# Estimating the Causal Relationship between Renewable Energy Consumption, Tourism and Economic Growth: Evidence from Algeria

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**Abstract:** The main objective of this study is to investigate the causal relationship between renewable energy consumption, tourism and economic growth in Algeria spanning the period 1990-2018. In order to examine the long-run relationship, the ARDL bound testing approach for cointegration is applied. The study further applied Toda-Yamamoto causality test to reveal the direction of causalities. The empirical results reveal the existence of a long-run relationship across the variables. However, Toda-Yamamoto causality findings support the presence of the unidirectional causal relationship running from tourism to renewable energy consumption. Algeria must implement sustainable tourism practices that could mainly cause an increase in renewable energy consumption.

**Keywords:** Renewable energy, Tourism, Economic Growth, ARDL bounds test, Toda-Yamamoto Approach.
**(JEL) Classification:** Q42 ،Q43, Z32, C32.

## 1. Introduction

Tourism represents the major socio-economic activity and one of the fastest growing industries in the world with a wide-ranging impact on the economic growth, employment and social development for the local economies. Today, international tourism is the world's third largest export category after chemicals and fuels, and ahead of automotive products and food (UNWTO, 2019). Given that tourism activities involve energy consumption directly through fossil fuels or indirectly through electricity power in each step from transportation to accommodation (Doğan, 2017), the tourism industry is one of the main contributors to greenhouse gas emissions (GHG). In global, tourism is currently producing 5.2 to 12.5% of global carbon dioxide emissions due to its heavy dependence on unclean energy resources (Işik, Dogru, & Sirakaya Turk, 2018), leading to serious damages of the environmental quality. In fact, managing tourism in a sustainable manner for the benefit of all is more critical than ever.

In this context, the transition to renewable energies has become an important step in reducing greenhouse gas (GHG) emissions in addition to its vital role on economic development. Renewables are the second largest contributor to global electricity production. They accounted for 25.2% of world generation in 2018, after coal (38.2%) and ahead of natural gas (23.1%). (IEA, 2020). Thus, investments of renewable energy and cleaner technologies in tourism sector for heat and electricity generation will reduce their energy cost and may further create zero GHG emissions hotels and attract a more environmentally-friendly tourists that are willing to pay more for sustainable tourism. For these reasons, the estimation of the interaction between tourism and renewable energy is an important issue. Furthermore, it is worth noting that both tourism and renewable energy sectors play a significant role in the economic development of many countries in the world by creating additional jobs and income. In this regard, many researchers focus on the relationship between renewable energy, tourism and economic growth, and conclude important recommendations for governments and policy makers to develop effective policies and strategies with relation to sustainable tourism development and environmental protection.

Algeria is an emerging tourism market which is primed to make use of its significant tourism potential. In order to increase its share in the international tourism market and create a good image for Algeria to be a successful destination of tourism, authorities are stepping up efforts to expand tourism as part of wider economic diversification plans. In that context, the Algerian government started to give more interest to the tourism sector by establishing a strategic framework to build a vision for 2030. According to statistics from the Ministry of Tourism, Crafts industry and Family Work (2020), the accommodation establishments are among the most important tourism services in Algeria, as the accommodation capacity of the various hotel establishments in 2019 reached about 125676 beds, 47% of them are classified. Moreover, annual visitors in Algeria during the last years exceeded 2 million tourists. After the political stability and the expenditures in the tourism sector, the number of visitors grows rapidly from 865984 in 2000 to 2.3m in 2019. Thus, the tourism sector has shown an exceptional improvement. The World Travel & Tourism Council (WTTC) put the contribution of the Algerian travel and tourism sector to GDP at DZD1159.9BN which is equivalent to 5.7% of total GDP in 2019. Furthermore, employment in this industry is increasing offering job opportunities to many local inhabitants by 647.7 thousand jobs. Its share in the employment is currently estimated at 6%. (WTTC, 2020).

With regard to renewable energies, Algeria is among the countries that have an important renewable energy potential, especially solar energy. while the potentials for wind, biomass, geothermal are less important. Thus, Algeria put greater focus on the deployment of large-scale renewables, but the achievements are rather modest compared to the forecasts. Since 2011, just 22 solar power plants have been installed in the country, totalling a capacity of just under 400MW altogether. That number is 20 times lower than the initial goal, set at 8000 MW. (Africa Energy Series, 2020). Moreover, despite the increase in electricity production from renewable energy in recent years to reach approximately 784GWh in 2018, the share of renewable energy in electricity production in overall is less than 2%. Thus, the objective of producing electricity from renewable sources (27% by 2030) is far from being achieved. In addition, the renewable energy share of total final energy consumption (TFEC) is still relatively small and does not exceed 0.2% until 2011. (IRENA, 2020)

Therefore**,** the Algerian state is working to raise the share of renewable energies into the energy mix through various incentive measures and with the aim of contributing to meeting the growing needs of the national market of electricity and preserving its hydrocarbon resources. In this regard, the use of renewable sources of energy will have an important role on reduction of the greenhouse gases emissions .One obvious solution is the adoption of the use of more renewable energy and cleaner technologies in not only overall production process but also tourism sector in particular. This is may increase the competitiveness of tourism services in Algeria in order to attract more tourists, and to achieve sustainable economic growth.

Because of the lack of econometric studies in relevance to the link between renewable energy consumption, tourism and economic growth this study aims mainly to describe the causal relationship between these variables, and investigates the contribution of renewable energies and tourism development to the overall economic. For this purpose, several econometrics test is used to examine the long-run and short-run relationship, and the direction of causality nexus between renewable energy consumption, the number of tourist arrivals and economic growth in Algeria.

The importance of this study lies to the fact that determining the nature and direction of the causal relationship between renewable energy, tourism and economic growth in Algeria is of paramount importance for designing a sustainable growth agenda regarding tourism development and environmental issues, and can help policy makers to develop effective policies and strategies to increase the exploitation of renewable energies and reduce the pressure on fossil sources. Furthermore, on the basis of the direction of the causal relationship, the state can determine the sectors from which it should benefit for investments and allocate its resources. In fact, this empirical analysis plays an important role for strengthening the renewable energy-tourism-growth literature.

## 2. Literature Review

The relationships between total energy consumption, economic growth have long been examined for different sets of countries. The essential implications of causality between economic growth and energy consumption have attracted tourism scholars to empirically investigate the causality between energy consumption, tourism and economic growth by adapting growth, conservation, feedback, and neutrality hypotheses. Thus, Literature on tourism-energy-growth nexus is generally synthesized into four hypotheses **(Işik, Dogru, & Sirakaya Turk, 2018)**. The growth hypothesis which is also known as the energy or tourism-led growth hypothesis, assumes unidirectional causality running from energy consumption or tourism to economic growth. On the other hand, the conservation hypothesis conjectures that there is a causality run from economic growth to tourism or energy consumption. However, the feedback hypothesis indicates that a bidirectional relationship between economic growth and tourism or energy consumption. Finally, Neutrality hypothesis implies no causal link between economic growth and tourism development or energy consumption.

Accordingly, the examination of the relationship between renewable energy consumption, tourism and economic growth was the subject of interest for some studies. However, it is not clear whether tourism development induces economic growth and renewable energy consumption (or vice versa), because there are a few researches that test the long-run relationship between these variables. Thus, this section ensures a review of the previous studies on the causal link between tourism, renewable energies and growth. For instance, **(Ben Jebli, Ben Youssef, & Apergis, 2014)** explored the relationship between carbon dioxide emissions, economic growth, renewable energy consumption, the number of tourist arrivals and trade in Central and South America spanning the period 1995-2010. They employed the panel cointegration techniques and panel Granger causality tests to investigate the short-run and the long-run relationship among the variables. Results reveal the presence of a long-run relationship across the variables under study. In the long-run, there is evidence of bidirectional causality between emissions, renewable energy consumption and the number of tourist arrivals. While, Short-run dynamics show a unidirectional causality running from renewable energy consumption to $CO_2$ emissions and from the number of tourist arrivals to trade.

Furthermore, **( Ben Jebli, Ben Youssef , & Apergis, 2015)** investigated the dynamic causal relationships between tourism and renewable energy consumption, more precisely combustible renewables and waste consumption. An autoregressive distributed lag (ARDL) approach was used to investigate the long-run relationship between GDP, combustible renewables and waste (CRW) consumption, CO2 emissions, and international tourism for the case of Tunisia spanning the period 1990-2010. The results from the ARDL bound test and Johansen test for cointegration confirm the

presence of a long-run relationship among the variables. In the long-run, the error correction terms confirm the presence of bidirectional causality relationships between variables under investigation. While, findings of the short-run Granger causality recommend a unidirectional causality running from economic growth and combustible renewables and waste consumption to CO2 emissions, a bidirectional causality between GDP and CRW and unidirectional causality running from GDP and CRW to international tourism.

Moreover, **(Işik & Radulescu, 2017)** study examined the long-run relationship among tourism receipts, renewable energy consumption and economic growth for the European Union countries, by applying the Padroni and Kao panel cointegration techniques, and FMOLS, DOLS and OLS methods. The long-run coefficients report that there is a positive impact of renewable energy, tourism receipts, gross fixed capital formation and labor force on economic growth. In addition, **(Doğan, 2017)** investigated the relationship of CO2 emissions, real GDP, renewable energy and tourism for the top 10 most-visited countries for the period 1995–2011. The empirical results show that the LM bootstrap cointegration test indicates that real GDP, renewable energy, tourism and CO2 emissions are cointegrated and hence have a long-run relationship. The DOLS and FMOLS estimators indicate that increases in renewable energy leads to environmental improvements whereas increases in real GDP and tourist arrivals lead to environmental degradation in the top 10 most-visited countries.

In addition**, (Işik, Dogru, & Sirakaya Turk, 2018)** investigated the contribution of renewable resources and tourism development to the overall economic performance in T-7 countries (France, the USA, Spain, China, Italy, Turkey, Germany). For this purpose, the bootstrap panel Granger causality technique developed by Emirmahmutoglu and Köse (2011) was used to examine the causal link between tourist arrivals, GDP, and renewable energy consumption. The results show that tourism development and economic growth are interdependent in Germany; whereas tourism development induces economic growth in China and Turkey, the reverse is true in Spain. The main results support the renewable energy-led growth hypothesis which implies unidirectional causal relationships running from renewable energy to economic growth in Spain and the conservation hypothesis (growth-led renewable energy) in China, Turkey, and Germany. Whereas the feedback hypothesis exists in Italy and U.S.A. Moreover, the Spanish, Italian, Turkish, and U.S. models demonstrate a unidirectional relationship stemming from tourism development.

Another study was conducted by **(Saad & Taleb, 2018)** to focus on the relationship between renewable energy consumption and economic growth, and analyzed the short-run and long-run nexus in 12 European Union countries spanning the period 1990 to 2014. they applied panel vector error correction model and Granger causality test to examine whether there exists any causal relationship between economic growth and renewable energy consumption. The results indicate the presence of unidirectional causality running from economic growth to renewable energy consumption in the short run. However, In the long run, there is evidence of bidirectional causality between variables under investigation.

Furthermore, **(Ben Jebli, Ben Youssef, & Apergis, 2019)** investigated the causal relationship between renewable energy consumption, the number of tourism arrivals, the trade openness ratio, economic growth, foreign direct investment (FDI) and carbon dioxide (CO2) emissions for a panel of 22 Central and South American countries, spanning the period 1995–2010. The main empirical

results indicate that there is a long-run relationship across the variables under study. In the long run, there is evidence of bidirectional causality between renewable energy, tourism, FDI, trade, and emissions. While, Short-run Granger causality tests show unidirectional causalities running from: economic growth to renewable energy and tourism; and renewable energy to CO2 emissions and trade; tourism to trade and FDI.

**(Zhou et al , 2019)** analysed the effect of renewable energy on tourism development by considering other potential determinants, such as the GDP per capita, trade openness and real effective exchange rates in the sample of G20 members spanning the period 1995- 2015. The panel econometric techniques are conducted to achieve the objectives of this study. The results for the long-run elasticities from the panel fully modified ordinary least squares (FMOLS) estimations suggest that the renewable energy uses and tourism investment have a considerable positive impact on both the tourism revenues and the tourist arrivals. Furthermore, **( Iqbal Khan, Yaseen, & Ali, 2019)** explained the nexus of GHG emission with tourism, financial development index, energy use, renewable energy, and trade in 34 high-income countries from three continents (Asia, Europe, and America) from 1995 to 2017. The main results of Dumitrescu and Hurlin non-causality test established the feedback hypothesis for renewable energy and GHG (Europe) and trade and tourism (America). The unidirectional causality was observed from tourism to GHG (Asia, Europe, America) and tourism to renewable energy (Europe, America).

Concerning the case of Algeria, there are different works in the tourism or energy literature that have examined the tourism or energy itself. To our knowledge, there is not any econometric study that examined the causal nexus between tourism, renewable energy consumption and economic growth for Algeria. For instance, **(Hallam, 2019)** analyzed the relationship between tourism, economic growth, Co2 emissions and trade openness in Algeria. This study used annual data covering the period from 1990 to 2017. The Johansen cointegration method was used to examine the long-run equilibrium relationship among variables under study. The empirical results show that there is a long-run relationship between variables, and the FMOLS estimators indicate that increase in real GDP and tourism expenditure leads to environmental pollution whereas increase in trade openness leads to decrease the Co2 emissions in Algeria. However, (**Chekouri , Chibi , & Benbouziane, 2020)** investigated the causal relationship between energy consumption and economic growth in Algeria by using yearly time series data for the period of 1971–2016. A modified version of the Granger (1969) causality test proposed by Toda and Yamamoto (1995) was applied to reveal the direction of causality. The empirical results show that there is a unidirectional causality running from GDP per capita to energy consumption.

As shown above, several recent studies analyze the renewable energy-tourism-growth causal relationship for single country and panel of countries cases. Findings of these studies show that although causal relationship between tourism, renewable energy and economic growth is generally supported, the strength and direction of relationship differs in time and across countries or regions around the world. This research contributes to the existing literature in several aspects. Mainly, some early works in the case of Algeria have focused on tourism or renewable energy itself, there is a scarcity or a lack of studies that use these two variables which affect economic growth in one equation. Thus, the current study aims to fill this gap.

## 3. Data and Methodology

Regarding to data description, economic growth is measured by real GDP per capita (in constant 2010 US$); Progress on renewable energy consumption is tracked as the RE shares of total final energy consumption (RE); and (TA) is the number of Tourists Arrivals; capital (K) is gross fixed capital formation (in constant 2010 US$) and labor (L) is number of labor force. The model also includes the capital use and labor force, because it derives from a Cobb-Douglas function.

The annual data for the analyzed variables is from 1990–2018 and provided by the World Bank Development Indicators (2020) for the (GDP, K, L); (TA) is available from the Ministry of Tourism, Crafts industry and Family Work. (2020), and (RE) is available from International Energy Agency (IEA) and International Renewable Energy Agency (IRENA). It is important that we use the available longest data.

Following studies Cem Işik and Magdalena Radulescu (2017), Cem Işik et al (2018), and Saad and Taleb (2017) this study uses the following model where economic growth (GDP) is the dependent variable and the renewable energy (RE), capital (K), labor (L) and tourism (TA) are the independent variables. The natural logarithm of all variables was considered and added to the model. We used EViews 10 econometric software for the estimations. The model can be written as:

$$\boldsymbol{GDP_t = F(K_t, L_t, RE_t, TA_t)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where t: denote the time period.

Before we proceed to Toda-Yamamoto causality approach, the crucial step of augmented Granger causality analysis is to investigate the stationary properties of variables in order to determine the order of integration in which the maximum number of lags ($d_{max}$) is determined. For this purpose, we used two-unit root test such as the Augmented Dickey–Fuller (ADF) unit root test and Phillips Peron test (PP), The null hypothesis of both tests indicates unit root process.

The ARDL bounds test for cointegration proposed by Pesaran et al, (2001) was used to test the existence of long-run equilibrium relationship among the variables. The ARDL cointegration approach has numerous advantages in comparison with other cointegration methods such as Engle and Granger, Johansen, and Johansen and Juselius procedures ( Ozturk & Acaravci, 2011). First, the ARDL procedure can be applied whether the regressors are I(1) and/or I(0). However, this technique will crash in the presence of integrated stochastic trend of I(2). Second, the ARDL procedure is statistically more significant approach to determine the cointegration relation in small samples. Third, it allows that the variables may have different optimal lags, while it is impossible with conventional cointegration procedures. The ARDL bound test can be implemented by including both short-run and long-run dynamics. The empirical equation of the ARDL bound model is given by:

$$\boldsymbol{\Delta LGDP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\, \Delta LGDP_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\, \Delta LK_{t-i} + \sum_{i=0}^{q} \alpha_{3i}\, \Delta LL_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\, \Delta LRE_{t-i} + \sum_{i=0}^{q} \alpha_{5i}\, \Delta LTA_{t-i} + \partial_1 LGDP_{t-i} + \partial_2 LK_{t-i} + \partial_3 LL_{t-i} + \partial_4 LRE_{t-i} + \partial_5 LTA_{t-i} + \mu_t} \ldots\ldots\ldots\ldots\ldots\ldots\boldsymbol{2}$$

Where : LGDP, LK, LL, LRE and LTA are variables of the study, $\mu_t$ is the white noise error term, Δ is the first difference operator ; (p, q) appropriate lags length of the first difference selected based on Akaike information criterion (AIC).

The bounds test is based on the joint F-statistic or Wald statistic for cointegration analysis. The hypothesis of no cointegration deals with. $H_0$: $\partial_1 = \partial_2 = \partial_3 = \partial_4 = \partial_5 = 0$, against the alternative hypothesis of cointegration $H_1$: $\partial_1 \neq \partial_2 \neq \partial_3 \neq \partial_4 \neq \partial_5 \neq 0$ which confirm the existence of long-run relationship between variables under study. F-statistics is calculated to compare with critical values of Pesaran et al. (2001), if F-statistics is less than the lower critical bounds value the null hypothesis cannot be rejected. If the value of F-statistics exceeds the upper critical bounds value the null hypothesis is rejected which implies that variables were cointegrated. If the F-statistic falls within the bounds then the test is inconclusive. Once the long-run relationship is confirmed, then we estimate the long-run coefficients using the following model:

$$\Delta LGDP_t = \partial_0 + \partial_1 LGDP_{t-i} + \partial_2 LK_{t-i} + \partial_3 LL_{t-i} + \partial_4 LRE_{t-i} + \partial_5 LTA_{t-i} + \mu_t \ldots\ldots\ldots 3$$

we can capture the short-run dynamics by applying an error correction specification (ECM) as follows:

$$\Delta LGDP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta LGDP_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \Delta LK_{t-i} + \sum_{i=0}^{q} \alpha_3 \Delta LL_{t-i} + \sum_{i=0}^{q} \alpha_4 \Delta LRE_{t-i} + \sum_{i=0}^{q} \alpha_5 \Delta LTA_{t-i} + \lambda ECM_{t-1} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

$\boldsymbol{\lambda}$**:** speed of adjustment parameter with a negative sign.
$ECM_{t-1}$: the error correction term.
$\alpha_{1i}, \alpha_{2i}, \alpha_{3i}, \alpha_{4i}, \alpha_{5i}$: the short-run dynamic coefficients of the model's adjustment long-run equilibrium.

For long-run convergence of dynamics, the coefficient of adjustment ($ECM_{t-1}$) must be negative and statistically significant sign. It represents the speed of adjustment to the long-run equilibrium level and it helps to adjust the long-run relationship due to the impact of a specific exogenous shock.

Moreover, a number of diagnostic tests is computed on the serial correlation (LM test), the residual heteroskedasticity (ARCH test), and normality tests to check the robustness of the estimated model. In addition, the cumulative sum (CUSUM) and the cumulative sum of the square (CUSUMSQ) tests are used to evaluate the stability of the long-run estimations. It is argued that if CUSUM and CUSUMSQ figures cannot reject the null hypothesis and the critical bound is within a 5% level, then the regression will be considered as stable. (Brown et al, 1975).

To reveal the direction of the causal relationship among the considered variables, this study applied an Augmented Granger causality test based on Toda-Yamamoto (1995) procedure. Toda-Yamamoto test is conducted from modified Wald test (MWald) for restriction on the parameters of the augmented VAR ($k + d_{max}$) where k is the optimal lag length of the first VAR model and $d_{max}$ is the maximal integrated order on system's variables (VAR model). An important feature of the Toda–Yamamoto approach is the fact that this procedure ignores any possible non-stationarity or cointegration between series when testing for causality (Toda & Yamamoto, 1995). Unlike the traditional granger (1969) causality test the Toda–Yamamoto test applies an augmented VAR model while variables are in levels rather than first differences to guaranty the asymptotic distribution of the Wald statistic (an asymptotic $\chi$2-distribution).

## 4. Results and Discussions

As mentioned earlier the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test statistics is employed to determine the maximum number of integrations. It is necessary to test for unit root to ensure that all the variables satisfy the underlying assumptions of the ARDL bounds testing approach of cointegration methodology before proceeding to the estimation stage. For this purpose, the unit roots were tested with intercept and with both intercept and time trends. Table (02) shows results from the ADF and PP unit root tests.

**Table (02). Augmented Dickey Fuller, and Phillips-Perron Unit Root Tests Results**

| | | Levels | | | | |
|---|---|---|---|---|---|---|
| | | **LGDP** | **LK** | **LL** | **LRE** | **LTA** |
| **ADF** | Intercept | -0.785 | -0.475 | -4.272* | -0.471 | -0.746 |
| | Intercept+Trend | -1.953 | -2.721 | -1.144 | -2.176 | -3.083 |
| **PP** | Intercept | -0.229 | 1.311 | -6.775* | -0.489 | -0.468 |
| | Intercept+Trend | -2.761 | -5.756* | -0.984 | -2.744 | -2.180 |
| | | **First-differences** | | | | |
| | | **LGDP** | **LK** | **LL** | **LRE** | **LTA** |
| **ADF** | Intercept | -3.355** | -6.363* | -4.306* | -6.741* | -3.466** |
| | Intercept+Trend | -3.094 | -6.203* | -6.768* | -7.417* | -3.569*** |
| **PP** | Intercept | -3.313** | -6.278* | -4.310* | -6.578* | -3.415** |
| | Intercept+Trend | -2.982 | -5.878* | -7.481* | -7.318* | -3.519*** |
| **Conclusion** | | I(1) | I(0) | I(0) | I(1) | I(1) |

**Note:** *, **, *** denotes the statistical significance at 1%, 5%, 10% respectively.
**Source:** Eviews10 outputs.

According to the reported results, the analyzed variables (K, L) are stationary at levels I(0) , while the variables GDP, RE, and TA are not stationary at levels but become stationary at first-differences at 5% level of significance, and no variable becomes stationary using the second difference, so that the first condition is validated for using the ARDL model.

It is known that the Akaike Information Criteria is more accurate than the other criteria for small samples. Thus, with the limited observations, this study used the AIC to select the number of adequate lags for the ARDL model. In order to check whether there is a long-run relationship among the variables of the study we applied the ARDL bounds test as a new approach for cointegration. The test can be performed by using the F-statistics to check the significance of the lagged coefficient in the unrestricted correction model (UECM).

Pesaran et al, (2001) have shown that if the F statistic exceeds the upper critical value, we reject the null hypothesis that there is no cointegration between the variables and accept the alternative hypothesis that confirm that there is evidence of a long-run relationship accross the variables under study. In this case, the F statistic is (8.385891) and exceeds the upper critical value. Thus, results suggest that the analyzed variables are cointegrated and thus have a long run relationship at 1%

level of significance. Results of the bounds testing approach for cointegration are reported in Table (03).

**Table (03). Results from the bounds test for cointegration**

| *F- bound test* | | | *Null Hypothesis: No level relationship* | |
|---|---|---|---|---|
| *Test Statistic* | *Value* | *Significance* | *Lower bounds I(0)* | *Upper bounds I(1)* |
| *F-statistic* | *8.385891* | *10%* | *2.45* | *3.52* |
| *K* | *4* | *5%* | *2.86* | *4.01* |
| | | *2.5%* | *3.25* | *4.49* |
| | | *1%* | *3.74* | *5.06* |

**Source:** Eviews10 outputs.

The next step is to estimate the elasticity of the long-run relationship and short-run relationship to determine the impact of independent variables on the dependent variable. Table 4 below show the long-run coefficients of tourism arrivals, renewable energy consumption, capital and labor and stress their impact on economic growth. The results for all the variables except labor force show that they are significant at 1% or 10% level of significance and have a positive impact on GDP (it agrees with the economic theory). The reported coefficients can be interpreted as the elasticities of the GDP with respect to the explanatory variables. Thus, a 1% increase in international tourism arrivals stimulates economic growth by 8.6%. It is observed from the analysis that tourism has a significant positive impact on GDP, this finding is in line with the results of Ben Jebli et al (2015) who suggested that tourism influences economic growth in Tunisia. Similarly, a 1% increase in renewable energy consumption increase economic growth by around 9%. In addition, 1% rises in capital boosts real GDP by 16%. These results are in line with the results of Cem Işik and Magdalena Radulescu (2017), who argued that renewable energy and fixed capital formation have a positive effect on economic growth in case of 28 European countries.

**Table (04). ARDL long-run Coefficients**

| Variables | Coefficient | Std.Error | t-Statistic | Prob. |
|---|---|---|---|---|
| **LK** | 0.166389 | 0.092162 | 1.805391 | 0.0984 |
| **LL** | 0.520707 | 0.299641 | 1.737766 | 0.1101 |
| **LRE** | 0.090626 | 0.015935 | 5.687088 | 0.0001 |
| **LTA** | 0.086790 | 0.018855 | 4.603099 | 0.0008 |
| **EC= LGDP-(0.1664*LK+0.5207*LL+0.0906*LRE+0.0868*LTA)** | | | | |

**Source:** Eviews10 outputs.

The confirmation of the cointegration relationship allowed us to estimate the error correction model, based on which we obtained the short-run relationships between variables. The short-run dynamics are reported in Table (05), indicating that fixed capital formation, renewable energy and tourism are significantly contributing to economic growth in the short-run. The results indicate that renewable energy consumption has significant positive impact on real GDP implies that increase in RE lead to increase in the real GDP and overall economic performance in Algeria in the short-run,

However, the results show that there is a negative relationship between tourism and economic growth. The negative effect of tourism on GDP is mainly due to the potential rises of taxes, because governments need to finance costly tourism infrastructure and the deadweight costs related government subsidies for tourism projects that will negatively affect economic activity in the short-run.

Furthermore, the ECM (-1) value indicates that there is a long-run relationship through this model. The coefficient of adjustment is equal to (-0.896) which means that 89.6% of the short-run errors can be corrected in one year in order to return to the long-run equilibrium level. Thus, the findings indicate that the speed of adjustment is very high and it will not take time for the system to get back to the long-run equilibrium after a short-run shock. The results also show that the coefficient of determination or R-squared is equal to ($R^2$=0.902506) this means that 90% of the changes in economic growth are explained by the explanatory variables, while an approximately of 10% of these changes can be explained by other economic variables not included in the model.

**Table (05). Results of the short-run Dynamics**

| **Dependent variable $DLGDP_t$** | | | | |
|---|---|---|---|---|
| **Unrestricted error correction model** | | | | |
| **Variables** | **Coefficient** | **Sts.Error** | **t-Statistic** | **Prob** |
| **D(LGDP(-1))** | 0.575586 | 0.113299 | 5.080234 | 0.0004 |
| **D(LGDP(-2))** | 0.502402 | 0.163790 | 3.067359 | 0.0107 |
| **D(LK)** | 0.055633 | 0.099468 | 0.559306 | 0.5872 |
| **D(LK(-1))** | -0.178593 | 0.090542 | -1.972492 | 0.0742 |
| **D(LK(-2))** | -0.197386 | 0.077675 | -2.541176 | 0.0274 |
| **D(LL)** | 0.174714 | 0.097693 | 1.788390 | 0.1013 |
| **D(LRE)** | 0.045134 | 0.010846 | 4.161384 | 0.0016 |
| **D(LTA)** | 0.005218 | 0.013700 | 0.380901 | 0.7105 |
| **D (LTA (-1))** | -0.108519 | 0.016352 | -6.636554 | 0.0000 |
| **ECM(-1)*** | -0.896924 | 0.114783 | -7.814092 | 0.0000 |
| **R-squared (0.902506)** | | | | |
| **Adjusted R-squared (0.847666)** | | | | |
| **Diagnostic Tests:** | | | | |
| **LM test** | | **ARCH test** | | **Normality test** |
| **F-Statistic (0.663)** | | F-Statistic (2.162) | | Jarque-Bera (0.337) |
| **Prob. F (3,19)** | | Prob. F (3,8) | | Prob |
| **(0.584)** | | (0.170) | | (0.844) |

**Source:** Eviews10 outputs.

Moreover, with regard to the diagnostic tests (i.e., LM, ARCH and normality tests) which help to confirm the good fit of the estimated model, it is clear that there is no serial correlation among the residuals, there is no heteroscedasticity problem and the residuals are normally distributed. In fact, diagnostic tests confirm the validity of the results (see table6). In addition, the CUSUM and CUSUMSQ statistical tests plots confirm that the model is overall stable as shown in the following Figures.

**Fig.(01):CUSUM**

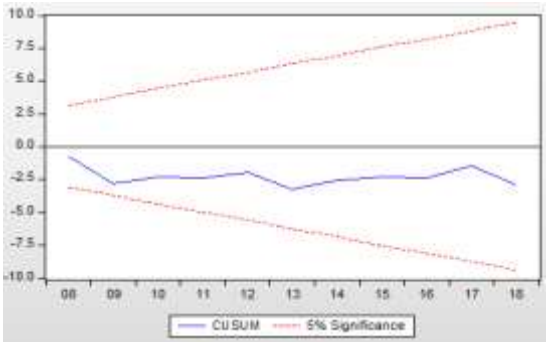
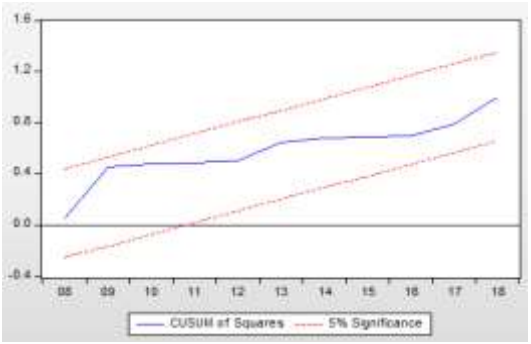



**Fig. (02): CUSUM of Squares Plots**




**Source:** Eviews10 outputs.

Although cointegration indicates presence of Granger causality, at least in one direction, it does not indicate the direction of causality between variables. Hence,

the direction of the Granger causality in this case can be detected through the Toda-Yamamoto approach. To conduct Toda-Yamamoto causality test we have determined the optimal lag length (k) based on AIC and SC criterion to be two, and the maximum order of integration ($d_{max}$) to be one using ADF and PP unit root tests. Finally, the VAR model ($k+d_{max}$) is estimated to reveal causality relation and direction. The results of the causality are estimated through MWALD test and reported in table (07).

**Table (07). Toda-Yamamoto Causality Test (Modified Wald Test)**

| From (Independent Variable) | To (Dependent Variable) | Tests statistics | P Value | Causality direction |
|---|---|---|---|---|
| **LK** | LGDP | 0.754 | 0.685 | LK ≠› LGDP |
| **LGDP** | LK | 1.544 | 0.462 | LGDP ≠› LK |
| **LL** | LGDP | 4.121 | 0.127 | LL ≠› LGDP |
| **LGDP** | LL | 0.651 | 0.722 | LGDP ≠› LL |
| **LRE** | LGDP | 2.046 | 0.359 | LRE ≠› LGDP |
| **LGDP** | LRE | 11.280 | 0.003 | LGDP => LRE |
| **LTA** | LGDP | 7.029 | 0.029 | LTA => LGDP |
| **LGDP** | LTA | 4.803 | 0.090 | LGDP => LTA |
| **LL** | LK | 2.874 | 0.237 | LL ≠› LK |
| **LK** | LL | 0.297 | 0.861 | LK ≠› LL |
| **LRE** | LK | 0.785 | 0.675 | LRE ≠› LK |
| **LK** | LRE | 3.250 | 0.196 | LK ≠› LRE |
| **LTA** | LK | 1.175 | 0.555 | LTA ≠› LK |
| **LK** | LTA | 0.931 | 0.627 | LK ≠› LTA |
| **LRE** | LL | 5.977 | 0.050 | LRE => LL |
| **LL** | LRE | 0.917 | 0.632 | LL ≠› LRE |
| **LTA** | LL | 1.425 | 0.490 | LTA ≠› LL |
| **LL** | LTA | 4.549 | 0.102 | LL ≠› LTA |
| **LTA** | LRE | 5.906 | 0.052 | LTA => LRE |
| **LRE** | LTA | 0.623 | 0.732 | LRE ≠› LTA |

**Source:** Eviews10 outputs.

The results show that a unidirectional causal relationship running from renewable energy consumption to labor force, which implies that the expansion of investments in renewable energy technology may create new jobs and hence lead to an increase in employment during the installation and maintenance phases of the required renewable energy systems. Moreover, a unidirectional causal relationship running from economic growth to renewable energy consumption which implies that the expansion of economic activities in Algeria is expected to cause the consumption of renewable energy. This result consistent with the conservation hypothesis which assumes that energy conservation policies do not have an adverse impact on economic growth in Algeria. Our finding is similar with Cem Işik et al (2018), where they have found that the growth-led renewable energy hypothesis exists in the case of china. It is further in line with Ben Jebli et al (2019) for a panel of 22 Central and South American countries.

Findings also show unidirectional causality running from tourism arrivals to renewable energy consumption. In this sense, sustainable tourism promotes and supports environmentally friendly practices thus leading increases in the use of renewable energy. Result is consistent with those provided by Iqbal Khan et al, (2019) who explained the nexus of GHG emission with tourism, financial development index, energy use, renewable energy, and trade in 34 high-income countries from three continents (Asia, Europe, and America), where a unidirectional causality was observed from tourism to renewable energy in the case of Europe and America. And it is in line with Cem Işik et al (2018), where they have found that Hypothesis of Tourism-led renewable energy exists in the case of Italy, Spain, Turkey and United States.

Furthermore, results indicate the presence of a bidirectional causal relationship between tourism and economic growth, this result supports the feedback hypothesis, and implies that an increase in tourism arrivals leads to an increase in economic growth and vice versa. This finding is in accordance with this reached by Cem Işik et al (2018) who asserted that although tourism can be a tool for economic development, it is also true that a higher level of economic growth influences tourism development in the case of Germany.

## 5. Conclusion

Based on the analysis above, the empirical literatures available suggest mixed results of direction of causality for both developed and developing countries. Therefore, this empirical research aims to investigate the direction of causality among tourism, renewable energy consumption and economic growth for Algeria. The ARDL bounds testing approach to cointegration was applied to test the existence of long run relationship between tourism arrivals, renewable energy consumption, gross fixed capital formation, labor force and economic growth. Furthermore, this study applied the Toda-Yamamoto test for causality to test the direction of causality between the variables under study.

According to empirical analysis, this study shows that the international tourism and renewable energies have a positive impact on the economic growth in the long-run. Which is proof of the positive influence exerted by the national policies of tourism development and environmental protection on economic growth in Algeria. But this influence still very weak with respect to the importance role of both renewable energies and tourism on economic development. This is due to several reasons, the most important one is Algeria's heavy dependence on the hydrocarbons sector, consider that Algeria is an energy-dependent country on fossil fuels. Moreover, this is mainly due to

the lack of the investments needed to integrate renewable energy into the national energy systems, and the unattractive environment for tourists due to the lack of the physical investments especially from the private sector for the creation of hotels, roads, airports, recreational parks and ports. In overall, it can be said that the effect of renewable energy consumption and tourism on economic growth will increase if the country's strategies and investment incentives are continued and developed.

The findings on existence and directions of causality confirm the importance of tourism for the renewable energy consumption and economic growth in Algeria. Policy recommendations based on these main findings may be offered regarding tourism. Thus, results may help government to establish priorities regarding to the assignment of the resources for national strategies to develop the tourism sector in order to achieve sustainable economic growth and clean energy. The unidirectional causal relationship between the number of tourist arrivals and renewable energy consumption implies that strategy and policy designed for the development of the sustainable tourism could be a good supportive policy for rising the contribution of renewables to the future energy mix. it should be noted that sustainability considerations in tourism destinations have an increasing influence on the use of clean energy because tourists seem to prefer visiting destinations with sustainable practices. Therefore, Algeria must implement sustainable tourism practices that could mainly cause an increase in renewable energy consumption. In this regard, the adoption of renewable energy technologies should be implemented more in tourism sector in Algeria, for example touristic facilities may build their solar panel system for producing energy to meet their needs. Furthermore, the government should sponsor more projects on the development of environmentally-friendly technologies, especially those in relation with tourism sector.

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