Sustainability, Stability, and Growth: A Time Series Analysis of Tourism Drivers in Thailand

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Abstract

This study examines the dynamic effects of renewable energy consumption, economic growth (GDP), and geopolitical risk (GPR) on tourism in Thailand during the period 1995-2023. Utilizing rigorous time series econometric techniques, including cointegration analysis and error correction modeling, the study examines both the short-run and long-run relationships between the selected macroeconomic variables and tourism development. The findings confirm that GDP and renewable energy both exert positive and statistically significant influences on tourism in the short and long term, mirroring economic strength and sustainability in driving tourism performance. The geopolitical risk, however, significantly negatively affects tourism in the long term, inferring that political instability and conflict in the region in the long term can ruin Thailand's image as a destination for tourists. These results emphasize the importance of sustainable energy investment, macroeconomic stability, and effective geopolitical risk management in supporting the growth and resilience of Thailand's tourism sector. The study offers valuable policy recommendations to create a secure, green, and economically prosperous tourism sector in Thailand.

Keywords: *Tourism; Renewable Energy; Geopolitical Risk; Economic Growth.*

Introduction

Relevance of the research topic

Tourism is a major industry in Thailand's economy and accounts for a considerable share of income, employment, and foreign exchange earnings. The tourism sector accounted for approximately 7.2% of the nation's GDP in 2023, a strong recovery from the COVID-19 pandemic era, with over 28 million international tourist arrivals recorded during the year (Statista, 2024; RoadGenius, 2024). As Thailand works towards positioning itself as a sustainable and resilient tourist destination, it has pursued an aggressive development of its renewable energy potential. Renewable energy sources represented nearly 25% of the country's electricity generation capacity by 2023, which was in alignment with Thailand's Alternative Energy Development Plan and broader climate targets (Energy Monitor, 2023). The sector, however, remains vulnerable to external event shocks, most significantly geopolitical instability. Thailand scored -0.28 on the World Bank's Political Stability Index in 2023, reflecting ongoing political uncertainties that have a detrimental effect on international travel itineraries and investor confidence in the tourism industry (The Global Economy, 2023).

The relationship between political and macroeconomic variables and tourism is an intricate situational one. While economic progress can enable tourism with better infrastructure and more investment, geopolitical strife will deter tourists and have an influence on sustainable tourism in the long run. Concurrently, embracing renewable energy will enhance a nation's image as an ecologically friendly sustainable destination to visit and enhance the sustainability of long-term industry. Although previous studies have analyzed each of these variables individually, there is little research that investigates their combined long- and short-run effects on tourism, particularly in the Thai context. Since Thailand is a unique case of a tourism-dependent economy that is undergoing both energy transition and political change, it makes an ideal case study. This research, therefore, attempts to examine the dynamic impact of renewable energy consumption, economic growth, and geopolitical risk on tourism in Thailand for the period 1995–2023 using robust econometric methods to offer policy-driven results. Compared with available literature that is likely to examine these variables in isolation or focus on large multi-country panels, the present study uses Thailand-specific time

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series data to make more nuanced observations about the functioning of a transitioning energy and politically unstable emerging economy. The novelty of the present analysis that includes geopolitical risk as a quantifiable macroeconomic variable together with renewable energy and GDP makes it an uncommon empirical approach. The research also contributes methodologically with the application of advanced econometric techniques (ARDL) to trace the short-run shocks and long-run equilibrium associations, offering stronger and policy-critical results. The holistic approach enables greater insight into how Thailand can grow its tourism industry in a sustainable manner during periods of global uncertainty and green transition.

This paper's remaining sections will be arranged as follows: The literature on the effects of independent variables on tourism is reviewed in Section 2. The data and methodology are described in Section 3. Empirical results are presented and discussed in Section 4. Section 5 brings the paper to a close.

Literature Review

Tourism is a vital sector of the world economy that is influenced by a series of economic, environmental, and geopolitical factors. There is some recent literature which has investigated the interlink between the consumption of renewable energy, Gross Domestic Product (GDP), Geopolitical Risk (GPR), and tourism expansion. This literature review highlights the major conclusions of previous research on the relationships between the variables.

Geopolitical Risk and Tourism

Renewable energy shifts have been linked to sustainable tourism development. Renewable energy infrastructure beautifies a tourist destination by tidying up the environment and promoting nature tourism. Hailemariam and Ivanovski (2021) used a structural vector autoregression (SVAR) model on US data from 1999–2020 and determined that growth of one standard deviation of GPR explained roughly 12.6% of changes in tourism service exports. Gozgor et al. (2022), with 18 developing economies' data, reported that the impact of GPR is adverse to tourism investment but discovered further that social globalization can be effective in offsetting the risk. Herman (2023) applied CS-ARDL panel testing to some nations recently and inferred that heightened geopolitical risks lead to a decline in tourist arrivals. In another line of investigation, Gunay et al. (2024) examined the interplay between everyday geopolitical risk and tourism through token (TTI) and equity (WHRL) indices. While overall co-movements were weak, the Russia-Ukraine conflict started bidirectional causality between GPR and equity market-based tourism indexes, demonstrating greater market responsiveness during conflict periods.

Economic Growth and Tourism

The relationship between economic growth and tourism is widely acknowledged as complex and bidirectional. Camacho and Romeu (2023) used a symbolic transfer entropy approach to 145 countries and determined that GDP growth precedes inbound tourism in the short run, suggesting that economic growth can increase tourism demand. Enilov and Wang (2022) applied mixed-frequency Granger causality to 23 countries and identified that international tourist arrival can be a leading indicator of economic growth, especially in post-crisis settings. For Europe, Pérez-Rodríguez et al. (2022) confirmed a long-term relationship between tourism and GDP for 14 countries, confirming the hypothesis of tourist-led growth. Other works expand on this. Saboori et al. (2023) confirmed that tourism market diversification (TMD) can boost economic development in low-income countries but prove to be either neutral or negative in high-income countries. In addition, Hajam et al. (2024), using Indian data, illustrated unidirectional causality from tourism to economic growth with emphasis on the growth potential of the sector in emerging economies.

Renewable Energy and Tourism

Empirical analysis of the relationship between tourism and renewable energy remains nascent but has positive implications for sustainable growth. Sarsar and Echaoui (2023) using observations on 48 African

countries, ascertained that attempts at energy transition may decrease revenues from tourism in the short term due to possibly large initial costs for infrastructure. On the other hand, Jiménez-Islas et al. (2024) depicted that a 1% rise in the use of solar energy is related to a 0.35% rise in tourist arrivals, emphasizing solar energy in attracting environmentally friendly tourists. Huseynli (2022) analyzed the causality and correlation of renewable energy consumption with tourism using Egypt's, Kenya's, and Ethiopia's annual time series data covering the period 1997-2015. He used Granger causality tests and the application of time series analysis. The author found that there is a significant and positive causality from tourist variables to the consumption of renewable energy in Egypt. But in Ethiopia and Kenya, there was no robust causality from renewable energy to tourism, suggesting that tourists in Ethiopia and Kenya may not yet put high value on environmental sustainability when making their travel decisions.

The literature examined provides a rich platform for comprehending the intricate relationship dynamics between geopolitical risk, economic growth, and renewable energy in influencing tourism dynamics. This study aims to explore empirically the dynamics of interactivity between the macroeconomic variables in driving Thailand's tourism sector. By focusing on a country that boasts a high tourism-to-GDP rate as well as robust sustainability intentions, the outcomes are expected to offer actionable intelligence for policymakers, investors, and tourism operators eager to future-proof the industry from financial crises and global uncertainties.

Materials and Methods

Data Source and Description of Variables

This study examines the relationship between tourism, renewable energy consumption, geopolitical risk and economic growth in Thailand. The choice of Thailand as the site of study is warranted by its heavy dependence on tourism, which accounts for around 20% of GDP (World Bank, 2023), and therefore the industry is very vulnerable to energy and geopolitical shocks. As an emerging economy, with a transition towards clean energy built in, with solar and biomass adoption targets established (Ministry of Energy Thailand, 2022), Thailand is a unique case to examine the interplay of sustainable energy policy and tourism resilience. Additionally, the country's exposure to geopolitical risks, such as internal political instability and cross-border tensions (Fund for Peace, 2023), along with steady economic growth (3.5% per annum over the last decade), creates a vibrant context for examining these interdependent factors. The findings of this research can guide policymakers in similarly tourism-based economies making their way through the challenges posed by decarbonization and geopolitical tensions.

The temporal scope of our data is from 1995 to 2023, thus enabling a full and extensive review. The logged variables are tourism (TOUR) and economic growth (GDP). More information about the data and the sources used may be found in the informative Table 1 shown below.

Table 1: Description of the variables.

Variable	Symbol	Measurement units	Data sources
Tourism	LTOUR	Total number of arrivals in the host country	World Development Indicators
Renewable Energy Consumption	REN	% of total final energy consumption	World Development Indicators
Geopolitical Risks	GPR	Index	https://www.matteoiacoviello.com/gpr.htm
Economic Growth	LGDP	GDP per capita (Constant 2015 US$)	World Development Indicators

ARDL and ECM Estimation Models

Autoregressive Distributed Lag (ARDL) and Error Correction Model (ECM) are widely used econometric tools to investigate short- and long-run variable relationships, particularly when cointegration exists (Pesaran et al., 2001). The ARDL model is flexible, with capabilities to accommodate variables of any integration order (I(0) or I(1)) and without testing for cointegration in large samples (Nkoro & Uko, 2016). The ECM, which is derived from ARDL, captures the speed of adjustment towards equilibrium in reaction to a short-run shock (Engle & Granger, 1987). The models are very useful in economic and financial studies where equilibrium corrections and dynamic relationships are extremely important.

This study utilizes the ARDL bounds testing procedure to check short- and long-run relationships between variables. The method is robust enough to accommodate mixed-order integration and estimates an error correction model (ECM) for the purpose of capturing adjustment rates to equilibrium (Banerjee et al., 1998). Its robustness in flexible lag selection raises model robustness (Lütkepohl, 2005).The model utilized for this study is specified in Equation 1.

$$LTOUR_t = \alpha_0 + \alpha_1 REN_t + \alpha_2 GPR_t + \alpha_3 LGDP_t + \varepsilon_t \qquad (1)$$

Where L in some variables denotes the logarithm transformation, TOUR refers to tourism, REN indicates renewable energy consumption, GPR indicates geopolitical risk index, GDP refers to economic growth and ε_t indicates the error term.

Equation 2 specifies the ARDL regression model employed in this research.

$$\Delta LTOUR_t = \alpha_0 + \sum_{k=1}^{n} \alpha_1 \Delta LTOUR_{t-k} + \sum_{k=1}^{n} \alpha_2 \Delta REN_{t-k} + \sum_{k=1}^{n} \alpha_3 \Delta GPR_{t-k} + \sum_{k=1}^{n} \alpha_4 \Delta LGDP_{t-k} + \lambda_1 LTOUR_{t-1} + \lambda_2 REN_{t-1} + \lambda_3 GPR_{t-1} + \lambda_4 LGDP_{t-1} + \varepsilon_t$$
(2)

Where Δ represents the first difference, α_1 through α_4 are the short-run coefficients, and λ_1 through λ_4 are the long-run coefficients.

Results and Discussion

Descriptive Statistics

Table 2: presents the descriptive statistics of the variables.

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	Obs.	Mean	max	min	Std. Dev.
LTOUR	29	16.419	17.502	13.616	.776
REN	29	21.369	24.400	15.620	2.098
GPR	29	.037	.068	.014	.014
LGDP	29	8.472	8.769	8.100	.222

The descriptive statistics in Table 2 are proof of steady economic growth (LGDP: mean=8.47, lean range 8.10-8.77) and moderate volatility in tourism (LTOUR: 13.62-17.50), the latter being the most variable (15.62-24.40, SD=2.098). Geopolitical risk (GPR) has a low baseline (mean=0.037) but sees periodic spikes (max=0.068), indicating widespread stable conditions with intermittent crises. The reverse patterns of volatility in the data, with GDP being least volatile and renewable energy most volatile, suggest Thailand's tourism sector presumably responds differently to economic as opposed to energy/geopolitical shocks, making it worthwhile to continue to examine these asymmetric relationships in the ARDL model.

Unit Root Test

Unit root tests are a simple diagnostic process in time series analysis, addressing several fundamental modeling problems. They reveal the presence of stationarity or unit roots among variables and, therefore, ensure appropriate model choice and prevention against spurious regression outcomes. By establishing the

integration order, unit root analysis reveals long-run behavior of economic variables, enhances the accuracy of predictions, and provides the conditions for valid cointegration testing that are required, particularly for ARDL and error correction modeling techniques. The results from the Augmented Dickey-Fuller (ADF) test for unit root are presented in Table 3.

Table 3: The results of the unit root test.

| Variable | ADF | | Remarks |
| | Level | 1st Diff. | |
	Prob.	Prob.	
LTOUR	.0166**	.9540	I(0)
REN	.9199	.0032***	I(1)
GPR	.1054	.0000***	I(1)
LGDP	.9068	0.0028***	I(1)

Note: **and *** indicate 5% and 1% significance levels, respectively.

As presented Table 3, in the unit root test statistics reveal mixed orders of integration, a critical assumption for ARDL modeling: LTOUR is level I(0) stationary (p=0.0166), while REN, GPR, and LGDP are only stationary after the first difference I(1) (all p<0.01). This combination of I(0) and I(1) variables validates the use of the ARDL bounds testing procedure to examine cointegration and dynamic relationships without requiring that all series be integrated of the same order.

Determining the Optimal Lag Structure in the ARDL Model

Table 4 presents the lag order selection results from the unrestricted VAR analysis. Based on the Akaike Information Criterion (AIC), the optimal lag length for the ARDL model is determined to be two. This applies to both the dependent variable (LTOUR) and the fixed explanatory variables included in the specification.

Table 4: Lag selection.

Lag	LL	LR	DF	P	FPE	AIC	HQIC	SBIC
0	-4.988				2.3e-05	0.666	.723	.858
1	81.350	127.67	16	0.000	1.3e-07	-4.544	-4.259	-3.585
2	101.991	41.282*	16	0.001	9.8e-08*	-4.888*	-4.374*	-3.160

* indicates lag order selected by the criteria

4.4. ARDL Bound Test

Table 5 presents the bounds test results, which assess coefficient significance and detect long-run relationships regardless of integration orders.

Table 5: Bound test for cointegration analysis.

Test statistic	Value	Significance level	I(0)	I(1)
F-statistic	13.034	10%	2.37	3.2
K	3	5%	2.79	3.67
		1%	3.65	4.66

With an F-statistic of 13.034 surpassing all critical bounds (1%, 5%, and 10%), we find decisive evidence of cointegration. This confirms the variables share a stable long-run equilibrium relationship, firmly rejecting the possibility of no cointegration.

Long-run and short-run Analysis of the ARDL Model

The findings of the ARDL model are given in Table 6.

Table 6: Long run and short run elasticities.

Dependent variable: LTOUR			
Variable	Coeff.	t-stat.	Prob.
Long –run coefficients			
REN	.11*	1.80	.089
GPR	-11.37**	-2.27	.037
LGDP	1.34***	4.28	.001
C	4.76	1.39	.184
Short-run coefficients			
D(LTOUR(-1))	.737***	5.326	.000
D(REN)	.184**	2.510	.023
D(REN(-1))	.212***	3.150	.006
D(LGDP)	7.901***	4.008	.001
D (LGDP(-1))	4.997**	2.585	.019
CointEq(-1)	-1.552***	-8.972	.000
R-Square	.8114		
AdjustedR²	.7664		

Note: *, ** and *** indicate 10%, 5% and 1% significance levels, respectively.

The long-term analysis reveals several strong relationships for Thailand's tourism sector. Renewable energy (REN) has a marginally positive relationship with tourism, reflecting potential sustainable tourism benefits. Geopolitical risk (GPR) has a significant negative relationship with tourism, revealing its disruptive influence. Economic growth (LGDP) has the strongest positive relationship, confirming tourism's vulnerability to macroeconomic conditions. These results are consistent with expectations that strong economic conditions take precedence over renewable energy's emerging influence in Thailand's tourism sector.

The ECM regression results display enormous short-run dynamics for the tourism sector of Thailand. The error correction term (CointEq (-1)) is highly negative (p=0.000), showing rapid adjustment to long-run equilibrium. Current and lagged renewable energy adjustments (D (REN) = 0.184, D (REN (-1)) = 0.212) show positive impacts on tourism in the short run, while GDP growth has particularly noteworthy immediate (7.901) and lagged (4.997) effects. The model explains 81.14% of tourism volatility (R²=0.8114) and all the coefficients are statistically significant at least at the 5% level, thereby confirming strong short-run relationships as well as the established long-run equilibrium.

Diagnostic Tests

As shown in Table 7, diagnostic tests re-establish the ARDL model's statistical appropriateness in relation to critical assumptions. Test for serial correlation and heteroscedasticity by Breusch-Godfrey (p=0.583) and Breusch-Pagan-Godfrey (p=0.267) provides fruitful coefficient estimates with accurate parameter values. Validity of residuals with normally distributed values (Jarque-Bera p=0.979) warrants sound inference, and proper model specification free from omitted variables or wrong function form according to Ramsey RESET test (p=0.143). The results collectively establish that the model satisfies principal statistical specifications guaranteeing valid analysis of tourism phenomena.

Table 7: Diagnostic tests for the ARDL approach.

Diagnostic test	Coeff.	Prob.	Outcomes
Breusch-Godfrey Serial Correlation LM Test	.560	.583	No serial correlation exists

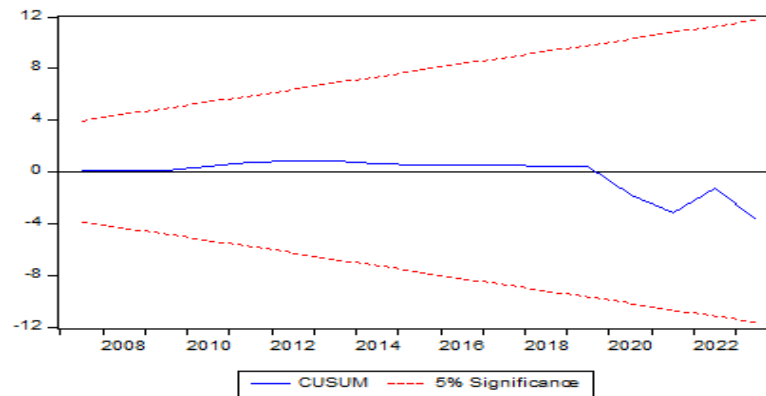|			
Breusch-Pagan-Godfrey Test	1.390	.267	No heteroscedasticity
Jarque-Bera	.042	.979	exists
Ramsey RESET Test	2.748	.143	Residuals are normally distributed
			Model is correctly specified

Figure1. Results of CUSUM test.

The CUSUM test results (Figure 1) confirm the model's stability, with all values remaining within critical bounds. This demonstrates consistent parameter stability over time, validating the model's reliability for analyzing both causal effects and long-run relationships.

Discussion

The results in Table 6 show that, in both the short and long run, renewable energy development positively affects tourism in Thailand, with the short-run effects being more statistically significant and stronger, likely due to immediate tourist responsiveness to recent improvements in renewable infrastructure, such as solar-powered resorts and eco-friendly transport, which quickly attract eco-conscious travelers. While the long-term effect is favorable, it is narrowly substantial, showing that ongoing investment in renewables further enables Thailand's role as an eco-friendly destination, as global tourism trends shift toward green habits. This is particularly pertinent given Thailand's aggressive marketing of eco-tourism and energy transformation goals in its Power Development Plan, as rising tourist interest in environmentally friendly travel enables the use of renewable energy as a key facilitator of destination competitiveness.

In the long run, GPR has a strong, statistically significant adverse effect on tourism. This suggests that a persistent increase in geopolitical risk severely reduces tourist arrivals or tourism growth in the long run. Our results are in line with those of Gozgor et al. (2022). This negative relationship highlights the long-run consequences of political instability and security concerns on the country's tourism sector. Recurring GPR in Thailand defaces its global reputation as a secure destination, discouraging both first-time travelers and high-expenditure tourists in the long run. It also lowers investor confidence in the Thai tourism sector, decelerating the growth of necessary infrastructure and services. Moreover, repeated policy changes and Thailand's closeness to neighboring conflicts add up to an impression of geopolitical uncertainty that deters long-term growth in tourism. These cumulative factors operate to explain why sustained increases in GPR in fact erode Thailand's tourist performance in the long run despite short-run impacts sometimes appearing confined.

The short-term and long-term positive and highly significant relationship between GDP and tourism is observed. Our findings are in line with those of Camacho and Romeu (2023). In the short run, contemporaneous and lagged GDP change matters significantly to tourist arrivals. Thus, when economic conditions are good (e.g., increasing employment, government spending on infrastructure, growth of

personal incomes), tourism responds in a timely fashion. In the long term, a rise in GDP provides strong support to tourism by improving public amenities, transport, hospitality facilities, and promotion drives. The strong and statistically significant long-run association between tourism and GDP in Thailand is proof of the important contribution of economic growth towards supporting the growth and popularity of the tourism industry. As Thailand's GDP increases, the government and private sector can invest more in tourist infrastructure, including transport networks, hotels, and recreational services, that allow for an improved general tourist experience. A growing economy also facilitates more effective promotion campaigns, improved public services, and greater political stability, all of which set the stage for a more favorable environment for local and foreign tourists. Besides, growth in GDP would usually be correlated with higher incomes among households, which can stimulate domestic tourism and increase consumer spending in tourism businesses. This persistent economic strength promotes Thailand's global competitiveness as a tourist destination and allows for sustainable development of tourism.

The very high and significant error correction coefficient indicates a very high and quick rate of adjustment towards long-run equilibrium. Around 155.2% of the last period's deviation is corrected within one period. This means that whenever tourism temporarily diverges from its long-run path due to shocks, the system quickly re-adjusts, bearing witness to the strength of Thailand's tourism sector.

Conclusion And Policy Implications

This study explored the short- and long-term effects of the renewable energy consumption, geopolitical risk, and economic growth on tourism in Thailand between 1995–2023 in the ARDL framework. The findings reveal that GDP and renewable energy have positive influences on tourism both in the short and long runs, indicating that economic growth and the development of renewable energy are the primary determinants of the growth and sustainability of the tourism sector. However, geopolitical risk reveals a strong negative relationship with tourism in the long term, signifying the vulnerability of the sector to political instability and regional uncertainties. These results emphasize how important macroeconomic stability, sustainable development, and risk management are in shaping tourism trends. Considered collectively, the study has significant implications for policymakers who wish to enhance the long-term competitiveness and sustainability of the tourism industry of Thailand.

Policy Implications

To offset the long-term negative impact of geopolitical risk, Thailand must offer political stability and practice effective crisis communication strategies to cope with external opinions and retain tourist confidence in times of unrest.

With the potential of renewable energy to positively contribute to tourism, policies that introduce clean energy sources to tourism activity, like green transport and ecotourism resorts, need to be widened in an attempt to make Thailand an increasingly sustainable tourist destination.

Whereas GDP growth supports tourism, consistent investment in tourist infrastructure, public services, and digital innovation will be needed to enhance visitors' experience and build tourism capacity.

In order to promote reduction in exposure to regional and geopolitical shocks, Thailand should focus on diversification of its tourism base by targeting new markets, promoting domestic tourism, and building longer-staying and higher-spending segments.

Policymakers need to put in place evidence-based and responsive tourism policies that are aligned with long-term economic and environmental trends to make the tourism sector remain robust amidst future global challenges.

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