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EEFFECTS OF TOURISM AND ECONOMIC GROWTH ON SUSTAINABLE ELECTRICITY CONSUMPTION: FRESH EVIDENCE FROM TÜRKIYE

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ABSTRACT

This study investigated the impact of tourism and economic growth on electricity consumption in the Turkish economy, which operates under an open system, throughout the time span from 1995 to 2022. The analysis employed the ARDL bounds test method and the wavelet-based Fourier causality test. The empirical evidence demonstrates the presence of a long-term cointegration relationship among economic growth, tourist arrivals, and consumption of electricity. The research findings indicate a positive relationship between economic growth, tourist arrivals, and power consumption. To enhance the robustness of the findings, the series underwent wavelet processing, followed by the application of Fourier causality analysis to these transformed series. Wavelet-based causality analysis reveals that trade openness exerts a significant influence on not only electricity consumption but also on tourism and economic growth. The results additionally indicate that shocks exhibit persistence across all components.

1. INTRODUCTION

Economic growth stands as a paramount objective within the realm of economic policy. Indeed, the assessment of economic policy efficacy is predicated upon the quantification of the economic growth rate. Countries characterized by high income rates are commonly perceived as having sound economic policies, whereas low-income countries are often interpreted as sending a message to the markets that their policies are flawed or inefficient. There exists an assumption that a correlation exists between economic growth and welfare. Higher levels of economic growth correspond to an increase in job prospects and a greater availability of goods and services to cater to consumer demands. Policymakers exhibit a significant level of interest in sectors that contribute to the enhancement of economic growth. Historically, their attention has been primarily directed on the industrial sector (Nissan et al., 2011). Nevertheless, it is indisputable that international travel and tourism have significantly contributed to the global economy since the 1960s, emerging as the dominant service sector in international trade (Lew, 2011; Du et al., 2016). Consequently, numerous nations have resorted to tourism as a feasible means to attain their economic objectives. Numerous studies have substantiated the significance of tourism as a pivotal industry for fostering growth in economically disadvantaged nations. According to Nissan et al. (2011), tourism serves as a valuable means of acquiring resources to address the imbalance in these countries.

The presence of tourism not only contributes to the enhancement of economic growth (Bulut, et al 2023; Işık et al., 2020, 2013), but it also generates a multiplier effect on the overall economy (Shaheen et al., 2019). Tourism is well acknowledged for its ability to contribute positively to long-term economic growth through many mechanisms. The tourism industry has a crucial role in producing revenue from foreign sources, which then enables the acquisition of imported capital goods or vital inputs used in the industrial process. Furthermore, tourism assumes a significant function in facilitating investment in novel infrastructure and fostering rivalry among local enterprises and enterprises situated in other tourist destinations. Additionally, it is worth noting that tourism has the capacity to provide economic growth in several industries through direct, indirect, and induced effects, as highlighted by Habibi et al. (2018). Furthermore, it is worth noting that the tourist industry continues to play a significant role in terms of job creation and income generation, both within the formal and informal sectors (Manzoor et al., 2019). Furthermore, the consumption and acquisition of goods and services by tourists have the potential to exert an influence on various sectors. The aforementioned sectors comprise several aspects of the tourism industry, including accommodation, transportation, tour operators, and tourism-related retail enterprises such as restaurants and souvenir merchants. Furthermore, the consuming and purchase behaviors of tourists can also have an impact on many tourist attractions, including those that are natural, cultural, historical, and developed.

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Tourism activity yields several economic advantages, such as tax revenues, employment opportunities, and supplementary income streams (Habibi et al., 2018). Hence, the tourist industry plays a substantial role in the economic development of numerous societies globally, as it possesses the capacity to create revenue, taxes, foreign exchange, and employment opportunities (Lee & Brahmasrene, 2013).

Tourism requires an extensive variety of infrastructure services, encompassing air transportation, railway systems, and telecommunications. The construction of tourism facilities gives rise to a range of environmental and ecological problems as a result of infrastructure operations. Given its ability to create cash for various stakeholders, the tourist sector exerts significant political, social, and environmental influences. As previously said, the tourist industry has an indirect impact on numerous economies through its contributions to the balance of payments, enhancement of residents' living standards, augmentation of products and services production, and accumulation of foreign exchange reserves. Nevertheless, while the aforementioned favorable consequences, it is important to acknowledge that the tourist sector might have adverse implications on the environment due to its reliance on non-renewable energy sources, namely oil, coal, and natural gas (Lee & Brahmasrene, 2013; Paramati et al., 2017). The rapid rise of the tourism industry has resulted in considerable environmental challenges, such as increased reliance on energy-intensive transportation, excessive use of water resources, biodiversity loss, overexploitation of natural resources, uncontrolled trash disposal, and waste creation. For more than a decade, the tourism industry has been identified as a carbon-intensive industry due to a variety of factors. Hence, it is evident that the phenomenon of environmental pollution might arise as a consequence of energy consumption associated with tourism, as well as the development of hotels and other related infrastructure (Pata & Balsalobre-Lorente, 2022).

The recognition of tourism as a significant energy-consuming sector was acknowledged during the World Summit on Sustainable Development in Johannesburg in 2002 (Liu et al., 2019). The tourist industry encompasses air transportation and lodging, both of which necessitate significant energy consumption. This energy usage has adverse environmental consequences, primarily in the form of substantial carbon dioxide ($CO2$) emissions and the release of greenhouse gases (GHGs) over international borders (Shaheen et al., 2019). The significance of energy within the tourist sector is of paramount relevance, given that the growth in tourism activities results in a corresponding surge in energy requirements across multiple operational domains. Therefore, with the progression of the tourism industry, it is anticipated that its need on energy will increase. According to Katircioglu (2014), this phenomenon will result in a rise in energy usage. The significance of the association between energy consumption, tourism, and environmental quality is noteworthy, as it stems from the direct influence of energy usage on greenhouse gas emissions and pollution. Hence, the burgeoning tourist population not only serves as a catalyst for economic growth but also amplifies the nation's energy consumption requirements and exacerbates environmental deterioration (Liu et al., 2019). Consequently, the promotion of tourism is imperative in order to facilitate and sustain economic development. The tourism sector necessitates the consumption of energy. Maintaining this delicate equilibrium is of utmost importance. Notwithstanding the significance of this delicate equilibrium, the existing body of research exhibits a dearth of comprehensive investigations into the interconnection among energy usage, tourism, and economic growth. The analysis of sustainable tourism is crucial in this regard. Within the given framework, the current study aims to examine the impact of tourism and economic growth on power consumption, with a focus on promoting sustainable electricity use within the Turkish economy. A limited number of studies (Tang et al., 2016; Lai et al., 2011; Liu et al., 2022; Yorucu & Mehmet, 2015; Bekun et al., 2023) have investigated the interrelationship between these three variables in the existing body of literature. Out of the several research considered, it is worth noting that Yorucu and Mehmet (2015) exclusively focused on analyzing a sample from Türkiye. In contrast to the aforementioned study, the present study utilizes more up-to-date data and incorporates the ARDL technique in addition to employing wavetable-based Fourier causality analysis. Fourier functions are important in elucidating gradual variations in causal relationships. Furthermore, the utilization of wavelet transforms enables the comprehensive analysis of causal relationships across many time scales, encompassing short, medium, and long-term periods. This is achieved by considering the frequency domain characteristics of the data series. By considering many aspects of the series, it will be feasible to derive more precise causal correlations. We endorse the utilization of the Fourier Toda Yamamoto (FTY) test due to its incorporation of two significant characteristics. This test can be conveniently obtained through the implementation of wavelet transformations. Therefore, it is expected that this study will provide a significant contribution to the current body of empirical research. The rationale for investigating the example of Türkiye in this study stems from its status as one of the top ten globally sought-after destinations, renowned for its diverse range of tourism activities across various regions. In light of its rich natural assets, significant historical backdrop, diverse cultural landscape, and favorable climatic conditions, the region attracted a substantial influx of over 50 million tourists in the year 2022, predominantly originating from nations within the OECD. Therefore, it has emerged as the fourth most popular tourist destination globally. The tourism industry holds significant economic importance in Türkiye, contributing 3.1% to the country's gross domestic product (GDP) (Aygün Oğur & Baycan 2023). There is little doubt that the rise of tourism in Türkiye will exert a substantial influence on energy consumption.

The article is organized into five distinct sections. After the introduction section, Section 2 provides a comprehensive overview of the existing literature. Section 3 supplies an exposition of the data, while Section 4 offers a comprehensive account of the employed approach. The findings and analysis are reported in Section 5, followed by the conclusions in Section 6.

2. LITERATURE REVIEW

Tourism is a significant economic endeavor on a global scale. In recent times, there has been a notable shift in the predominant area of interest, transitioning from positive associations pertaining to tourism to negative aspects encompassing energy, environment, and climate change (Pablo-Romero et al., 2019). The environment is impacted by tourism as a result of its energy use. The tourism industry exerts both beneficial and negative influences on the economy, with the former manifesting as sustainable economic growth and the latter manifesting as environmental repercussions. The engagement in tourism-related pursuits, including but not limited to transportation, lodging, air travel, and jet boating, necessitates the utilization of energy derived from fossil fuels such as oil, gas, and coal. Consequently, this reliance on fossil fuels contributes to the escalation of carbon dioxide (CO2) emissions (Shaheen et al., 2019). In order to ensure the long-term viability of the tourism industry, it is imperative to adopt sustainable practices in the utilization of tourism-related resources, including transportation and the environment (Martín-Cejas & Sanchez, 2010). The primary objective of this study is to examine the interplay between energy use, tourism, and their impact on economic growth. The emphasis placed on the tourist sector is crucial, since it not only exerts a substantial influence on economic growth but also entails considerable energy consumption, making it a key component in the pursuit of sustainable development.

Tablo 1. Literature

Author(s)	Method	Sample period/Region	Findings
Tourism and Economic Growth			
Bahar & Bozkurt (2010)	GMM	1998–2005/ 21 countries	Tourism ↑↑ GDP
Işık (2012)	VECM and Granger causality	1990-2008/ Türkiye	Tourism → GDP
Mérida & Golpe (2016)	Granger causality	1980-2013/ Spain	GDP→Tourism (1985 yılına kadar) GDP↔Tourism (2000 yılından itibaren)
Işik, et al. (2017)	Emirmahmut oglu–Kose bootstrap Granger non-causality	1995–2013/ Top 10 most-visited countries	Tourism → GDP
Işik, et al. (2018)	Panel cointegration	1995–2012/ seven countries (T-7)	Tourism → GDP
Turgut et al. (2021)	ARDL	1998Q1- 2019Q4/ Turkiye	Tourism → GDP
De Siano & Canale (2022)	Spatial analysis	2005-2018/ Italian provinces	Tourism → GDP
Bulut, et al. (2023)	Panel cointegration	1990-2018/50 US states	Tourism → GDP
Razzaq et al. (2023)	Panel quantile regression	1995-2018/ top 10 GDP countries between	Tourism → GDP
Tourism and Electricity Consumption			
Lee (2013)	GARCH-M(1,1)	January 1983-June 2011/ Singapore	Tourism ↑↑ ELEC
Pablo-Romero et al. (2019)	Panel	1999-2014/ Spain-12 states	Tourism ↑↑ ELEC
Visas et al. (2023)	FGLS PCSE	1995–2014/ BRICS	Tourism ↑↑ EC
Electricity Consumption and Economic Growth			
Işik & Radulescu, (2017)	ARDL and RWA	1980-2014/Turkiye	ELEC →GDP
Aydin (2019)	Panel causality	1980–2015/ 26 OECD countries	ELEC ↔ GDP
Muhammad (2019)	SUR GMM	2001-2017 / 68 countries	EC ↑↑ GDP (developed and developing countries) EC ↑↓ GDP (MENA countries)
Mohapatra & Giri (2020)	ARDL, VECM	1981-2017/ India	GDP ↑↑ ELEC TDI ↑ ↓ ELEC GDP → ELEC TDI → ELEC
Rahman (2020)	FMOLS DOLS	1971-2013/ 10 countries	GDP → ELEC
Stamatiou (2022)	ARDL Cointegration Test	1990–2018/ Italy	Tourism → ELEC Tourism → GDP
Electricity Consumption, Economic Growth and Tourism			
Lai et al. (2011)	VECM	1999Q1–2008Q4	Tourism ↑↑ ELEC Tourism ↑↑ GDP
Yorucu &Mehmet (2015)	ARDL	1960–2010/ Turkiye	ELEC ↑↑ tourism ELEC ↑↑ GDP
Tang et al. (2016)	Gregory–Hansen test	1971-2012/ India	Tourism →EC Tourism →GDP
Liu et al. (2022)	ARDL, Bayer and Hanck tests	1980-2017/ Pakistan	EC ≠ Tourism EC ≠ Tourism
Bekun et al. (2023)	ARDL	1995-2019/ South Africa	Tourism ↑↑ GDP ELEC ↑↑ Tourism

ELEC: electricity consumption, EC: Energy consumption, TDI: technology development index

3. DATA

This study used international tourist arrivals as an independent variable to advocate for the promotion of sustainable electric energy consumption and, consequently, the stimulation of economic growth in an open economy. The study's samples encompass a time span from 1995 to 2022, owing to the accessibility of data. The data were sourced from various databases, including the World Bank (WB) for Growth, Urban, and Trade statistics, Enerdata for electricity consumption data, and TUIK for tourism data. Tables 2 and 3 provide comprehensive depictions and statistical summaries of the data, respectively.

Table 2. Variables Used in the Model

Variable	*Description*	*Source*
Elec	Electricity consumption	Enerdata
Growth	GDP per capita growth (annual %)	WB
Urba	Urban population growth (annual %)	WB
Tour	International tourism, number of arrivals	TUIK
Trade	Trade openness [(exports+ imports)/GDP]	WB

Note: Note: All variables (except growth and urba) are in natural logarithmic form.

Table 3: Descriptive statics

	lnElec	lnTrade	lnTour	Growth	Urba
Mean	3.327103	1.709648	7.339569	3.563974	2.158827
Median	3.349438	1.695655	7.413860	4.619681	2.265683
Maximum	3.529145	1.905785	7.713885	10.51288	2.735903
Minimum	3.055526	1.575937	6.874308	-7.138251	1.255117
Std. Dev.	0.143713	0.070136	0.269984	4.317549	0.399468
Skewness	-0.293478	0.814002	-0.359460	-0.910825	-1.007042
Kurtosis	1.812428	4.022041	1.694726	3.500248	3.061766
Jarque-Bera	2.047319	4.310791	2.590686	4.163432	4.737077
Probability	0.359278	0.115857	0.273804	0.124716	0.093617
Sum	93.15889	47.87013	205.5079	99.79127	60.44716
Sum Sq. Dev.	0.557640	0.132813	1.968073	503.3132	4.308517
Observations	28	28	28	28	28

4.METHOD

The ARDL bounds test exhibits distinct characteristics in comparison to other cointegration tests. The ARDL bounds test was created by Pesaran et al. (2001) as a method to assess data sets characterized by varying orders of integration. For instance, the explanatory variables may exhibit either integrated of order zero (I(0)) or integrated of order one (I(1)), however the dependent variable must strictly exhibit integration of order one (I(1)). It is crucial to ensure that both the dependent and independent variables are not integrated of order 2 (I(2)) simultaneously.

The ARDL technique is comprised of three steps, as outlined by Pesaran, Shin, and Smith (2001). The initial procedure involves doing a cointegration analysis between the variables utilizing the bounds test approach. In the present context, a model known as the unrestricted error correction model (UECM) is formulated. The bounds test was employed in this study to analyze the UECM model as described by Equation 1.

$$\Delta lnEC = \alpha_0 + \sum_{i=1}^{j} \alpha_{1i}\,\Delta lnEC_{t-i} + \sum_{i=0}^{k} \alpha_{2i}\,\Delta lnTrade_{t-i} + \sum_{i=0}^{l} \alpha_{2i}\,\Delta lnTour_{t-i} + \sum_{i=0}^{m} \alpha_{2i}\,\Delta Urba_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\,\Delta GDP_{t-i} + \beta_0 lnEC_{t-1} + \beta_1 lnTrade_{t-1} + \beta_2 lnTour_{t-1} + \beta_3 Urba_{t-1} + \beta_4 GDP_{t-1} + \varepsilon_t \quad (1)$$

The equation represents α_(1….4) and β_(1…4) coefficients, Δ the difference operator, α_0 the constant term and ε_t the random error term. Additionally, j,k,l,m,n display the optimal lag lengths selected by the information criteria.

The subsequent stage of the ARDL bounds test involves the estimation of the long-run coefficients by employing the level equations. The subsequent phase involves the estimation of the short-term model, namely the error correction model (ECM). An ARDL-based ECM equation can be formulated in the following manner:

$$\Delta lnEC = \theta_0 + \sum_{i=1}^{a} \theta_{1i}\,\Delta lnEC_{t-i} + \sum_{i=0}^{b} \theta_{2i}\,\Delta lnTrade_{t-i} + \sum_{i=0}^{c} \theta_{2i}\,\Delta lnTour_{t-i} + \sum_{i=0}^{d} \theta_{2i}\,\Delta Urba_{t-i} + \sum_{i=0}^{e} \theta_{2i}\,\Delta GDP_{t-i} + \vartheta ECT_{t-i} + \varepsilon_t \quad (2)$$

In Equation 2; θ_(1….4) refers to the short-term coefficients, Δ the difference operator, θ_0 the constant term and ε_t the random error term. Additionally, a,b,c,d,e show the optimal lag lengths selected by the information criteria. The ECT coefficient is understood as the speed of adjustment, as estimated. In essence, a negative and statistically significant coefficient for the Error Correction Term (ECT) indicates the speed at which short-term deviations return to the long-term equilibrium.

This methodology offers some key advantages compared to alternative methods. Firstly, the analysis can be conducted on variables exhibiting varying degrees of integration, namely I(1) and I(0). This approach is equally efficacious when used to samples of a relatively modest size. Additionally, the ARDL bounds test addresses the issue of residual correlation by employing suitable lag selection techniques, hence mitigating the problem of endogeneity. Furthermore, the approach employed in this study yields impartial estimations and statistically significant t-values, irrespective of the potential endogeneity of certain explanatory variables (Menegaki, 2020).

5. EMPIRICAL FINDINGS

The first step in the examination of multivariate time series data often involves conducting unit root tests to assess the stationarity of the data. As previously stated, when employing the ARDL estimate strategy, it is necessary for the series to possess integrated of order one (I(1)) or stationary (I(0)) properties, while series with integrated of order two (I(2)) or above are not suitable for this method. In the research, the series were additionally subjected to wavelet modification and thereafter categorized into short, medium, and long periods. The extended Dickey-Fuller (ADF) test is employed for conducting unit root tests. The results of the examinations are displayed in Table 4.

Table 4. Unit Root Tests

Original series	Variebles.	Level		First Dif.		Result: (dmax=1)
Constant		Test sta.	Prob	Test sta.	Prob	
	lnElec	-2.007	0.280	-4.614	0.001	I(1)
	lnTrade	0.966	0.994	-5.845	0.001	I(1)
	lnTur	-2.251	0.195	-1.102	0.696	I(1)
	Growth	-4.776	0.000	-	-	I(0)
	Urba	-1.666	0.435	-2.959	0.052	I(1)
Constant and Trend	lnElec	-1.992	0.579	-4.663	0.005	I(1)
	lnTrade	-2.143	0.499	-6.912	0.000	I(1)
	lnTour	0.968	0.999	-4.840	0.003	I(1)
	Growth	-4.776	0.003	-	-	I(0)
	Urba	-2.643	0.265	-	-	I(1)
Decomposed Series Short Term	Variebles.	Level		First Dif.		Result: (dmax=0)
Constant		Test sta.	Prob	Test sta.	Prob	
	lnElec	-5.471	0.002	-	-	I(0)
	lnTrade	-4.472	0.002	-	-	I(0)
	lnTour	-3.138	0.037	-	-	I(0)
	Growth	-5.694	0.000	-	-	I(0)
	Urba	-5.913	0.000	-	-	I(0)
Constant and Trend	lnElec	-5.318	0.001	-	-	I(0)
	lnTrade	-4.361	0.011	-	-	I(0)
	lnTour	-3.238	0.039	-	-	I(0)
	Growth	-4.784	0.003	-	-	I(0)
	Urba	-5.723	0.001	-	-	I(0)
Decomposed Series	Variebles.	Level		First Dif.		Result:

Medium Term						(dmax=1)
Constant		Test sta.	Prob	Test sta.	Prob	
	lnElec	-2.722	0.087	-	-	I(0)
	lnTrade	-4.078	0.005	-	-	I(0)
	lnTour	-3.319	0.026	-	-	I(0)
	Growth	-0.970	0.744	-6.677	0.000	I(1)
	Urba	-2.326	0.173	-2.686	0.093	I(1)
Constant and Trend	lnElec	-2.169	0.480	-	-	I(1)
	lnTrade	-4.764	0.005	-	-	I(0)
	lnTour	0.968	0.999	-	-	I(1)
	Growth	-1.039	0.915	-	-	I(1)
	Urba	-2.162	0.484	-	-	I(1)
Decomposed Series **Long Term**	Variebles.	Level		First/second Dif.		Result: (dmax=2)
Constant		Test sta.	Prob	Test sta.	Prob	
	lnElec	-1.560	0.487	-3.308	0.025	I(1)
	lnTrade	-2.314	0.176	-3.402	0.022	I(2)
	lnTour	-4.960	0.000	-	-	I(0)
	Growth	-3.336	0.024	-	-	I(0)
	Urba	-1.511	0.509	-	-	I(1)
Constant and Trend	lnElec	-0.392	0.982	-	-	I(1)
	lnTrade	0.336	0.997	-	-	I(1)
	lnTour	-4.750	0.001	-	-	I(0)
	Growth	-4.776	0.003	-	-	I(0)
	Urba	-3.732	0.041	-	-	I(0)

The results of the unit root tests conducted on the original series, as shown in Table 4, suggest that some of the variables examined in the analysis demonstrate stationarity (I(0)), whereas the bulk of them exhibit non-stationarity (I(1)). To clarify, it is important to note that all time series utilized in the empirical study exhibit stationarity after undergoing the process of first differencing. This implies that none of these variables possesses an integrated order of 2 (I(2)). In order to do the causality test, the series undergo a transformation via the wavelet approach. In the aforementioned series, namely the short, medium, and long-term series, it is seen that only the lnTrade series exhibits stationarity at the second difference in the long run. However, given that the ARDL approach will not be utilized for these series, there is no issue. Based on The results of the unit root tests conducted on the original series, the decision was made to undertake cointegration analysis. This choice was motivated by the observation that a majority of the time series employed in the analysis exhibited stationarity after differencing. However, given that a subset of the series displayed I(0) characteristics, the ARDL bounds test was selected as the preferred analytical approach, as suggested by Pesaran et al. (2001). In the context of the ARDL bounds test, which shares similarities with unit root tests, the determination of the appropriate lag length is accomplished by employing the Schwartz Information Criterion (SIC). This choice is made due to the limited number of observations, as recommended by Pesaran & Pesaran (1997). Based on the analysis conducted, it can be concluded that the ARDL (2, 0, 2, 1, 1) model is the most suitable choice. Table 5 displays the estimation outcomes of the ARDL (2, 0, 2, 1, 1) model, as well as the results of the diagnostic tests conducted on the model.

Table 5. ARDL (2, 0, 2, 1, 1) Estimation Results

Variables	**Coefficient**	**Std. error**	**t-Statistic**
lnElec (-1)	0.434870*	0.247438	1.757494
lnElec (-2)	0.405547*	0.225842	1.795712
lnTrade	-0.034483	0.045477	-0.758250
lnTour	0.006899	0.015313	0.450511
lnTour (-1)	-0.020144	0.017025	-1.183210
lnTour (-2)	0.056235***	0.019006	2.958741
Growth	0.002155***	0.000415	5.189004
Growth (-1)	0.001861**	0.000759	2.451213
Urba	-0.047125***	0.012031	-3.916868
Urba (-1)	0.036651***	0.010662	3.437552
Intercept	0.306616***	0.086287	3.553435
Diagnostic test results			
Normality (JB)	0.461653[0.79]		
B-G Serial Cor. LM	0.666328 [0.53]		
Heteroskedasticity (White)	1.162087 [0.38]		
Ramsey RESET	1.061281 [0.32]		
F-stat	944.9927[0.000]		
R2	0.99		

*, **, and *** are used to denote statistical significance at the 10%, 5%, and 1% levels, respectively. The p-values are denoted by values enclosed in square brackets.

Based on the diagnostic test outcomes presented in Table 5, it can be observed that the ARDL (2, 0, 2, 1, 1, 1) model demonstrates the absence of autocorrelation as per the Breusch Godfrey LM test. Additionally, the model exhibits variance changes in accordance with the White test, and is devoid of functional form issues as indicated by the Ramsey RESET test. Furthermore, based on the findings of the Jarque-Bera test, it may be concluded that the residuals in the model have a normal distribution. Following the estimation of ARDL model with lag orders of (2, 0, 2, 1, 1, 1), a bounds test analysis was performed to ascertain the existence of a long-run equilibrium connection. To ascertain the cointegration relationship between variables in the ARDL bounds test, it is imperative to conduct a comparison between the F statistics and the critical values of the bounds proposed by Pesaran et al. (2001). Moreover, in situations where the sample size is limited, it is crucial to assess the F statistics in relation to the critical values specified by Narayan (2005). In the event that the value of the F statistic above the critical value, it is appropriate to reject the null hypothesis, hence suggesting the existence of cointegration. Conversely, if the value of the F statistic falls below the lower bound, it is not feasible to reject the null hypothesis. The observed result indicates the lack of cointegration. However, when the F statistics fall inside the predetermined range of the upper and lower bounds, the interpretation of the cointegration relationship becomes ambiguous. The results of the ARDL bounds test are presented in Table 6.

Table 6. ARDL bounds testing results

F-stat=8.67366 (k=4) [n=28]				
H0: no cointegration				
Bounds value				
Pesaran et al. (2001)	Asymp.: n = 1000			
	Significance	I(0)	I(1)	Cointegration
	10%	2.45	3.52	✓
	5%	2.86	4.01	✓
	1%	3.74	5.06	✓
Narayan (2005)	Finite sample: n = 45			
	10%	2.752	3.994	✓
	5%	3.354	4.774	✓
	1%	4.768	6.67	✓
t-stat=-7.411780				
Pesaran et al. (2001)	10%	-2.57	-3.66	✓
	5%	-2.86	-3.99	✓
	1%	-3.43	-4.6	✓

Case III, the model assumes an unlimited intercept and no trend. The optimal lag durations are computed using SIC.

Based on the ARDL F-bound test findings presented in Table 6, it can be observed that F statistic (8.67) surpasses the critical values provided in the tables of Pesaran et al. (2001) and Narayan (2005). The results of this investigation indicate the existence of a sustained equilibrium relationship among the variables incorporated in the model. The results of the ARDL bounds test suggest the presence of a long-term cointegration relationship among the variables. In accordance with the model specifications outlined by Pesaran et al. (2001), case 3 was chosen for inclusion in the ARDL model. Consequently, in addition to conducting the F-boundary test, the t-boundary test was also carried out. The findings of this examination are additionally documented in the lower section of Table 6. The t-bound test statistic, when compared to the upper critical values in the table provided by Pesaran et al. (2001), consistently exceeds these values at all levels of significance. This confirms that the cointegration conclusion obtained by the F-bound test is likewise supported by the t-bound test. To assess the efficacy of the error correction mechanism in resolving deviations from the long-run equilibrium caused by shocks, it is necessary to examine the estimate outcomes of the short-run error correction regression. Table 7 presents the estimation outcomes for the regression model that incorporates short-run error correction.

Table 7. Short-run error correction regression estimation results

Variables	Coefficient	Std. error	t-Statistic
ΔlnElec(-1))	-0.405547**	0.189324	-2.142079
ΔlnTour	0.006899	0.011100	0.621510
ΔlnTour(-1))	-0.056235***	0.012211	-4.605392
ΔD(Urba)	-0.047125***	0.009820	-4.798873
ΔD(Growth)	0.002155***	0.000295	7.294001
ECT(t-1)	-0.159583***	0.021531	-7.411780
*, **, and *** are used to denote statistical significance at the 10%, 5%, and 1% levels, respectively.			

According to the findings presented in Table 7, the error correction coefficient (ECT) has a negative value and demonstrates statistical significance. This observation implies the presence of a significant and enduring relationship between the variables being examined. This finding also suggests that a system for mistake correction operates to mitigate the impact of shocks in the short term. The coefficient of ECT suggests that, following one session, around 15 percent of the deviation from equilibrium will be eliminated.

In order to examine the impact of economic growth and international visitor arrivals on energy consumption in an open economy, it is crucial to assess the long-term coefficients of the ARDL model. In order to fulfill this objective, Table 8 presents the results of the long-run coefficient estimation for the ARDL model.

Table 8. Lon-run error correction regression estimation results

Variables	Coefficient	Std. error	t-Statistic
lnTrade	-0.216083	0.331571	-0.651695
lnTour	0.269386***	0.063410	4.248287
Urba	-0.065632	0.038122	-1.721653
Growth	0.025164**	0.010234	2.458852
*, **, and *** are used to denote statistical significance at the 10%, 5%, and 1% levels, respectively.			

According to Table 8, both the tour and growth variables are statistically significant and have a positive sign in the long run. Therefore, it can be argued that the relationship between tourism, economic growth, and sustainable power use in an open economy is one that yields beneficial outcomes. Nevertheless, over the course of time, the impact of tourism arrivals surpasses that of economic growth. On the other hand, the trade variable used to represent an open economy and the Urba variable used for urbanization are statistically insignificant and have a negative sign.

In order to assess the credibility of the research findings, the CUSUM and CUSUM of Squares structural break tests, as described by Brown et al. (1975), were computed. This was done to account for any alterations in the Turkish economy over the analyzed period. Figure 1 displays the outcomes of the CUSUM and CUSUM of Squares tests.

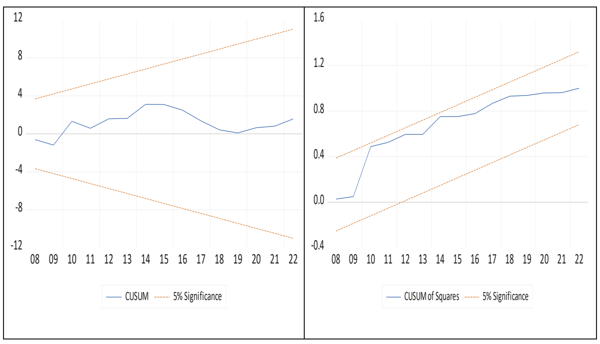

Figure 1. CUSUM and CUSUM of Squares Test Results

The outcomes of the CUSUM test and the CUSUM of Squares test are depicted in Figure 1, with the left panel representing the former and the right panel representing the latter. Based on the findings from both test results, it can be observed that the test statistics fall within the 5 percent confidence interval. Put otherwise, the calculated parameters remain inside the critical limitations. Hence, it may be concluded that the predicted parameters remain unaffected by any potential alterations in the data period.

Furthermore, the present work employs the Fourier TY causality test, which has been adapted to incorporate wavelet transformations. This approach offers a full study of causality, yielding significant results by considering the temporal and frequency dimensions of the variables, as well as accounting for smooth transitions (Pata et al., 2023). In order to achieve this objective, variables are initially segregated into components that correspond to short, medium, and long-term durations. The Daubechies model is employed for the aim of this investigation. In order to use the least asymmetric scaling technique, we adhere to the methodology proposed by Gençay et al. (2010) and opt for LA8 as the wavelet length. In accordance with the research conducted by Andersson (2016), this study categorizes the components into short-term (d1 + d2 = 2–8 years), medium-term (d3 = 8–16 years), and long-term (d4 =+16 years) segments. Next, we proceed to analyze the causal connections between the original data and the wavelet-decomposed series by employing the Fourier TY causality method. The outcomes of this analysis are then succinctly shown in Table 9.

Table 9. Fourier and Fourier TY causality

Original	Test stats	Boostrap prob.	p	k	Short term (< 8 years)	Test stats	Boostrap prob.	p	k
Trade=>Elec	1.436	0.238	1	0.8	Trade=> Elec	0.060	0.772	1	0.8
Tour=> Elec	1.870	0.186	1	0.8	Tour=>Elec	0.413	0.476	1	0.8
Growth=> Elec	3.665*	0.074	1	0.8	Growth=> Elec	1.022	0.253	1	0.8
Elec=>Trade	14.599**	0.003	1	0.8	Elec=>Trade	10.601**	0.027	1	0.8
Tour=> Trade	0.283	0.603	1	0.8	Tour=> Trade	0.485	0.449	1	0.8
Growth=>Trade	1.509	0.259	1	0.8	Growth=>Trade	0.309	0.529	1	0.8
Elec=> Tour	2.222	0.148	1	0.8	Elec=> Tour	0.133	0.636	1	0.8
Trade =>Tour	2.800*	0.125	1	0.8	Trade =>Tour	35.057***	0.000	1	0.8
Growth=>Tour	0.001	0.982	1	0.8	Growth=>Tour	0.301	0.499	1	0.8
Elec=> Growth	1.574	0.237	1	0.8	Elec=> Growth	0.036	0.804	1	0.8
Trade=>Growth	0.097	0.724	1	0.8	Trade=>Growth	0.095**	0.741	1	0.8
Tour=> Growth	82.774***	0.000	1	0.8	Tour=> Growth	39.051	0.000	1	0.8
Medium term (8–16 years)	Test stats	Boostrap prob.	p	k	Long term (> 16 years)	Test stats	Boostrap prob.	p	k
Trade=>Elec	0.225	0.882	2	2.9	Trade=>Elec	8.482	0.147	2	4.5
Tour=>Elec	1.235	0.544	2	2.9	Tour=>Elec	21.235***	0.036	2	4.5
Growth=> Elec	1130.25***	0.000	2	2.9	Growth=> Elec	82.25***	0.001	2	4.5
Elec=>Trade	666.36***	0.000	2	2.9	Elec=>Trade	208.36***	0.000	2	4.5
Tour=> Trade	0.352	0.812	2	2.9	Tour=> Trade	0.525	0.906	2	4.5
Growth=>Trade	0.971	0.556	2	2.9	Growth=>Trade	33.702**	0.012	2	4.5
Elec=> Tour	56.413***	0.000	2	2.9	Elec=> Tour	0.589	0.891	2	4.5
Trade =>Tour	155.705***	0.000	2	2.9	Trade =>Tour	36.949**	0.011	2	4.5
Growth=>Tour	1.801	0.399	2	2.9	Growth=>Tour	0.685	0.868	2	4.5
Elec=> Growth	0.028	0.980	2	2.9	Elec=> Growth	2.844	0.495	2	4.5
Trade=>Growth	221.68***	0.000	2	2.9	Trade=>Growth	2.382	0.573	2	4.5
Tour=> Growth	500.97***	0.000	2	2.9	Tour=> Growth	7.670	0.180	2	4.5

Note: p: Appropriate delay, k: Appropriate frequency, *, **, and *** are used to denote statistical significance at the 10%, 5%, and 1% levels, respectively.

The Fourier TY causality test was employed because to the original series having a maximum degree of integration (Dmax = 1). Based on the fractional Fourier TY causality test, the results indicate the presence of unidirectional causality in the following relationships: economic growth (EG) to electricity consumption (EC), EC to trade openness (TO), and tourism to EG. No causal relationship was identified for the other factors. The results suggest that the shocks exhibit a permanent nature as evidenced by the fractional frequency values.

In the immediate time frame, a fractional Fourier causality test was employed due to the series having a maximum degree of integration (Dmax=0). Based on the findings, the results indicate a unidirectional causal relationship from EC to TO, TO to tourism, and tourism to EG. No causal relationship was identified for the other factors. The results suggest that the shocks have a lasting impact.

Based on the analysis conducted using the fractional Fourier TY causality test in the medium term, it was observed that a unidirectional causality exists from EG to EC, from EC to TO, from EC to tourism, from TO to tourism, from TO to EG, and from tourism to EG. No causal relationship was identified for the other factors. Hence, the interactions among variables have a higher magnitude in the medium term. The results indicate that the shocks have a lasting impact.

Based on the long-term analysis conducted using the fractional Fourier TY causality test, it was shown that a unidirectional causation exists solely from tourism and EG towards EC. Additionally, a unidirectional causality was identified from EC to TO, from EG to TO, and from TO to tourism. No causal relationship was identified for the other factors. The results indicate that the shocks have a lasting impact.

6. CONCLUSION AND RECOMMENDATION

This research investigates the effect of tourism and economic growth on electricity consumption in order to assess the potential for sustainable electricity usage within the Turkish economy. The ARDL bounds test method is employed for the examination of the time frame spanning from 1995 to 2022. Furthermore, in order to conduct the causality test, the series are subjected to transformation using the wavelet approach. The Fourier causality test is utilized to examine these altered series, encompassing short, medium, and long-term components. The empirical evidence indicates the presence of a long-term cointegration association among economic growth, tourist arrivals, and power usage. The findings of the investigation show a favorable correlation between economic growth, tourist arrivals, and power use. However, the commerce variable, which is employed to symbolize an open economy, and the urba variable, which is utilized to measure urbanization, exhibit insignificance in the analysis. The alteration of the series modifies the impact of one series on the others.

Consequently, the initial series of observations revealed a unidirectional causal relationship, wherein EG exerted an influence on EC, EC impacted TO, and tourism contributed to EG. In the immediate term, the study identified a unidirectional causal relationship whereby EC influenced TO, TO influenced tourism, and tourist influenced EG. In the intermediate timeframe, there is a greater degree of interaction across variables. The analysis revealed a unidirectional causal relationship between EG and EC, EC and TO, EC and tourism, TO and tourism, TO and EG, and tourism and EG. Ultimately, it was determined that there exists a unidirectional causal relationship in the long run, wherein tourism and EG have an impact on EC, EC influences TO, EG affects TO, and TO impacts tourism. The results additionally indicate that the shocks have a persistent nature across all components. Based on the results obtained, it is possible to provide certain suggestions to researchers and policymakers. The study possesses significant limitations that necessitate further clarification and expansion in future research endeavors. This report employs foreign visitor counts as a metric to assess the tourist business. Incorporating supplementary tourism metrics, such as international inward investment and the generation of tourism revenue, provide a favorable approach to expanding the scope of the study. The tourism-led growth hypothesis is substantiated by the empirical findings, which have implications for policymakers. This implies that the robust economic expansion in Türkiye can be attributed to the significant contributions of the tourism industry. In the present climate, it is imperative for policymakers to allocate increased attention towards the tourism sector. Various strategies can be employed to achieve this objective, encompassing enhancements in the tourism regions' infrastructure, more international dialogue, and the implementation of institutional learning initiatives. In addition, careful consideration should be given to the implementation of well-crafted regulations and tax structures that align with a sustainable shift towards electricity generation, while also taking into account the need for proper legislation and policies pertaining to tourism, as well as the adoption of clean energy technologies. The integration of energy-efficient technology is of paramount importance for the tourism industry. There is a pressing need for more funding towards tourism programs that have positive environmental impacts. As an illustration, bicycle tourism has the potential to serve as a substitute for environmentally detrimental forms of transportation (Bekun et al., 2023; Dogru, et al., 2020).

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