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Macro Modelling of Electricity Price Towards SDG7

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ABSTRACT
Energy is a very important issue to achieve Sustainable Development. Energy availability and affordability are key aspects for ending poverty and giving access to base commodities. In addition our daily lifes rely on electric appliances and gadgets to perform inumerous tasks so electricity price is a crucial issue due to its economic, environmental and social impacts. In this work it was studied the correlation of electricity price with the electricity mix from the several sources, GDP, energy productivity, electricity consumption per capita, fossil fuel reserves, and diesel price using Spearman correlation. The Kruskal-Wallis test was then applied considering the significant correlations and the macro variables that presented statistically significant differences were used to model electricity price. The logarithmic and linear model based on energy productivity to predict electricity price were the best models. The models were applied to the data and the average deviation was 10.3% and 11.7% which is satisfactory. Millions of people in the World are affected by electricity price and it is important to have models to predict electricity price to help in the decision-making process and in management.

Keywords: Energy; Electricity price; Sustainable Development Goals; Regression models

1. INTRODUCTION
Depletion of natural resources and pollution problems are major concerns that are linked to a rising World population and unsustainable consumption patterns. Humanity demand for resources and services in a given year exceeds Earth capacity of regeneration. For many countries the Earth Overshoot Day day falls already in the first six months of the year [1]. The Sustainable Development (SD) requires a new paradigm that is living well within the limits of Earth. The Sustainable Development Goals (SDG) adopted by the United Nations in 2015 are a measure to achieve several global aims [2]. SDG are very important and have been addressed by several authors [3]. The seventh SDG (SDG7) is related to affordable and clean energy since this is fundamental to have a good quality of life. An effort is being made to increase the share of renewables and there are many studies that address that subject [4,5,6] and the second target of SDG7 reflects this concern since it aims to increase substantially the share of renewable energy by 2020. The third and last target of SDG7 intends to double the rate of improvement in energy efficiency by 2030. Electricity is a form of energy that is fundamental in daily life because of the rising number of appliances and gadgets. Thus, in this work it was studied the relation between electricity price and some macro variables such as GDP, energy productivity, electricity consumption per capita, etc. It was used correlation analysis to find significant correlations, Kruskall-Walis test to analyse the effect of variables on electricity price, and linear and nonlinear regression to study models that can be used to predict electricity price. The existence of simple models that can predict the electricity price with more global scale can be very relevant to politicians and decision makers.

2. METHODS
The first step was to select variables that could potentially affect electricity price, specificaly: percentage of electricity produced from fossil fuels (FF), percentage of electricity produced from renewable sources (R), percentage of electricity produced from nuclear (N), gross domestic product (GDP), energy productivity (EnP), consumption of electricity per capita (CEC), fossil fuel reserves (FFR) and diesel price (DP). To assess the relationship between variables, different methods can be used. Spearman's correlation was used since it does not require a normal distribution being a nonparametric method. To assess normality the Shapiro-Wilk test was used in all data sets. The Kruskal-Wallis nonparametric test was then applied to the variables that present a significant correlation either positive or negative with electricity price as a confirmation process to determine if there were statistically differences between groups of a categorical independent variable on a continuous dependent variable. Finally, linear regression and nonlinear regression was applied to study possible models to predict electricity price. The Software used was SPSS Statistics 26.

3. RESULTS AND DISCUSSION

After applying Spearman's correlation it was possible to conclude that there are four significant correlations between electricity price (EP) and some of the macro variables namely with GDP, energy productivity (EnP), Consumption of electricity per capita (CEC) and diesel price (DP), all of them positive, which means the higher the value of the variables the higher the price of electricity.

The Kruskal-Wallis test was then applied considering these variables and for each variable 3 groups were considered. With this methodology it was found that only energy productivity, consumption of electricity per capita and diesel price present significant results since the p value is less than 0.05. This means that there is evidence that there is a significant difference between the electricity price across the three groups of each variable. These three variables were then used in linear and nonlinear regression in 21 models analysing the sum of squares of residuals, the R square and the corresponding coefficients. The best models found to predict electricity price were logarithmic and linear model of energy productivity. Applying the models the average deviation was 10.3% and 11.7% which is satisfactory.

4. CONCLUSION

European countries present still many differences in many important aspects. Electricity is produced using different sources, with a few countries having almost all electricity production based on renewables and the others on fossil fuels. The consumption of electricity per capita is also different and only a few countries present high GDP and most countries need to improve energy productivity. Most European countries do not own fossil fuel reserves [7] and at last, but not the least electricity price that varies substantially across European countries.

In this work several variables that can potentially affect electricity price were selected and a correlation analysis was performed. GDP, EnP, CEC and DP presented positive significant correlations with electricity price. Afterwards, a Kruskal-Wallis test was applied to these variables and it was possible to conclude that EnP, CEC and DP present significant differences and GDP does not. These three variables were then used in linear and nonlinear regression applied to 21 models. The best models were logarithmic and linear model of energy productivity to predict electricity price. Applying the models to the data, the average deviation was 10.3% and 11.7% which is reasonable.

It is relevant to analyse correlations between variables such as energy productivity, GDP, etc. and electricity price and to have good models to help in the decision-making process and in management.

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