



## **TOURISM AND HOSPITALITY SECTOR ELECTRICITY USE: EVIDENCES FROM 12 EU COUNTRIES**

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### **Abstract:**

At the Paris Conference of the Parties (COP21) in 2015, 195 countries agreed to strengthen the global response to the threat of climate change. Along this line, the EU is committed to a 40% reduction in their domestic greenhouse gas emissions by 2030. This new target represents a significant progression beyond its existing 20% emission reduction commitment by 2020. Thus, greater efforts will be needed affecting all productive sectors in order to reduce CO<sub>2</sub> emissions and energy consumption.

In order to reach this ambitious target, new measures affecting all economic sectors would be needed. This paper focuses on the tourism sector. This aim of this study is to investigate the relationships between tourist overnight stays and the hospitality sector electricity consumption. These relationships are studied for 12 EU countries during the period 2005-2012, accordingly with the available data. With this aim, econometric panel data techniques are used in order to estimate an electricity consumption function for the hospitality sector which depends on tourism, income, price and climate variables.



The Environmental Kuznets Curve hypothesis is also tested. An Energy-tourism Kuznets Curve would show that increasing earnings from tourism will bring about reduced electricity consumption from a threshold point, which could be related to the fact that more earnings could imply undertaking more energy efficiency measures.

**Keywords:** Tourism growth, electricity consumption, hospitality sector, EU countries, Environmental Kuznets Curve, panel data.

**JEL codes:** C23, O13, O44, Q01, Z23



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### **1. Introduction**

At the Paris Conference of the Parties (COP21) in 2015 195 countries agreed to strengthen the global response to the threat of climate change. Along this line, the EU is committed to a 40% reduction in their domestic greenhouse gas emissions by 2030 (United Nations,2015). This new target represents a significant progression beyond its existing 20% emission reduction commitment by 2020. Thus, greater efforts will be needed affecting all productive sectors in order to reduce CO2 emissions and energy consumption.

In order to reach this ambitious target, new measures affecting all economic sectors would be needed. This paper focuses on the tourism sector. This aim of this study is to investigate the relationships between tourist overnight stays and the hotels& restaurants electricity consumption. These relationships are studied for 12 EU countries during the period 2005-2012, accordingly with the available data. With this aim, econometric panel data techniques are used in order to estimate an electricity consumption function for the hotels & restaurants sector which depends on tourism, income, price and climate variables. This study is limited to analyzing a part of the energy consumption generated by tourism, since it does not include, among others, the energy consumption associated with the trips of the tourists, nor the possible electricity consumption caused by the tourists in economic sectors other than accommodation and food and beverages.

The Environmental Kuznets Curve hypothesis is also tested. An Energy-tourism Kuznets Curve would show that increasing earnings from tourism would bring about reduced electricity consumption from a threshold point, which could be related to the fact that more earnings could imply undertaking more energy efficiency measures.

### **2. Data**

This study covers the 12 European countries and the time period from 2005 to 2012, depending on the Hotels & Restaurants electricity consumption availability data. The European countries for which there are available data are the following: Croatia, Cyprus, Denmark, France, Germany, Italy, Malta, Netherlands, Portugal, Spain, Sweden, United Kingdom.



Hotels & Restaurants electricity consumption data came from the Odyssee Energy Efficiency Database published by Enerdata. This database offers information about energy consumption by sectors. The energy consumption of the service sector is divided into 8 branches, being one of them Hotel & Restaurant which corresponds to Section I of the International Standard Industrial Classification (ISIC) of economic activities. It covers electricity consumption in the provision of short-stay accommodation for visitors and other travelers and the provision of complete meals and drinks fit for immediate consumption. In this study, figures are expressed in natural logs of thousand tons of oil equivalents (ktoe) per thousand inhabitants, with the population data coming also from the same database.

Tourism data came from the Eurostat database. In this study, total overnight stays are considered as a measure of tourism, therefore is measured as nights spent at tourist accommodation establishments, which include hotels, holiday and other short-stay accommodation, camping grounds, recreational vehicle parks and trailer parks. Total overnight have been used before as a proxy to measure tourism as in the studies by Cortés-Jiménez and Pulina (2019) and Gómez-Calero et al. (2014), and more recently in the study by Pablo-Romero et al. (2017a). Figures are expressed in overnight stays per inhabitants in natural logs.

In addition, to properly estimate the relationships between hotels & restaurants electricity consumption and tourism some other variables have also been taken into account. GDP per capita by country has been considered as a measure of per capita income as in Pablo-Romero et al (2017a). These data came also from the Odyssee database. Figures are expressed in thousands of 2005 constant Euros per inhabitants in natural logs.

Moreover a climate variable has been considered in order to take into account possible differences in energy consumption associated to differences in climate conditions. In this sense, recent studies relating electricity consumption with GDP include some kind of climate variables as controls For example, Lee and Chiu (2011) use average temperature. Nevertheless, more recent studies tend to use heating and cooling degree days (HDD and CDD, respectively), as in Fan and Hyndman (2011), Serrano et al. (2017) and Mohammadi, H., & Ram, R. (2017) for instance. In this study, only HDD have been considered as CDD is not available for the studied period. The HDD is measured as the difference between the daily temperature mean- $T_m$ -(high temperature plus low temperature divided by two) and  $18^{\circ}\text{C}$ , being zero if  $T_m$  is greater than  $15^{\circ}\text{C}$ . These values are sum in order to obtain the annual HDD. Data come from the Odyssee database. Figures are expressed in Celsius degrees.



Finally, electricity prices have been also considered. Some previous studies have been including the energy prices when estimating electricity demand functions, for example for households, as in Silva et al (2017) or transport energy functions as in Pablo-Romero et al (2017) for European countries. Following this last study, Eurostat database energy price data have been considered. Prices are expressed as the annual rate of change in electricity, gas, solid fuels and heat energy in harmonized consumer price indices, which is analogous to logarithm differences of the indices' values. No more detailed prices are available.

### 3. Model

Following the previous study referring to the relationships between tourism and the hospitality sector electricity consumption (Pablo-Romero et al. 2017a), the starting point of the modeling setting in this study is that hotels & restaurants electricity consumption may be conditioned by tourism, but also by other factors. Therefore, following Pablo-Romero et al. (2017), the general specification model for testing the influence of tourism on the hotels & restaurants electricity consumption may be expressed as follows:

$$E_{it} = A_{it} + \beta_1 Y_{it} + \beta_3 T_{it} + \beta_4 T_{it}^2 + \beta_5 tem_{it} + e_{it} \quad (1)$$

where E is the Hotels & Restaurants electricity consumption in per capita terms expressed in logarithms, Y is the GDP per capita expressed in logarithms, T is the variable representing the country tourism, expressed in night stays in at tourist accommodation establishments in per capita terms, also expressed in logarithms, tem is the temperature variable measure in terms of HDD, also in logarithms terms, A represents the sum of the time effect and country effect and i and t denote each one on the European countries considered in the study and years from 2005 to 2012, respectively. Finally, e is a random error term.

GDP is included in the model in order to take into account the effect of restaurants services demand performed by residents. In that sense, it may be expected that greater demand for restaurant services may affect the electricity consumption of the sector, which may be related to the residents' income. Likewise, the temperature has been included in the model as in, for example as in Fan and Hyndman (2011), Serrano et al. (2017) and Mohammadi, H., & Ram, R. (2017). These measures are used to take into account that energy consumption depends strongly on weather conditions. If the temperatures are low, more energy is consumed for heating, while if temperatures are high more energy is also consumed for cooling.

Finally, The squared value of Tourism is initially included in the model, as in Pablo-Romero et al. (2017), in order to test if the electricity consumptions tend to vary when the tourism level change. Nevertheless, when including also squared variables in the in the estimated functions, multicollinearity among these explanatory variables may appear (Narayan and Narayan (2010). The second column in Table 1 shows that multicollinearity exists among T and T2. In that sense, according to previous studies (Pablo-Romero and Sánchez-Braza, 2015), the values of the variance inflation factors (VIF) for each variable should not exceed the value of 5, or at least 10; being much higher for these variables. In order to mitigate this problem, the data were converted to deviations from the geometric mean of the sample, being the multicollinearity problem ruled out. The third column in Table 2 shows that any VIF value for the transformed variables exceed the value of 5.

**Table 1**

Variance inflation factors.

Variables	VIF (variables)	VIF (deviations from the geometric mean)
Y	1.83	1.83
T	2387.31	4.10
T <sup>2</sup>	2431.43	3.51
tem	3.93	3.93
Mean VIF	1206.13	3.34

In order to correctly estimate the equation (1), the stochastic nature of the variables was analyzed. Firstly, in order to determinate if it is convenient to use second generation panel unit root, cross-section dependence in the data was tested by using the Pesaran CD test (Pesaran, 2004), under the null hypothesis of cross-section independence,. As shown in Table 2, the null hypothesis is rejected in all cases, except for the tourism squared variable. Therefore second generation panel data are used to investigate the presence of unit roots in all variables, except for this one.

**Table 2**

Panel cross-section dependence tests.

Variables	CD test
E	8.88***
Y	8.55***
T	5.33***
T <sup>2</sup>	0.26***
tem	10.40***

Note: \*\*\* denotes significance at the 1% level

Table 3 shows the results of applying the CIPS test proposed by Pesaran (2007) which capture the cross-sectional dependence that arises through a single-factor model, for E, Y, T and tem variables. In addition, Table 4 shows the results of applying the Maddala and Wu (1999) test (MW) which assumes cross-section independence, for T<sup>2</sup> variable. Both tests consider the null hypothesis of non-stationarity. The results show that variables are I(1), as they are stationary in first differences and non-stationary in levels, when considering intercept and trend.

**Table 3**

Unit root test

Variables	Test	Level	First Differences
		Intercept and trend	Intercept and trend
E	CIPS	-2.750	-2.567**
Y	CIPS	-1.906	-3.170**
T	CIPS	-1.294	-2.969**
T <sup>2</sup>	MW	8.530	70.264***
tem	CIPS	-2.412	-2.253**

Note: *t*-bar statistics \*\*\* denotes significance at the 1% level and \*\* at the 5% level. Lags included in each individual regression calculated with an iterative process from 0 to 2 based on F joint test.

Table 4 shows the computed values of the Westerlund co-integration tests (2007) which examine the existence of a structural long-run relationship among the series. The null hypothesis of these tests is no co-integration. The advantage of these tests is that can

accommodate the cross-sectional dependence in the series through bootstrapping. In this study, 100 replications were made. The test results show that the null hypothesis of no co-integration cannot be rejected for any of the four statistics. Thus, the model may be estimated by using first differences.

**Table 4**

Westerlund co-integration tests.

Dependent variable	Independent variables	Cointegration tests			
		Gt	Ga	Pt	Ga
E	Y, T, T <sup>2</sup>	5.100	3.677	3.506	1.781

Note: Test regression fitted with constant and trend. Kernel bandwidth set according to the rule  $4(T/100)^{2/9}$ . The  $p$ -values are for a one-sided test based on 100 bootstrap replications.

Using  $\Delta$  to indicate the first differences and a topline over variables to indicate that variables have been converted to deviations from the geometric mean of the sample, equation (1) may be rewritten as follows,

$$\Delta \bar{E}_{it} = \Delta \bar{A}_{it} + \beta_1 \Delta_1 \bar{Y}_{it} + \beta_2 \Delta \bar{T}_{it} + \beta_3 \Delta \bar{T}_{it}^2 + \beta_4 \Delta \overline{tem}_{it} + e_{it} \quad (2)$$

Where  $\Delta \bar{A}_{it} = \delta_t + \alpha_i$

Due to the price variable is expressed in annual rate of change and variables in equation 2 are in logs and first differences, which are analogous, it is possible to incorporate the price variable to the model to test its effect to the electricity consumption. Therefore, the new equation to be estimated is now expressed as

$$\Delta \bar{E}_{it} = \delta_t + \alpha_i + \beta_1 \Delta_1 \bar{Y}_{it} + \beta_2 \Delta \bar{T}_{it} + \beta_3 \Delta \bar{T}_{it}^2 + \beta_4 \Delta \overline{tem}_{it} + \beta_4 P_{it} + e_{it} \quad (3)$$

where P is the annual rate of change of price.

In order to properly estimate this model, the Wooldridge test for autocorrelation (2002) (under the null hypothesis of no first-order autocorrelation) and the Wald test for homoscedasticity (Greene, 2002) (under the null hypothesis of homoscedasticity) were also performed. Table 5 shows the presence of serial correlation and heteroscedasticity, therefore the feasible generalized least squares model (FGLS) was used to estimate the complete equation (3).



**Table 5**

Autocorrelation and Homocedasticity test

Wooldridge test	Wald test
55.413***	2056.45***

Note: \*\*\* denotes significance at the 1% level

Once the equation (3) is estimated, the  $\beta$  coefficients obtained may inform about the relationships between the electricity and the tourism variable. If  $\beta_2$  is positive and significant, tourism affects positively to hotels & restaurants energy consumption. Additionally, if  $\beta_3$  coefficient is also positive an increasing relationship exists between both variables. However, if this value is negative, an decreasing relationship exists between both variables and the Energy-tourism Kuznets Curve hypothesis may be supported.

**4. Results and discussion**

Table 6 shows the results of estimating Equation (3), for 12 European countries in the period 2005 to 2012, by using the FGLS model. The second column shows the estimate results when only T and T2 are taken into account. The following columns show the estimate results when P, HDD and Y variables are added to the model. Finally, the last columns show the estimate results when the T2 variable is excluded.

The results show that coefficients associated with the T in all estimates are positive and significant, being their values decreasing as the other variables are introduced in the model and when the squared value is eliminated. Therefore, the hotels & restaurants electricity consumption per capita elasticity with respect to tourism per capita is positive in the central point of the sample, meaning that tourist night stays increases tend to raise the electricity consumption in the hotels & restaurants sector.

**Table 6**

Estimate results of equation (3)

	FGLS (a)	FGLS (b)	FGLS (c)	FGLS (d)	FGLS (e)
T	0.046*** (0.013)	0.046*** (0.013)	0.044*** (0.014)	0.025** (0.012)	0.017** (0.009)
T <sup>2</sup>	-0.016*** (0.007)	-0.018*** (0.006)	-0.011 (0.008)	-0.002 (0.004)	-
P	-	0.00001** (0.000)	0.00001** (0.000)	0.00001** (0.000)	0.00001** (0.000)
Tem	-	-	0.006** (0.002)	0.006*** (0.002)	0.006*** (0.002)
Y	-	-	-	0.056*** (0.022)	0.057** (0.022)

Note: Standard errors are shown in parenthesis, \*\*\* denotes significance at the 1% level and \*\* at the 5% level All estimates include time and individual dummies.

The results show that coefficients associated with the T in all estimates are positive and significant, being their values decreasing as the other variables are introduced in the model and when the squared value is eliminated. Therefore, the hotels & restaurants electricity consumption per capita elasticity with respect to tourism per capita is positive in the central point of the sample, meaning that tourist night stays increases tend to raise the electricity consumption in the hotels & restaurants sector.

However, the values of the T2 coefficients are negative and significant in the two first estimates. In those cases, the, although the energy consumption elasticity is positive respect to tourism, the elasticity value tends to decrease as the tourist nights stays grow. Therefore, for an tourist stays level, the electricity consumption in the hotels & restaurants sector would decrease. Nevertheless, it may be also highlighted that the estimates results presented in Columns c and d show that although T2 coefficients are negative, there are non-significant. Therefore, the existence of this decreasing relationship is weak. Thus, when removing T2 the other coefficient estimate values do not noticeable change, except for variable T, which reduce its value. In that sense, the results do not support the Energy-tourism Kuznets Curve hypothesis, but neither an increasing relationships between the variables is observed. Only, a linear relationship between variables is confirmed. Therefore, if tourism tends to grow, the electricity consumption will also grow. Therefore, some energy policy measures will be needed in



order to control these increases in electricity use. In this regard, energy efficiency measures are recommended.

The results also show that all the controls variables included in the model are significant and positive. Firstly, the price variable coefficients show positive values. However, these values are close to zero, indicating that energy prices do not affect the electricity consumption in the sector. Prices often do not seem to have effect to electricity consumption in previous estimates related to household's behavior, especially for high-level income. Thus, if hotels & restaurants services demand were associated with higher income-level, energy policies focusing on prices would not be a good option to disincentive electricity consumption. Nevertheless, these estimate results should be interpreted with caution, because the price data available used in this study refer not only to electricity, but also to gas, solid fuels and heat energy.

Secondly, temperature coefficients are also positive and significant. Thus, lower temperatures tends to increase electricity consumption, especially for heating, in hotels & restaurant. In that regard, the changing of the temperatures through this period is significant to affect the electricity use. It is worth noting that perhaps higher temperatures would have more effect on electricity consumption than lower ones, due to spaces cooling needs; being especially relevant for south European countries. In that sense, it is desirable to elaborate CDD series for European countries, which at date are not available.

Finally, estimated coefficients for income also show positive and significant values. Therefore, as income grows, also the electricity consumption in the studied sector does. In that sense, the economic growth raise will induce the electricity consumption. Therefore, energy efficiency measures are needed to control the electricity increase in the sector.

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