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Modeling Electricity Consumption for Growth in an Open Economy

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ABSTRACT

The purpose of this paper is to analyze the long run equilibrium relationship of electricity consumption in Italy from a unique perspective, taking tourism expansion as a proxy for exogenous growth. The sample used is annual data covering the period 1990–2018. The Autoregressive Distributed Lag (ARDL) bounds testing approach and the causality method of Toda and Yamamoto (1995) are applied, as the most appropriate for the integration of the variables and the sample size. The ARDL results, as well as additional cross checking test, reveal a long run relation between electricity consumption, foreign tourist arrivals and economic growth in the country. Foreign tourist arrivals and economic growth have significant impact on electricity consumption, both in the short and in the long run. The causality results support unidirectional causalities running from foreign tourist arrivals and economic growth to electricity consumption. In addition, foreign tourist arrivals influence electricity consumption both directly and indirectly through economic growth. Policy implications are further discussed.

Keywords: Foreign Tourist Arrivals, Electricity Consumption, Economic Growth, ARDL Cointegration Test
JEL Classifications: C22, C32, Z32, Q43

1. INTRODUCTION

It is generally known that economic growth is the most important factor in macroeconomic analysis. Therefore, policy makers are necessary to confirm the main catalysts of growth in order to formulate effective policies for long term growth rates. Nowadays, tourism and energy are vital forces of sustainable growth in the world. In modern societies, tourism and energy considered as an integral component. During the last decades tourism's importance to the global economy is unbelievable, since it's one of the largest and fastest growing sectors. Tourism is a key factor for the economic growth of a country by encouraging the creation of new jobs, enhancing investments in new infrastructure and increasing foreign earnings.

According to UNWTO (2021) Europe is the most visited region in the world, given that it accounts for 50% of the world's tourist arrivals and 37% of global tourism receipts. In 2018 (pre-Covid 19 normal), there were 713 million international tourist arrivals, this has increased from 670 million in 2017. As a result, Europe contributed by 782 billion dollars in 2018 and 14.4 million jobs. In addition, the European Union (EU) includes many "most visited" countries among the world's top ten destination, with Italy in the third place after Spain and France. Thus, tourism is a driver of wealth and employment creation in the EU, since it plays a major role in the shaping of the union's economic indicators. On the other hand, there are significant concerns about the social and economic inequalities and the environmental costs.

According to European Commission (2014) "*energy efficiency has a fundamental role to play*". Energy efficiency contributes on reducing carbon dioxide emissions which are considered as the main cause of the greenhouse effect. High energy efficiency not only will help EU countries to implement the plan for climate change, as agreed by the new Paris agreement (2015), but also will bring economic benefits and maintain growth expectations of the economy.

Electricity is a kind of secondary energy which is obtained from primary energy conversion. However, the relationship between electricity consumption and economic growth is very important for improving energy efficiency and further enhancing the development of both the economy and society. Electricity consumption (especially industrial electricity consumption) is a basic index for a country's development level.

According to IEA (2018), in 2017, the global increase of energy demand was 2.1% against the increase of 0.9% in 2016, and the average increase of 0.9% during the past 5 years. Electricity is consumed in all sectors with its higher demand to be more than the total energy demand. Therefore, the economic growth of a country is very much dependent on electricity consumption. During the last years, electricity demand in Italy has increased rapidly.

The purpose of this study is to investigate empirically the long and short run dynamics and casual relationships between electricity consumption, economic growth and tourism in Italy using data covering the period 1990-2018. The methodology used in the paper relies on the latest modeling and economic approaches. According to the best of our knowledge, in the literature there has not been any study undertaken so far that analyzes empirically the relationship between electricity consumption, economic growth and tourism in the case of Italy. Given that tourism sector transversal, this paper contributes to the existing literature by including electricity consumption in the model in order to explore the links between economic growth and tourist arrivals.

This study contributes to enriching the existing literature in various ways:

1. First, this article differs from that of previous work by highlighting the impact of electricity consumption rather than energy consumption as a variable control, due to its use in all sectors of activity including the tourism sector and the higher growth of electricity demand (see also Menyari, 2021).
2. The consumption of electricity plays an important role in economic growth. Ferguson et al. (2000) argued that there is a strong correlation between electricity consumption and wealth creation. However, electricity consumption has a negative effect on the environment since its produced from certain energy sources such as coal, oil, or gas which includes CO_2 emissions (see for example Shaari et al., 2017; Rahman, 2020). So, electricity consumption should get priority over the energy consumption nexus for the tourism-growth linkage analysis.
3. In addition, a unique feature of the study is that, in the model, foreign tourist arrivals used as a proxy for the openness of the economy which is a main determinant of domestic electricity consumption (see also Yorucu and Mehmet, 2015).

Italy enjoys a wide range of natural resources in terms of landscape, pleasant climate, traditional, culture and gastronomy. It attracts many international tourists every year (more than its population), so it is necessary to investigate the effects of international tourism in energy and economic growth for the country.

The choice of the country is motivated by the fact that Italy is a representative country interested in stimulating a competitive reorientation of its tourism industry as a way to boost growth performance. The country, remains one of the leading tourist destinations worldwide. In 2021, according to the UNWTO (2021), it ranked 5th in the world as well as 3rd in Europe, with respect to both international tourism receipts and arrivals.

In addition, Italy is one of the three most populous European Union countries, regarding the growth of energy demand (Statista, 2021). For this reason, Italian government has put energy and climate at the centre of its political agenda. The national energy plan set very ambitious targets by 2030, aiming to reach 30% in total energy consumption and 55% in electricity generation.

The overall purpose of the study is to explore the long run equilibrium of electricity consumption in the open Italian economy exposed to exogenous shocks from foreign tourist arrivals. In order to achieve the objectives of the study the ARDL bounds testing approach of cointegration, in combination with additional cross checking test, is employed followed by Toda-Yamamoto (1995) causality test.

The rest of the paper is organized as follows: The next section presents the literature review. Section 3 contains the theoretical framework. Then, section 4 describes data and methodology. Empirical results are discussed in section 5. Concluding remarks are given in section 6.

2. LITERATURE REVIEW

Economic growth has always been the subject of numerous studies in the economics and finance literature. In all countries, either developed or developing, the purpose of policy makers is to attain sustainable growth rates, which is the key for long term profitability.

Although higher growth rates are associated with a higher standard of living, it is also known that are responsible for increased carbon dioxide (CO_2) emissions and environmental degradation. The environmental impact of economic growth includes the increased consumption of non-renewable resources. Therefore, the results are higher levels of pollution, global warming and the potential loss of environmental habitats. However, it is worth noting that not all forms of economic growth cause damage to the environment.

According to Nepal et al. (2019), tourism sector is a key factor for understanding economic and environmental relations, and then ensuring long term socio-economic development. Energy consumption and tourism revenues create employment and contribute to a blueprint for a sustainable future for all (Dogan and Aslan, 2017). Lenzen et al. (2018) argued that the world's CO_2 emissions increased from 3.9 to 4.5 $GtCO_2e$ from 2009 to 2013, and also that the tourism sector accounts for almost 8% of the world's CO_2 emissions. Frantal and Urbankova (2017) claimed that energy demand is closely related with tourism activities in combination with functions such as transportations and accommodations.

The energy supply from renewable sources can protect the ecological environment (Ogbonnaya et al., 2019). Nowadays, the use renewable energy is an urgent need in the process of transformation to a low carbon economy. During the last decades, the cost of renewable energy use has significantly decreased. The "soft" forms of energy as they are called (forms of usable energy derived from various natural processes such as solar, wind, hydrothermal, geothermal, ocean energy and biomass) can compete the traditional energy sources, such as coal and nuclear energy. Energy consumption, both renewable and non-renewable, as well as foreign tourist arrivals have positive effects on capital formation, unemployment, trade and development of a country (Croes et al., 2018; Yao et al., 2019).

In recent decades, there are many empirical studies that investigate the long run relationship between economic growth and energy consumption for a variety of countries. The energy-growth nexus has categorized in four hypotheses (see also Rahman et al., 2016). Neutrality hypothesis argues that there is no correlation between energy consumption and economic growth. Feedback hypothesis emphasizes bidirectional (mutual) causality between energy consumption and economic growth. Conservation hypothesis claims unidirectional causality running from economic growth to energy consumption. While, growth hypothesis supports unidirectional causality running from energy consumption to economic growth.

The tourism-growth nexus has also been excessively studied in the literature. The origin of the links between economic growth and tourism is based on the tourism-led growth (TLG) and growth-led tourism (GLT) hypotheses. Since 2000, from the original study of Pigliaru and Lanza (2000) who analyzed the tourism-led growth hypothesis, there is an increased empirical literature in the field. However, the results of these studies seem to depend on the period the study was conducted, as well as the stage of economic development of the country. Therefore, the findings on tourism-growth nexus can be categorized in four plausible hypotheses namely tourism-led growth, economy-driven tourism, bidirectional causality or no causality (Antonakis et al., 2016).

Not many studies have assessed the causality relations between tourism and energy consumption. Based on our reading, the empirical studies on the casual linkage between tourist sector and global energy consumption are not as extensive as energy-growth studies and tourism-growth nexus.

Although the link between energy consumption, tourism and economic growth is very important, it has received little attention. The coordination of energy consumption and tourism with economic growth has been analyzed in very recent studies. In the next sub-sections we present the previous literature on the relationship between energy consumption, tourism and economic growth based, mainly, on European countries.

2.1. Energy/Electricity Consumption and Economic Growth

A large number of studies have investigated the energy-growth nexus. Fuinhas and Marques (2012) found that there is a bidirectional causality relationship between energy consumption and economic growth for PIGST (Portugal, Italy, Greece, Spain and Turkey), suggesting the existence of feedback hypothesis. This feedback hypothesis is also validated in Hungary (Ozturk and Acaravci, 2010) and in the following G7 countries: Canada, Italy, Japan, UK (Soytas and Sari, 2006). The second hypothesis (conversation hypothesis), exists in the case that energy consumption is the result rather than the cause of economic growth. This hypothesis is validated in France and Italy (Lee, 2006) and in Germany (Soytas and Sari, 2006). The growth hypothesis refers to unidirectional causality from energy to economic growth. Lee (2006) supported the existence of a unidirectional causality with direction from energy to economic growth for the case of Belgium, Netherlands, Switzerland and Canada. Finally Ozturk and Acaravci (2010) found that neutrality hypothesis exist for the case of Albania, Bulgaria, and Romania implying that energy consumption is not correlated with economic growth.

2.2. Tourism and Economic Growth

In this sub-section we attempt to discuss the results on previous empirical studies on the causality relationships between international tourism and economic growth. In a more traditional way tourism is a source of a long term growth, through different channels. There are several studies that support the tourism-led growth hypothesis. Balaguer and Cantavella-Jorda (2002) found that tourism cause economic growth in Spain. However, no reverse causality relationship is supported. Likewise, Dritsakis (2004) for Greece, as well as Brida et al. (2010) for Italy. On the other hand Katircioglu (2009a) supported the case for an economy-driven tourism in Cyprus. As far as the bidirectional causality between tourism and economic growth, Katircioglu (2009b) found that it is verified in Malta. In addition, Katircioglu (2009c) claimed that no causality relationship exists for the case of Turkey.

2.3. Tourism and Energy/Electricity Consumption

Kelly and Williams (2007) argued that the relationship between tourism and energy consumption has received little attention from academics. Lai set al. (2011) supported that tourism has a significant effect on energy consumption for the case of OECD countries. In addition Katircioglu (2014) found that tourist sector is an important contributor to energy consumption in Turkey. International tourist arrivals have increased significantly the long run energy use in the country. A similar study (Katircioglu et al., 2014) revealed a positive long run relation between tourist arrivals and the level of energy use in Cyprus. More recently, Pablo-Romero et al. (2019) examined the links between accommodations and electricity consumption for 12 Mediterranean regions of Spain. Authors stated that there exists a positive causal relationship between electricity depletion and tourist arrivals. They concluded that an increase in high star hotels causes a further increased in the electricity consumption. Finally, Shaheen et al. (2019) supported that there is a bidirectional causal relationship between energy requisition and tourist sector for the top 10 tourist countries in the world.

2.4. Tourism, Energy/Electricity Consumption and Economic Growth

In the literature, the economic impact of the tourism industry and the relationship between economic growth and the quality of the environment has been the subject of several studies. However, according to our knowledge, there are few studies that examine the relationship between these variables for a specific country. Yorucu and Mehmet (2015) found that an increase in economic growth, and in the number of foreign tourist arrivals influence significantly the electricity consumption in Turkey. In addition, Sghaier et al. (2019) supported that tourism growth has a negative effect on the equality of the environment for the case of Egypt. On the other hand, for the case of Tunisia and Morocco authors stated that there is a positive and a neutral effect respectively. Furthermore, Liu et al. (2019) stated that tourist receipts have no significant effect on environmental quality, while economic growth and energy consumption are the main determinants of CO_2 emissions in Pakistan. Finally, Gao et al. (2021) argued that tourism has a negative and significant effect on CO_2 emissions in the Southern Mediterranean countries.

3. THEORY AND MODELING

As noted in the previous section, there is an extensive literature on the determinants of energy consumption. Such methodology, on energy consumption and economic growth for Italy was implemented by Stamatiou and Dritsakis (2019). However, according to our knowledge, there are very few studies that link electricity consumption with tourism within a growth accounting framework. In this paper we use foreign tourist arrivals as an exogenous variable, independently enhancing economic growth and together influencing electricity consumption.

Following Yorucu and Mehmet (2015), we specify the function form as shown in the next equation:

$$EL_t = f(FTA_t, GDP_t) \quad (1)$$

where EL_t = electricity consummation, FTA_t = foreign tourist arrivals, GDP_t = economic output and t = the number of observations over time. The functional relationships in Equation (1) can be expressed in natural logarithms:

$$LEL_t = a + \beta_1 LFTA_t + \beta_2 LGDP_t + u_{it} \quad (2)$$

where LEL_t = the natural logarithm of electricity consummation, $LFTA_t$ = the natural logarithm of foreign tourist arrivals, $LGDP_t$ = the natural logarithm of economic output, β_1 = the estimated coefficient of FTA, β_2 = the estimated coefficient of GDP and u_t = the error term. The expected signs of estimated coefficients β_1 and β_2 are positive implying that foreign tourist arrivals and economic growth have a positive impact on electricity consumption growth in Italy.

Equation (1) may not captures how quickly the variables return to the long run equilibrium level. Therefore, we estimate the following error correction model (ECM) in order to capture the speed of adjustment among the short and long run equilibrium levels of electricity consumption:

$$\Delta LEL_t = a + \sum_{i=1}^{p} \beta_1 \Delta LEL_{t-i} + \sum_{i=0}^{q} \beta_2 \Delta LFTA_{t-i} + \sum_{i=0}^{c} \beta_3 \Delta LGDP_{t-i} + \beta_4 u_{t-1} + \varepsilon_t \quad (3)$$

Where Δ= the difference operator, μ_{t-1}= is the lagged error correction term (ECT_{t-1}) from equation (2). As indicated by Gujarati (2003) the coefficient of ECT_{t-1} should be negative and statistically significant (but see also in subsection 4.3).

4. DATA AND METHODOLOGY

4.1. Variables and Data

In order to gain valuable insights regarding the short and long run dynamics, as well as the causal relationships among electricity consumption, real GDP and foreign tourist arrivals in Italy, three variables are used in the functional form. The sample data of this study is from 1990-2018. The selection of sample is based on the availability of data. Data are gathered from several databases such as: the economic database World Development Indicators (WDI) of the World Bank (2021) (for real GDP data), Enerdata (2021) (for electricity consumption data) and CEIC Data (for international tourist arrivals data) and converted to natural logarithms. The description of all the variables is as follows:
EL: Electric power consumption (kwh per capita)
GDP: Gross domestic product (constant 2010 prices)
FTA: International tourism (number of arrivals).

4.2. Unit Root Tests

We selected Augmented Dickey-Fuller (ADF) (1981) and Phillips-Perron (PP) (1988) unit root approaches in order to test the integration order of the variables and the possible cointegration among them. PP test is applied as an alternative to ADF since it computes a residual variance robust to autocorrelation. In both tests, the null hypothesis is that the variable contains a unit root (i.e., it is not stationary).

4.3. ARDL Bounds Testing Approach

We continue by testing the long run relationships between the examined variables using the Autoregressive Distributed Lag (ARDL) approach which developed by Pesaran et al. (2001). ARDL methodology can be applied regardless of the order of integration of the variables (e.g. I(0) or I(1) or mixed). However, requires that no variables is integrated at second differences, which is I(2).

The ARDL method has a number of advantages over the conventional econometric techniques: (i) it is valid irrespective of whether the variables are purely integrated at level or first differences or mutually cointegrated, (ii) provides consistent empirical results for small data samples, (iii) allows simple interpretation due to its simple equation set up, (iv) unlike the traditional approach it is valid by using different number of lags for the variables, (v) provides effective results of long run parameters, (vi) eliminates the problems of autocorrelation and endogeneity, and (vi) a dynamic model (error correction model) can be derived from the ARDL methodology through a simple linear transformation.

The ARDL modeling approach involves the estimation of the next error correction model (ECM):

$$\Delta LEL_t = a + \beta_1 LEL_{t-1} + \beta_2 LGDP_{t-1} + \beta_3 LFTA_{t-1} + \sum_{i=1}^{p}\gamma_i \Delta LEL_{t-i} + \sum_{i=0}^{q}\delta_i \Delta LGDP_{t-i} + \sum_{i=0}^{c}\zeta_i \Delta LFTA_{t-i} + \varepsilon_{1t} \quad (4)$$

In equation (4) Δ is the difference operator, EL GDP and FTA are the variables of the study. The white noise error term ε_{1t} is serially independent with zero mean and finite cocariance matrix. The optimal lag length, p, q and c was selected by the minimum values of criteria AIC, SC and HQ.

Pesaran et al. (2001) propose the F test, for joint significance of the coefficients of the lagged level of variables, in order to examine the possibility of long run relationships in equation (4). Under the above equation, the null and the alternative hypotheses are:

H_0: $\gamma_i = \delta_i = \zeta_i = 0$ (no cointegration exists)

H_1: $\gamma_i \neq \delta_i \neq \zeta_i \neq 0$ (cointegration exists)

Pesaran et al. (2001) developed bounds critical values tables, for several cases (e.g. different number of variables), for the asymptotic distribution of the F-statistic. However, since our study is based on a small data sample we are based on the results with the critical values collected from Narayan (2005). Narayan (2005) critical values are more suitable for small samples.

Two sets of critical values for a given level significance are specified. The lower critical value obtained by supposing that all variables are integrated at levels. On the other hand, the upper critical value by supposing that all variables are integrated at first differences. In the case that the F-value exceeds the critical value of upper limit the null hypothesis of no cointegration is rejected. In addition, if the F-value is lower that the critical value of lower limit the null hypothesis of no cointegration is accepted. Finally, in the case that the F-value is between the lower and the upper limit the decision of cointegration is unclear and other approaches of cointegration should be applied.

Following Giles (2013) (but see also Rahman and Kashem, 2017), as a cross-check we should also perform a Bounds t-test of H_0: $\beta_1 = 0$ against H_1: $\beta_1 < 0$. If the t-statistic for EL_{t-1} in equation (4) exceeds the I(1) bound from Pesaran et al. (2001) table on pp. 303-304, this would support the conclusion that there exists cointegration among the variables. On the other hand, in the case that the t-statistic is less than the I(0) bound we would conclude that the data are all stationary.

As we mention before (in the advantages of ARDL model), a dynamic error correction model (ECM) can be derived through a simple linear transformation. The following ECM integrates the short run dynamic with the long run equilibrium, without losing long run information:

$$\Delta LEL_t = a + \sum_{i=1}^{p}\gamma_i \Delta LEL_{t-i} + \sum_{i=0}^{q}\delta_i \Delta LGDP_{t-i} + \sum_{i=0}^{c}\zeta_i \Delta LFTA_{t-i} + \lambda ECT_{t-1} + \varepsilon_t \quad (5)$$

where ECT_{t-1} is the error correction term. The coefficient of ECT_{t-1} should be negative and statistically significant, implying the long run causality. This coefficient (λ) indicates how quickly the variables return to the long run equilibrium (the speed of adjustment). The short run causality is shown by the coefficients δ and ζ (coefficients of explanatory variables).

4.4. Diagnostic Tests of the Model

One of the most important and crucial assumptions in the bounds testing approach is that the error terms of equation (4) have to be serially independent and normally distributed. So, the diagnostic tests of Jarque-Bera (normality), Breusch-Godfrey (serial correlation), ARCH (heteroscedasticity) and Ramsey (specification) are performed.

4.5. Testing Stability in ECM

The existence of cointegration does not necessarily imply the dynamic stability of the model. Pesaran et al. (2001) proposed checking the stability of the autoregressive model by using Brown et al. (1975) tests based on the cumulative sum of recursive residuals (CUSUM) and cumulative sum of recursive residuals of squares (CUSUMQ).

4.6. Granger Causality Test

The aim of this paper is to determine the causality relations between electricity consumption, economic output and foreign tourist arrivals for the case of Italy using data for the period 1990-2018. The existence of cointegration among the variables implies that there must be a causality relationship between them in at least one direction. On the other hand, the opposite does not exist (Giles, 2011). In addition, according to Granger (1969), even in the case that our variables are cointegrated we should to cross check the causality results. Granger (1969) stated that correlation does not confirm causation.

In this study we follow the Toda-Yamamoto (1995) causality approach for the determination of the direction of causality between the examined variables. This methodology: (i) provides efficient causality results regardless the condition of stationary or cointegration of the series, (ii) gives valid estimated parameters even the VAR model is not cointegrated, (iii) estimates a standard VAR model in the levels of the series (rather than in the first differences such as in Granger's technique) having as a result the elimination of the problems related with the possibility of the wrong specification of the integration order of the series, or the presence of a long run relationship among them, (iv) eliminates the distortion of the test's sizes as a result of pretesting, (v) generally improves the power of Granger causality technique.

Following Toda-Yamamoto (1995) the form of the general VAR model is shown below:

$$Y_t = \mu_0 + \sum_{i=1}^{k} a_{1i} Y_{t-i} + \sum_{j=k+1}^{d\max} a_{2j} Y_{t-j} + \sum_{i=1}^{k}\beta_{1i} X_{t-i} + \sum_{j=k+1}^{d\max}\beta_{2j} X_{t-j} + \varepsilon_{1t} \quad (6)$$

$$X_t = \varphi_0 + \sum_{i=1}^{k} \gamma_{1i} X_{t-i} + \sum_{j=k+1}^{d\max} \gamma_{2j} X_{t-j} + \sum_{i=1}^{k} \delta_{1i} Y_{t-i} + \sum_{j=k+1}^{d\max} \delta_{2j} Y_{t-j} + \varepsilon_{2t} \quad (7)$$

Where k is the appropriate lag order of the initial VAR model based on the usual information criteria such as AIC, SC, FPE, LR HQ, dmax is the maximum integration order in VAR model.

We apply Granger causality and Modified Wald (MWALD) techniques for the significance of parameters on the equations (6) and (7). In equation (6), X_t causes Y_t if $\beta_{1i} \neq 0$, for all i. Similarly, in equation (7), Y_t causes Xt if $\delta_{1i} \neq 0$ for all i.

5. EMPIRICAL RESULTS

5.1. Unit Root Analysis

The preliminary stage of the analysis is to define the integration order for each time series. As confirmed by both ADF and PP test (proposed by Dickey and Fuller (1979) and Phillips and Perron (1988) respectively), EL variable is stationary in levels with trend, which means that EL is integrated I(0). On the other hand, FTA and GDP variables are found to be non stationary in levels with or without trend, while they turned to be stationary in first differences. This means that FTA and GDP variables are integrated I(1). Table 1 presents the ADF and PP stationary test results.

5.2. ARDL Cointegration Analysis

The mix order of integration of the variables justifies using the ARDL bounds methodology of cointegration. As required by the ARDL modeling approach the results of ADF and PP unit root tests reveal that no variable is I(2).

The Akaike Information Criterion (AIC) has been used in order to select the optimal lag length of the model. AIC showed that the optimal lag length of the variables EL, GDP and GDP are: p=4, q=3, c=3 respectively. Therefore the selected ARDL model is (4, 3, 3).

Table 1: Unit root testing

Var.	ADF		P-P	
	C	C, T	C	C, T
LEL	−1.94 (1)	−3.12 (0)**	1.94[2]	−3.12[4]**
ΔLEL	−1.31 (0)	−3.83 (2)**	−3.44[2]**	−3.33[2]*
LFTA	−0.72 (0)	−2.91 (1)	−0.52[5]	−2.28[2]
ΔLFTA	−4.02 (1)***	−3.86 (1)**	−4.56[7]***	−5.10[8]***
LGDP	−0.95 (0)	−2.02 (1)	−1.00[1]	−1.43[1]
ΔLGDP	−3.21 (0)**	−3.09 (0)	−3.25[1]**	−3.14[1]

***, ** and * show significant at 1%, 5% and 10% levels respectively. The numbers within parentheses followed by ADF statistics represent the lag length of the dependent variable used to obtain white noise residuals. The lag lengths for ADF equation were selected using SIC. Mackinnon critical value for rejection of hypothesis of unit root applied. The numbers within brackets followed by PP statistics represent the bandwidth selected based on Newey West (1994) method using Bartlett Kernel. C=Constant, T=Trend.

For k = 2 (number of independent variables) the relevant critical bound values with unrestricted intercept and no trend derived from table on p. 1990 of Narayan (2005) are given below. Table 2 summarizes the bound test results suggested by Pesaran et al. (2001). The associated F-statistic of ARDL bounds testing is 14.33% confirming the existence of long run relationship among the series (F value exceeds upper critical bounds at 1% significance level). The ARDL model fulfills the assumptions of normality, autoregressive conditional heteroscedasticity (ARCH), functional forms and serial correlation of models.

Furthermore, the t-statistic for LEL_{t-1} in equation (4) is −4.34. Based on critical values tabulated by Pesaran et al. (2001; pp. 303-304) we see that that the I(0) and I(1) bounds for the t-statistic at 1%, 5% and 10% significant levels are [−3.96, −4.53], [−3.41, −3.95] and [−3.13, −3.63] respectively. So, following Giles (2013) cross checking for cointegration, we conclude that there is long run relationship among the variables at 5% level of significance.

Table 3 presents the results of long run relationship between the variables estimated using the ARDL (4, 3, 3) model.

From the results of the Table 3 we can see that the coefficients are significant for the variables GDP and FTA. This indicates that economic growth and foreign tourist arrivals have positive impacts on electricity consumption in the long run, which is confirmed by the signs and statistical significance on the respective coefficients in the above table.

The following OLS equation is tested in order to explore the short run dynamics in ARDL (4, 3, 3) framework. The results are given in the next Table 4.

We conclude that there are short run dynamics in conjunction with the long run relationships. The lagged error correction term ECT_{t-1} (CointEq(-1)) is negative and statistically significant (even at 1% level) which implies a long run relationship between the examined variables in the model. In addition the value of ECT coefficient is 0.93 which means that in the short term the deviations from the long run equilibrium are adjusted by 93 % every year.

Lag periods of GDP and FTA have positive and significant impact on electricity consumption in the short run. This is confirmed by the sign and statistical significance of the coefficients of its current, first, second, third and fourth lagged values in the first differences of GDP and FTA.

5.3. Stability of the Model

The existence long run relationship among the variables does not necessarily imply that the estimated coefficients are stable. Therefore, Pesaran et al. (2001) proposed testing the stability of estimated coefficients in estimated models using cumulative sum (CUSUM) and as cumulative sum of squares (CUSUMSQ) (Brown et al., (1975) tests). The graphs of these tests are presented in Figure 1.

Figure 1: Plots of CUSMU and CUSUMQ

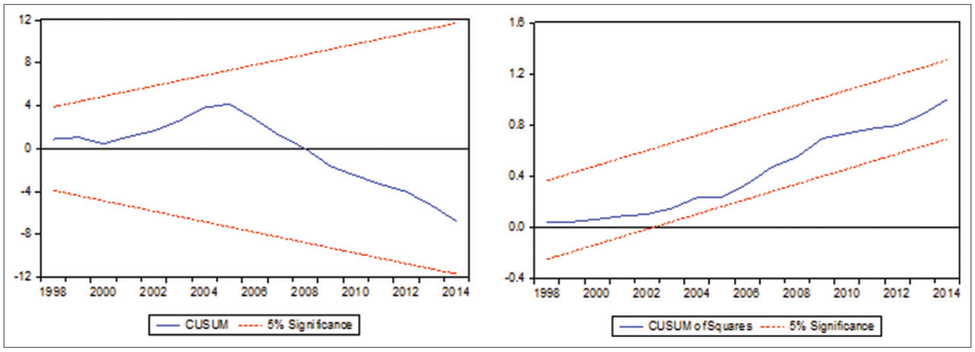

Table 2: The Results of ARDL Cointegration Test

Bounds testing to cointegration			Diagnostic tests			
Estimated model	**Optimal lag**	**F-stat.**	**Prob. NOR**	**Prob. ARCH**	**Prob. RESET**	**Prob. SERIAL**
F^{LEL} (LEL/LGDP, LFTA)	(4,3,3)	14.33***	0.787	0.068	0.840	0.110
Significant level			**Lower bounds**		**Upper bounds**	
			***I* (0)**		***I* (1)**	
1% level			7.97		9.41	
5% level			5.55		6.74	
10% level			4.57		5.60	

The optimal lag length is determined by AIC. Critical values are from Narayan (2005). Narayan (2005) critical values are more suitable for small samples. ***shows significant at 1% level. Serial for LM serial correlation test, ARCH for autoregressive conditional heteroscedasticity, White for white heteroscedasticity and Reset for Ramsey Reset test.

Table 3: Long run coefficients using ARDL approach

Dependent variable = LEL			
Long run analysis			
Variable	**Coefficient**	**T-statistic**	**Prob.**
LEN_{t-1}	0.002635	0.012428	0.9909
LEN_{t-2}	−0.514767	−1.852574	0.1610
LEN_{t-3}	−0.453471	−1.924024	0.1500
LEN_{t-4}	1.534649	1.631112	0.2014
$LGDP_{t}$	0.215284	2.992798	0.0580*
$LGDP_{t-1}$	0.394710	−4.288563	0.0233**
$LGDP_{t-2}$	0.342363	3.206716	0.0491**
$LGDP_{t-3}$	0.410229	−3.040384	0.0559*
$LFTA_{t}$	0.399532	2.620508	0.0790*
$LFTA_{t-1}$	0.312545	−2.371052	0.0984*
$LFTA_{t-2}$	0.240698	5.383441	0.0126**
$LFTA_{t-3}$	0.447994	−3.355841	0.0439**
C	6.005068	2.308513	0.1042
R-Squared		0.98	
F-Statistic		24.45	

** and * show significant at 5% and 10% levels respectively.

Table 4: Short run coefficients using ARDL approach

Dependent variable = ΔEL			
Long run analysis			
Variable	**Coefficient**	**T-statistic**	**Prob.**
ΔLEN_{t-1}	0.566411	0.849591	0.4580
ΔLEN_{t-2}	−1.081178	−0.802947	0.4807
ΔLEN_{t-3}	−1.534649	2.308513	0.1042
ΔLEN_{t-4}	0.947387	2.196831	0.1155
$\Delta LGDP_{t}$	0.215284	2.992798	0.0580*
$\Delta LGDP_{t-1}$	0.067866	−2.842048	0.0655*
$\Delta LGDP_{t-2}$	0.410229	3.040384	0.0559*
$\Delta LGDP_{t-3}$	0.279169	−3.778071	0.0325**
$\Delta LFTA_{t}$	0.399532	−5.383441	0.0126**
$\Delta LFTA_{t-1}$	0.207296	2.322463	0.0592*
$\Delta LFTA_{t-2}$	0.447994	3.355841	0.0439**
$\Delta LFTA_{t-3}$	0.573824	2.620508	0.0790*
C	6.005068	2.072112	0.1300
$LGDP_{t-1}$	0.247292	−3.371246	0.0434**
$LFTA_{t-1}$	0.120309	2.419317	0.0270**
LEN_{t-1}	0.430954	3.122158	0.0062***
CointEq(-1)	−0.930055	−10.710040	0.0017***

***, ** and * show significant at 1%, 5% and 10% levels respectively.

As can be seen from the above figure, the plots of both tests remain within the 5% critical bound which implies the parameter constancy and model stability. In addition, the results show that there is no systematic change identified in the coefficients at 5% significance level during the study period.

5.4. Toda-Yamamoto Causality Test

As we found that long run relationship exists between the electricity consumption, tourism and economic growth we continue with the determination of the causality between the variables. The next table presents the results of Toda and Yamamoto (1995) procedure within an augmented VAR model.

The results of Table 5 provide evidence of two unidirectional causalities running from real GDP and foreign tourist arrivals to electricity consumption at 5% level of significance. The findings also support the existence of a unidirectional causality between foreign tourist arrivals and real GDP, with direction from foreign tourist arrivals to real GDP at 10% level of significance (but see also Figure 2). Therefore, we may conclude that the growth in foreign tourist arrivals and real GDP are the reasons for electricity consumption in Italy. In addition, we see that foreign tourist arrivals are catalysts for the economic growth of the country. The results of Table 5 support the tourism-led

Figure 2: Causal Channels

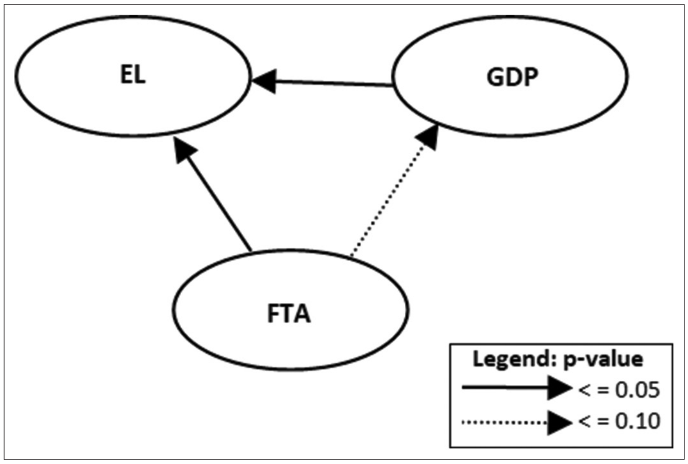

Table 5: Results of toda and yamamoto causality test

Dependent variables	MWALD Test			Causality inference
	LEL_t	$LGDP_t$	$LFTA_t$	
LEL_t		7.773 (0.020)**	6.727 (0.034)**	$LGDP_t \rightarrow LEL_t$ $LFTA_t \rightarrow LEL_t$
$LGDP_t$	0.274 (0.872)		7.728 (0.052)*	$LFTA_t \rightarrow LGDP_t$
$LFTA_t$	2.031 (0.362)	0.341 (0.843)		No Causality

** and * show significant at 5% and 1% level respectively, p values in parentheses.

growth hypothesis, while reject the energy-led growth hypothesis in Italy. The knowledge about the direction of causality will help policy makers to develop a proper economic policy for sustainable growth.

6. CONCLUSION AND POLICY IMPLICATIONS

This paper investigates the relationship among foreign tourist arrivals, electricity consumption and economic growth in the case of Italy, using data covering the period 1990-2018. The study examines the long-run equilibrium of electricity consumption in Italy, within an open economy model explicitly featuring the relationship between tourism expansion and economic growth.

We have applied the ARDL bounds testing approach to explore the cointegration, unrestricted error correction model for the short and long run dynamics, as well as the Toda-Yamamoto (1995) procedure for Granger causality using a standard VAR model in the levels of the variables.

The ARDL results, as well as additional cross checking test suggest that there is a strong evidence of cointegration among the examined variables, which indicates that the there is long run equilibrium relationship between foreign tourist arrivals, electricity consumption and economic growth. For the short run effects, the estimated coefficients of economic growth and foreign tourist arrivals are shown to be statically significant. In addition, the estimated model fulfils all the diagnostics tests and is also found to be stable.

Furthermore, the Granger causality test reveals the existence of two unidirectional causalities running from foreign tourist arrivals and economic growth toward electricity consumption, as well as a unidirectional causality relation running from foreign tourist arrivals to economic growth. Tourist flows (both directly and indirectly through real GDP) are a key determinant for electricity consumption in Italy.

The empirical results of the study support the tourism-led growth hypothesis. This means that tourism sector is a catalyst for higher growth rates in Italy. So, the country's policy makers should give more emphasis on improving the tourism industry. The key factors of enhancing the tourist related infrastructures include better transportation and accommodation. In addition, the higher education institutions could also play an important role in attracting more and larger incoming tourist though the organization of more international conferences and educational programs (Tang et al. 2016).

The findings of the study also reveal that the energy-led growth hypothesis is rejected. Italy turns to be not an energy dependent economy meaning that policymakers could implement an energy conservation policy in order to reduce environmental costs without any negative effects on the process of economic development. Regulatory policies are necessary to put in place in order to increase the share of renewable energy sources. The results of the paper are in line with these of Stamatiou and Dritsakis (2019) who argued that Italy should displace the energy use from carbon to alternative renewable energy sources even more rapidly. Authors concluded that more concentration should be given in alternative energy sources in electricity consumption such as solar, wind and wave.

Policy makers should implement a certain number of measures targeting at ensuring sustainable financing of the energy transition, by mobilizing existing financial tools and developing new ones. Tax and regulatory measures should also be considered to ensure the energy transition. (Menyari, 2021). Clean energy technologies, in combination with proper environmental laws and policies and auditing legislation are the targetable future for Italy, since they encourage existing and new investors to switch in efficient energy sources. The adoption of energy clean technologies in tourism sector is necessary. More and bigger environmentally friendly projects related to the tourism sector should be sponsored by the Italian government in combination with the European Union (EU). For example, bicycle oriented tourism could be adopted in replacement of the environmentally unfriendly transports (Dogan and Aslan, 2017).

Although the results of the analysis are of immense importance to public authorities, they represent some limitations, which we should address and extend for future research. This paper uses international tourist arrivals as an indicator of tourism sector. A favorable way to extend the study is to use other tourism indicators such as tourism receipts and tourism foreign direct invetsmnets (FDI) and then to check if the results obtained are robust. In addition, the present study examines the relationship between electric consumption, tourist arrival and economic growth in a single country (Italy). However, future research should study the same model on a panel of countries (e.g. the most populous European Union countries, regarding the growth of energy demand and/or international tourism receipts and arrivals).

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