \sum {}^{q}{}_{i=1}\gamma_2 LTR_{t-1} + \sum {}^{q}{}_{i=1}\gamma_3 LGDP_{t-1} + \sum {}^{q}{}_{i=1}\gamma_4 LFD_{t-1} + \theta ECT_{t-1} + \varepsilon t \quad (4)$$

In Equation (4), the dynamics of error correction and the long-term links between the series are displayed, where q represents the lag length of the series and Δ is the first difference operator. The ECT notation refers to the error correction term, and the coefficient of the ECT is denoted by θ. This analysis used FMOLS, DOLS, and CCR to examine how energy consumption was affected by various factors over time as part of a robustness evaluation. The cointegration requirement among the I (1) parameters must be satisfied before using FMOLS, DOLS, or CCR. These techniques account for endogeneity and serial correlation biases resulting from the cointegration connection, producing asymptotically efficient results. Figure 1 presents the analysis flowchart in its entirety.

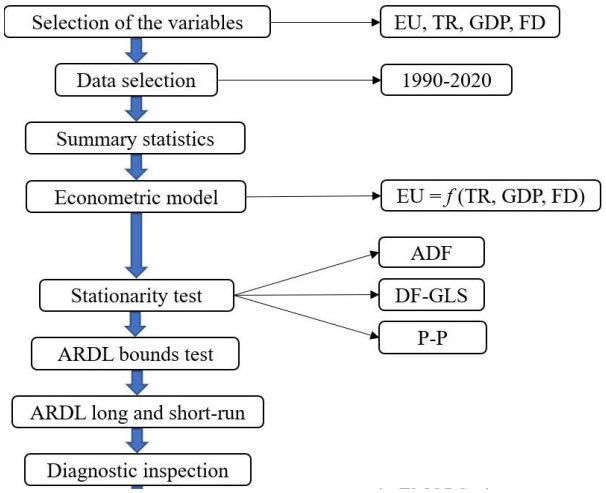

Figure 1. Flow Chart of the Analysis

RESULT AND DISCUSSION

The results of the evaluation of the unit root test provide crucial information on the integration characteristics of the parameters. This information is necessary to develop long-term relationships. The ADF, DF-GLS, and PP tests were used to evaluate the series' integration features.

Table 2 outlines the results of the stationarity test, revealing that LEU, LTR, and LGDP exhibited a unit root problem at the level before becoming stationary after taking the first difference. The DF-GLS test showed that LFD was not stationary at the level, but became stationary after taking the first difference. The ADF and P-P tests revealed that LFD was stationary at the level I(0), and became I(1) after taking the first difference.

Table 2. Unit Root test results; *** and ** indicate the significance level at 1% and 5%, respectively

Variables	ADF		DF-GLS		P-P	
	levels	first difference	levels	first difference	levels	first difference
LEU	-1.730	-5.502***	-0.174	-3.469**	-1.289	-7.813***
LTR	-1.246	-3.728***	-1.255	-3.507**	-1.271	-3.753***
LGDP	-1.990	-4.318***	0.180	-4.341***	-1.990	-4.305***
LFD	-3.228**	-4.181***	-1.380	-4.130***	-3.141**	-4.154***

In light of the unit root test findings, the ARDL bounds test was carried out to determine whether the variables connected over time. The results of the cointegration study are detailed in Table 3, which can be found here. According to the results, the F-statistic value (7.032) was much greater than the critical values at the top limits of 1%, 5%, and 10%. Therefore, it may be concluded that these factors have a long-term correlation.

Table 3. ARDL bounds test results
(Source: Authors estimations)

F-bounds test		Null hypothesis: No degrees of relationship		
Test statistic	Estimate	Significance	I(0)	I(1)
F-statistic	7.032	At 10%	2.37	3.20
K	3	At 5%	2.79	3.67
		At 2.5%	3.15	4.08
		At 1%	3.65	4.66

Table 4. ARDL long and short-run results: dependent variable LEU. (Source: Authors estimations) *** and ** indicate the significance level at 1% and 5%, respectively

Variables	Long-run			Short-run		
	Coefficient	t-Statistic	p-value	Coefficient	t-Statistic	p-value
LTR	0.021***	2.186	0.006	0.026**	1.954	0.013
LGDP	0.948***	13.747	0.000	0.638***	4.589	0.000
LFD	0.036***	2.922	0.005	0.014**	1.936	0.013
C	10.716	2.900	0.137	-	-	-
ECT (-1)	-	-	-	-0.596***	-4.481	0.000
R^2	0.987					
Adjusted R^2	0.974					

The research used the ARDL method to investigate the long-term and short-term interplay between the variables, following a long-term relationship established in the bound test. The results of the long-run and short-run estimations are presented in Table 4. The study revealed a positive and statistically significant coefficient for LTR, indicating that a 1% rise in tourist arrivals leads to a 0.021% increase in energy consumption in the long term and a 0.026% increase in the short term. This suggests that the rapid growth of the tourism industry in Malaysia has had a positive impact on energy

consumption both in the short and long term. Additionally, the ARDL results showed that GDP and financial development positively influence energy consumption, with a significance of 1%. A 1% rise in GDP is associated with a long-term increase in energy consumption of 0.95% and a short-term increase of 0.64%. The rapid economic expansion of Malaysia has favorable implications for energy usage both in the short and long term. Similarly, the coefficient of LFD shows that a 1% rise in financial development has a positive effect on energy consumption patterns in the long run (0.036%) and the short run (0.014%). This suggests that greater economic progress is associated with higher energy use, regardless of other variables.

Other studies have found similar results in economies comparable to ours (Saud et al., 2019; Begum et al., 2020; Jahanger et al., 2023; Voumik et al., 2022a; Liu et al., 2023). The growth of GDP leads to increased energy consumption and environmental pollution (Majumder et al., 2023; Voumik et al., 2022b). Additionally, Foreign Direct Investment (FDI) can both promote new sectors and product lines while also impacting emissions and pollution (Ridzuan et al., 2022).

Our findings are consistent with previous research, which has demonstrated that tourism activity can lead to an increase in carbon dioxide emissions, as noted in the case for Mediterranean countries (Gao et al., 2021), high-income countries in OECD (Balsalobre-Lorente et al., 2023), golf member countries (Farooq et al., 2023), cases among middle East nations (Onifade et al., 2023), the case of emerging countries (Nathaniel et al., 2023), and a case in Malaysia reported by Rahman et al. (2022). Few studies have suggested that tourism can lead to a reduced level of CO_2 emissions, with exceptions in the Middle East (Voumik et al., 2023a), countries members of the G7 group of nations (Ahmad et al., 2022), selected top tourist destinations (Ansari and Villanthenkodath, 2022), and selected countries participating in the Belt and Road initiative (Umurzakov et al., 2023). It is highly plausible that variations in the relationship between CO_2 emissions and tourism activities can be attributed to differences in energy policies, tourist attractions, available infrastructure, technological stage of countries, environmental regulations, and infrastructure among others (Jahanger et al., 2023; Banga et al., 2023).

The regression model fits the data well with R2 and adjusted R2 values of 0.987 and 0.974, respectively. This implies that changes in the independent variable can be explained nearly completely by the independent causes. Short-run results indicate that tourism, economic expansion, and financial development have positive impacts on energy consumption. If short-term deviations are balanced over the long run, as the ECT suggests, the error correction coefficient should be calculated. The ECT was negative and statistically significant at 1%, indicating that the shock from the previous year would be mitigated by 0.60 percentage points this year. The critical level was set at 1%. As time passes, the amplitude of the fluctuation decreases, making it possible for a return to equilibrium in the future.

To validate the model's accuracy, several diagnostic tests were conducted. The log transformation of time-series data was evaluated. The results of these tests are presented in Table 5. The Lagrange Multiplier test showed no serial correlation, indicating that the data was unrelated. The series was found to have a normal distribution using the Jarque-Bera normality test, and the Breusch-Pagan-Godfrey heteroscedasticity test demonstrated that the observation did not contain any errors in regression. The Ramsey RESET test confirmed that the regression was correctly specified. The log form of time-series data did not have any issues with heteroscedasticity or serial correlation, and the model passed the stability test since its residual was normally distributed. The p-value of the F-statistic was 0.0000, indicating that the linear relationship between the variables had statistical significance. The CUSUM and CUSUMSQ tests were used to determine if there was a stable link over a long period, and the plots of the model's coefficients were within the critical bounds and significance level (Figure 2). No lines passed the critical bound, indicating the stability of the model was confirmed.

Table 5. The results of ARDL model diagnostic tests

Diagnostic tests	Coefficient	p-value	Decision
Lagrange Multiplier test	1.831	0.173	No serial correlation exits
Jarque-Bera test	1.491	0.474	Residuals are normally distributed
Breusch-Pagan-Godfrey test	1.732	0.183	No heteroscedasticity exists
Ramsey RESET test	2.426	0.102	The regression is properly specified
F-statistic	220.491	0.000	The linear relationship of this model is significant

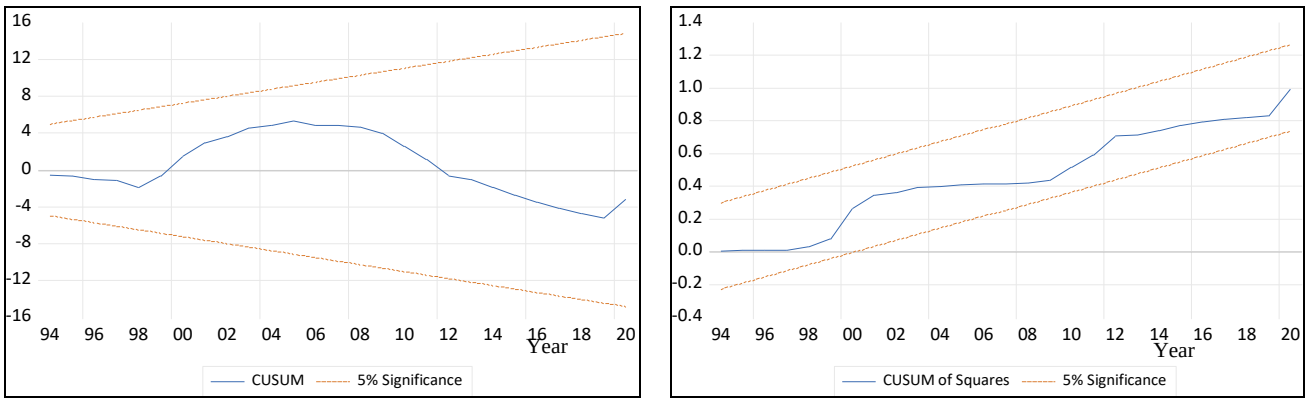

Figure 2. The results of CUSUM and CUSUMSQ tests

Over the past three decades, Malaysia has seen a significant increase in the number of tourists visiting the country, as well as in income growth and energy use. In 2019, the number of tourists visiting the country was over five times higher

than in 1991, and GDP per capita increased by approximately three times during the same period (World Bank, 2022). Energy consumption by individuals also rose by 27%. This is because an increase in tourist arrivals leads to increased economic activity and production, requiring more energy for infrastructure, facilities, and services associated with tourism. Additionally, transportation associated with tourism is a significant contributor to total energy consumption. Therefore, an increase in the number of tourists results in a higher demand for energy. The study's findings suggest that a rise in energy consumption due to an increase in the number of international visitors to Malaysia could negatively impact the environment through increased emissions. Tourism also affects not only the biophysical environment but also the sociocultural components, such as contributing to air pollution and noise pollution. The introduction of trash can transform a beautiful location into a landfill, and deforestation is a significant negative impact of increasing tourist numbers on the ecosystem. To mitigate these negative effects, sustainable tourism must be developed to reduce its impact on biodiversity and the economy.

CONCLUSION AND POLICY IMPLICATIONS

1. Conclusion

This study analyzes tourism's impact on energy consumption, accounting for improved living standards and economic conditions. Time series data from 1990 to 2020 were examined using ADF, DF-GLS, and P-P unit root tests, confirming stationarity, while ARDL bounds tests indicated long-term cointegration. Results revealed significant positive influence of GDP, financial development, and tourism on Malaysia's energy consumption in both short and long terms. ARDL estimates indicated 1% increases in GDP, financial development, and tourist arrivals correspond to energy consumption growth by 0.02%, 0.95%, and 0.04% in the long run, and 0.03%, 0.64%, and 0.01% in the short run, respectively. Findings underscore the need for environmentally responsible tourism policies, aligning with Malaysia's 2030 target for sustainable tourism fostering job creation, cultural preservation, and economic support.

2. Policy implications

To address the issues of energy consumption, climate change, and CO_2 emissions, Malaysia should implement robust policies that encourage tourism stakeholders to adopt renewable energy, carbon-neutral transport, and emission-free technologies. Incentives can be provided to encourage the adoption of eco-friendly public transport, offer tax benefits, and incentivize energy-efficient tourism services. The government can also integrate energy-efficient features in popular tourist destinations, fostering reduced energy costs and emphasizing energy efficiency in hotels and eateries. Energy efficiency not only mitigates pollution and emissions but also saves money, creates long-term jobs, and aligns with sustainable practices.

The Malaysian government plans to implement a system to hold tourists, residents, and visitors accountable for their impact on natural environments at popular tourist attractions. The tourism sector will be encouraged to adopt sustainability and environmental responsibility, providing a better experience for tourists while promoting environmental education. To support a campaign promoting energy conservation, the public will be informed through flyers, brochures, infographics, and updates on authorities' green initiatives. Encouraging eco-friendly infrastructure, alternative energy sources, and low-carbon logistics for tourism businesses, coupled with eco-focused events, could curtail CO_2 emissions and resource depletion. Measures like monitoring energy use, efficient lighting, eco-friendly air conditioning, reduced water consumption, and efficient heating could be adopted. Environmental levies could be implemented at popular tourist spots to ensure sustainable practices. Investing in energy efficiency, waste management, and modernizing public transportation can reduce tourism-induced CO_2 emissions. Malaysia's enhanced energy and environmental regulations could serve as a model for other developing nations grappling with tourism-related environmental deterioration from fossil fuel-based energy.

Collaborative efforts among Southeast Asian governments could yield effective strategies for regional sustainable tourism development. This research addresses tourism and energy consumption, a significant knowledge gap in the Malaysian context. Results carry the potential to inform policymaking by highlighting the impact of visitor numbers on energy use. Energy security is vital for both tourism and economic growth. Diversifying into sustainable energies is vital for long-term energy security and environmental preservation. Policymakers must align energy and tourism policies with Malaysia's National Tourism Policy (NTP) 2020-2030, which aligns with the Sustainable Development Goals (SDGs). The tourism sector should boost competitiveness through sustainable practices, revenue generation, and community engagement. Aligning with NTP's strategies and SDGs can create jobs, conserve biodiversity, and protect cultural heritage, fostering responsible consumption and green practices across the tourism sector.

3. Limitations and future research directions

The study's findings could have significant implications for sustainable tourism policies, but the research had limitations in using econometric approaches due to the absence of data beyond the study's time frame. Further studies could examine the effectiveness of regulations to convert Malaysia's tourism sector to renewable energy and the cost-effectiveness of building green-energy tourism. Policymakers, government officials, and the tourism industry need to conduct further research to evaluate the impact of the tourism-energy connection in the context of the COVID-19 crisis, particularly in regards to air transport, travel, and tourism. This analysis could aid in coping with the economic disruption caused by COVID and could be broadened to aid in the economic recovery.

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