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A comparison between Turkey and other countries of electricity consumption characteristics of structure and energy density

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Abstract
The aim of this paper is to investigate the relation between Turkey's electricity consumption and other countries' electricity consumption that has similar characteristic features with Turkey. This study is also discussed between the electricity consumption modeling of Turkey and the other countries for this purpose, the results was analyzed as similarity linear by collecting datas between the years of 1971-2016 by the MATLAB program. According to the results, it was examined whether or not R^2value is close to zero or close to one by obtaining the coefficient of determination of linear regression model. The measure of goodness of fit was performed according to the R^2value. Data and graphs were drawn as the results obtained with the Excel program. The data and graphs were drawn by considering results obtained with the Excel program. The equation of linear regression was created with the resulting coefficients. The analysis of equation was performed. As a result, this study indicates that characteristic features of the countries that are similar linear regression models of electricity consumption are the same relationship. In addition, the countries that its characteristics are similar, its energy densities are not similar.

Keywords: Electricity consumption characteristics, R^2 value, energy density.

1. Introduction

Energy is an indispensable input of production for the continuation of the production process. When energy is considered as an input to production, its importance has been neglected until the oil crises of the 1970s. Especially the two oil crises that lived in the 1970s revealed the importance of energy and started to be considered as an energy production factor and added to the production function. A study by the International Energy Agency (IEA) has also been applied to some developing countries that were included in the energy production function and taken for granted during the 1981-2000 period. In countries that are in the intermediate stages of economic development in the study, the contribution to economic growth is large, resulting in the fact that energy plays an important role [1].

When energy is analyzed by its components, it is seen that electricity is the highest quality energy component and its share in energy consumption increases rapidly [2]. Electricity is followed by natural gas, petroleum, coal and bio-fuels, respectively. This view is also supported when prices per unit of energy, which is also proportional to the marginal product of these fuels, are taken into account [3]. Electricity is the most flexible structure among the energy items that form one of the vital elements of the socio-economic infrastructure. For this reason, it has wide use areas in every field of daily life. Just as the consumption of various goods and services in each country along with economic development in Turkey is increasing [4]. The first of these is the use of electricity. Also, it is one of the basic inputs used in the industry. On the other hand, the dependence of the use of new goods on electricity to increase the quality of life increases the dependence on electricity energy [5].

Turkey is in a position dependent on foreign largely in terms of basic energy use. Especially in oil and natural gas, this dependency is more. If new resources cannot be used and substitute resources cannot be introduced, this dependency is expected to continue in the future [6].

Electric energy has an important part of energy consumption. Although electricity consumption during the examined period have shown an average annual increase of 8,7% electricity consumption, Turkey does not still reached the level of OECD countries [7].

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Given the orientation of thought to increase with the increase in demand of electricity supply increased in Turkey, the importance of the analysis of electricity demand is more evident [8]. In another study, total electricity consumption was examined by using data from 1962-1996 [4].

The idea which increases with the guidance of an increase in demand of electricity supply increased in Turkey [8] is taken into account, the importance of the analysis of electricity demand is more evident. In another study, [4] the total electricity consumption using data from 1962-1996 was examined.

Electricity is a form of energy and occurs when electrons move. As is known, all matter consists of atoms, and atoms consist of a core in its centers and negatively charged particles surrounding it (electrons). Positively charged protons and uncharged neutrons are present in the atomic nucleus. The negative charge of electrons in an atom is the positive charge of protons, and the number of electrons is usually equal to the number of protons [9]. If this equality between electrons and protons is destroyed by an externally applied force, the atom can gain or lose electrons [10]. If an atom loses electrons, the free movement of these electrons creates an electric current. Electricity is the most common form of energy used in the world. A second source of energy is derived from the conversion of primary energy sources such as electricity, water, coal, natural gas, oil and nuclear energy [11]. For example, many cities are located near large waterfalls, which are the most important source of mechanical energy and enable the gaining of electrical energy by turning giant wheels. (Tübitak, 2013).

2.Data, model and methodology

Ease of use, the time required to convert to other forms of energy, the prevalence of daily life, electricity consumption per person today is considered one of the most important indicators of the country's level of development. The development and structural change in the direction of progress in Turkey has shown a steady increase over the years as electricity consumption in parallel [5].

The data obtained for the model and the comparison covers the years 1971-2012. Electricity consumption per person was 271 kWh in 1971, 556 kWh in 1980, 726 kWh in 1985, 1016 kWh in 1990, 1389 kWh in 1995, 1908 kWh in the year 2000, 2310 kWh in the year 2005 and 2877 kWh in the year of 2010. Turkey data rate of increase of electricity consumption in 1971 between the years 1971 to 2011 may be regarded as 4,17% 1980, 9,09% 1985, 7,55% 1990, 10,26 kWh in 1995. In 2000, 8,47 kWh, 7,20 kWh in 2005, 8,40 kWh in 2010 and 5,20 kWh in 2012, respectively.
As consumptions are increasing in each sector, changes in sector share have observed in total consumption. In the sectoral consumption of electricity, the industry sector has the largest share, followed by the residential use [12]. The share of residential consumption increases as the share of the industrial sector in total use decreases while the share of residential consumption increases due to the expansion of the urbanization and transmission network [13]. The decline in the share of the industrial sector can be attributed to the increase in the use of alternative energy and the increase in the self-employed. There is also a similar increase in the trade sector. It can be said that the share of electricity consumed in the official circles did not change during the period [5].

In addition to the increase in total electricity consumption, a remarkable situation is the excess in the total loss rate.

Reducing losses can lead to both a reduction in consumer use costs and an increase in producer incomes. Increasing the number of controls and inspections may be benefit for this [17]. Turkey and other countries of the electricity consumption, energy intensity of the comparison needs to hear from Turkey's Energy Ministry data, obtained from the Scientific and Technological Research Council of Turkey and the World Bank database. Regression model in this data; the consumption of electricity was generated using Excel MATLAB Program for Turkey and Turkey’s similar countries. The results obtained by modeling with SPSS were compared through correlation analysis.

The correlation between the two variables is called the direct expression correlation. Linear correlation coefficient is indicated as r in the analysis [18]. The statistical method used to determine the degree of correlation or correlation between two variables is called Correlation Analysis. The variable to be estimated is called the independent variable when the variable to be estimated is called the dependent variable [19].

Table 2.1. Between the years 1971-2016 and Turkey's Electricity Consumption Per Person Electricity Consumption over Year with Growth rate [14] [15]

Years	Electricity consumptions in Turkey (kwh)	Increase Rate Over Years (%)	Per Person Electricity Consumption in Turkey (kWh)
1971	9781000000	13,43	271
1972	11242000000	14,94	304
1973	12000000000	6,75	327
1974	13000000000	8,33	346
1975	16000000000	23,07	394
1976	19000000000	18,75	456
1977	21000000000	10,53	505
1978	22000000000	4,76	525
1979	24000000000	9,09	543
1980	25000000000	4,17	556
1981	26000000000	4,00	580
1982	28000000000	7,69	609
1983	30000000000	7,14	620
1984	33000000000	10,00	680
1985	36000000000	9,09	726
1986	40000000000	11,11	790
1987	45000000000	12,50	857
1988	48000000000	6,67	904
1989	53000000000	10,42	961
1990	57000000000	7,55	1016
1991	60000000000	5,26	1061
1992	67000000000	11,67	1155
1993	73000000000	8,95	1238
1994	78000000000	6,85	1287
1995	86000000000	10,26	1389
1996	95000000000	10,46	1512
1997	106000000000	11,58	1653
1998	114000000000	7,55	1755
1999	118000000000	3,51	1792
2000	128000000000	8,47	1908
2001	127000000000	-0,78	1866
2002	132553000000	4,50	1938
2003	141151000000	6,50	2052
2004	150018000000	6,30	2168
2005	160794000000	7,20	2310
2006	174637000000	8,60	2495
2007	190000000000	8,80	2699
2008	198085000000	4,30	2788
2009	194079000000	-2,00	2694
2010	210434000000	8,40	2877
2011	230306000000	9,40	3103
2012	242370000000	5,20	3224
2013	246357000000	1,60	3235
2014	257220000000	4,40	3310
2015	265724000000	3,30	3373

2016	278345000000	4,70	3487

Table 2.2. Turkey's electricity lost amount between the years 1971-2012 [16] 2012-2017 [20]

Years	Turkey's electricity lost amount (kwh)
1971	983000000
1972	1130000000
1973	1283000000
1974	1488000000
1975	1635000000
1976	1712000000
1977	2078000000
1978	2188000000
1979	2562000000
1980	2824000000
1981	2931000000
1982	3317000000
1983	3422000000
1984	3740000000
1985	3945000000
1986	5447000000
1987	5518000000
1988	6308000000
1989	6247000000
1990	6681000000
1991	7561000000
1992	8995000000
1993	10252000000
1994	11842000000
1995	13769000000
1996	15854000000
1997	18582000000
1998	20795000000
1999	21545000000
2000	23756000000
2001	23329000000
2002	23932000000
2003	24052000000
2004	23243000000
2005	24044000000
2006	24810000000
2007	26647000000
2008	27481000000
2009	28991000000
2010	30222000000
2011	32941980000
2012	35906758200
2013	58500000000
2014	62000000000
2015	525000000000
2016	61000000000
2017	60000000000

The Correlation Coefficient determines how much the fit of two variables is. In fact, in many cases, it is not known which of the variables of the model is independent or which is the dependent variable. In such cases, the correlation coefficient, which is a proportional measure, is used to determine the degree of the relationship [19]. The minimum value that the correlation coefficient can take is -1 and the maximum value is +1. Correlation coefficient with another expression r; It takes a value between $-1 \leq r \leq 1$. If the sign of the correlation coefficient is positive, the value of one of the variables increases (decreases) while the value of the other increases (decreases). If the sign of the correlation coefficient is negative, the value of one of the variables increases (decreases) while the value of the other decreases (increases). So there is an opposite relationship. Correlation coefficient is calculated in Eq. 1 [19].

$$r = \frac{\sum x_i y_i}{\sqrt{\sum x_i^2 y_i^2}} = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{(X_i - \bar{X})^2 (Y_i - \bar{Y})^2}} \quad (1)$$

Regression analysis determines the relationship between a dependent variable and an independent variable or variables. The general regression formula between the independent variables x, x_1, x_2, x_3, x_4,… , x_n and the dependent variable y is calculated Eq. 2.

$$y = b_0 + b_1 * x + b_2 * x_1 + b_3 * x_2 + b_4 * x_3 + b_5 * x_4 + \cdots + b_{n+1} * x_n \quad (2)$$

Here, $b_0, b_1, b_2, b_3, b_4, b_5, \ldots, b_{n+1}$ are unknown parameters. The random error ε has zero mean and constant standard deviation. The simplest regression model is the model in which the dependent variable is assumed to change linearly over time. Namely, it is defined in Eq. 3.

$$y^* = a + bx \quad (3)$$

The a and b constants are derived from the time series data itself, based on the least squares method, which attempts to minimize the sum of the squared differences between observed and predicted values. (y_i, x_i), the raw data showing the time series i. And i = 1,2,3,4, ..., n.

$$S = \sum_{i=1}^{n} (y_i - a - bx_i)^2 \quad (4)$$

S is defined as the sum of the squared deviations between the observed and predicted values. The a and b values are determined by resolution of the following required conditions to minimize S.

$$\frac{\partial S}{\partial a} = -2 \sum_{i=1}^{n} (y_i - a - bx_i) = 0 \quad (5)$$

$$\frac{\partial S}{\partial b} = -2 \sum_{i=1}^{n} (y_i - a - bx_i) x_i = 0 \quad (6)$$

After algebraic operations we get the following solution.

$$b = \frac{\sum_{i=1}^{n} y_i x_i - n \bar{y} \bar{x}}{\sum_{i=1}^{n} x_i^2 - n \bar{x}^2} = 0 \quad (7)$$

Here;

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \quad (8)$$

$$\bar{y} = \frac{\sum_{i=1}^{n} y_i}{n} \quad (9)$$

It can be seen that we need to first calculate b to calculate the value of a from the equations. The estimation of a and b is valid for any probability distribution of y_i. However, if y_i is normally distributed with standard robustness, the confidence interval is calculated as follows from the estimated mean value at x=x^0.

$$a + bx^0 \pm t_{\propto/2, n-2} \sqrt{\frac{\sum_{i=1}^{n} (y_i - y_i^*)^2}{n-2}} \sqrt{\frac{1}{n} + \frac{(x^0 + \bar{x})^2}{\sum_{i=1}^{n} x_i^2 - n \bar{x}^2}} \quad (10)$$

$(y_i + y_i^*)$ is the time period of the dependent variable i. It shows the difference between observed and predicted values. For future estimates of the dependent variable y, these values are dealt with in the forecast interval (instead of the confidence interval in the mean value). As can be predicted, the forecast range of the future value is wider than the confidence interval at the average value. The prediction range formula is exactly the same as the confidence interval except that the term 1/n is replaced by (n+1)/n in the second square root. The linear prediction equation $y^* = a + bx$ can be controlled by calculating the correlation coefficient r, which is found in the following formula:

$$r = \frac{\sum_{i=1}^{n} y_i x_i - n \bar{y} \bar{x}}{\sqrt{(\sum_{i=1}^{n} x_i^2 - n \bar{x}^2)(\sum_{i=1}^{n} y_i^2 - n \bar{y}^2)}} \quad (11)$$

Here, r is $-1 \leq r \leq 1$. If r = ± 1, there is a possible linear relationship between x and y. Generally, |r| as approach value 1, the linear relationship increases. If r = o then y and x can be independent [18]. MATLAB program for the first assigned to a variable for electricity consumption in Turkey. In our comparison model, this variable name is called "T". The other countries have been assigned separate variables. For example, "A" for Argentine, "B" for Brazil, "ISP" for Spain. Electricity consumed since 1971 has been assigned to all variables in matrix format. >> fold = polyfit (T, ISP, 1) and the regression coefficients were obtained. ISP_regression the polyvalent >> = (coefficient U, T); This code shows the new value generated by the result of the

regression. Correlation analysis was applied to the comparison results of SPSS. Thus, it was examined whether the model was correct or not and whether the relation between the characteristics was high.

3.Results

Given the ease of use of electricity and the prevalence of each area, increases in consumption may be expected to increase public well-being. The use of many tools and equipment that make daily life easier depends on the power. Accordingly, it can be said that there has been a parallel development between per person national income increase and electricity consumption per person.

Electricity consumption per person is decreasing during recession periods, which is lower than per person income reductions. Per person consumption during the period showed a negative reduction only in the 2001 and 2009 crises. The result is a steady increase in per person electricity consumption. Turkey's electricity consumption characteristics similar output with high power consumption of 21 different countries. In addition, there was a very weak linear relationship with these countries based on energy intensity. The electricity consumption in Turkey and Argentina characteristics were determined by a linear relationship is very strong positive correlation 0,990.

According to the results of this analysis resident made for the corresponding energy density of 0.246 correlation between Argentina and Turkey shows that weak positive linear relationship. electricity consumption and energy intensity characteristic of the relationship between the state as a result of other twenty countries and Turkey are shown in Table 3.1 looking at the energy intensity, Israel is the most successful country. The comparison of electricity consumption characteristic graph, model, correlation table and energy intensity, model and correlation table are the same among the other countries. If the codes are written in the MATLAB and SPSS programs as above, other results will be seen.

Table 3.1. Comparison between Electricity Consumption Characteristics and Energy Density of Turkey and other countries

Countries	Electricity Consumption' Characteristic Relation Correlation Value and Situation	Relative Correlation Value and Status of Energy Intensity
Turkey - Brasil	0,975 strong positive linear relationship	-0,495 negative linear relationship
Turkey - United Arab Emirates	0,992 very strong positive linear relationship	0,380 weak positive linear relationship
Turkey - Indonesia	0,997 very strong positive linear relationship	-0,340 weak negative linear relationship
Turkey - Filipinler	0,991 very strong positive linear relationship	0,348 weak positive linear relationship
Turkey - India	0,995 very strong positive linear relationship	0,071 very weak positive linear relationship
Turkey - İran	0,998 very strong positive linear relationship	0,236 weak positive linear relationship
Turkey - Spain	0,989 strong positive linear relationship	0,236 weak positive linear relationship
Turkey - India	0,989 strong positive linear relationship	0,064 very weak positive linear relationship
Turkey - Israel	0,995 strong positive linear relationship	0,430 positive linear relationship
Turkey - Kuwait	0,986 strong positive linear relationship	0,200 positive linear relationship
Turkey - Malaysia	0,989 strong positive linear relationship	-0,120 negative linear relationship
Turkey - Mexico	0,981 strong positive linear relationship	0,544 positive linear relationship
Turkey - Egypt	0,996 Correlation value between Egypt and Turkey, very strong positive linear relationship	0,055 very weak positive linear relationship
Turkey - Pakistan	0,987 strong positive linear relationship	-0,122 weak negative linear relationship
Turkey - Portugal	0,981 strong positive linear relationship	0,209 weak positive linear relationship
Turkey - Singapore	0,988 strong positive linear relationship	-0,011 weak positive linear relationship
Turkey - Portugal	0,992 very strong positive linear relationship	0,149 weak positive linear relationship
Turkey - Chile	0,992 very strong positive linear relationship	0,119 weak negative linear relationship
Turkey - Thailand	0,993 strong positive linear relationship	-0,523 negative linear relationship
Turkey - Greece	0,978 strong positive linear relationship	0,515 negative linear relationship

Appendix

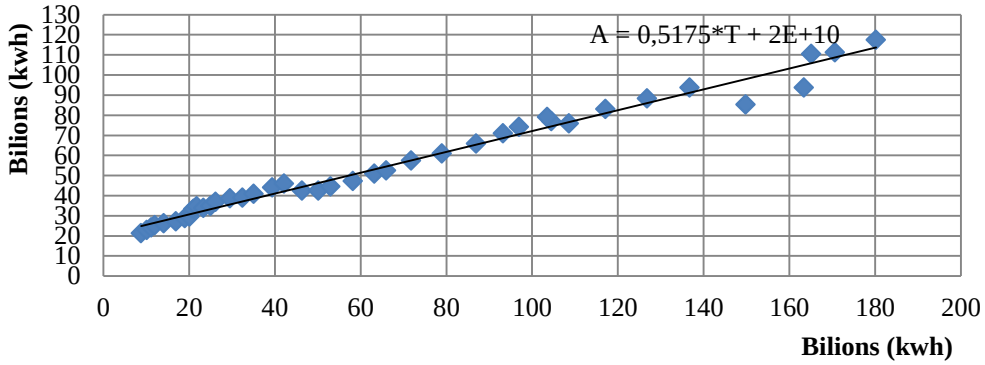

Figure 4.1. Comparison of Characteristics of Argentina - Turkey Electricity Consumption.

Table 4.1. SPSS - Electrical Consumption Correlation Result.

		ARGENTINA	TURKIYE
ARGENTINA	Pearson Correlation	1	,990
	Sig. (2-tailed)		,000
	N	40	40
TURKIYE	Pearson Correlation	,990	1
	Sig. (2-tailed)	,000	
	N	40	40

Table 4.2. SPSS - Electrical Consumption Correlation Result.

		TURKEY	ARGENTINA
TURKEY	Pearson Correlation	1	,246
	Sig. (2-tailed)		,126
	N	40	40
ARGENTINA	Pearson Correlation	,246	1
	Sig. (2-tailed)	,126	
	N	40	40

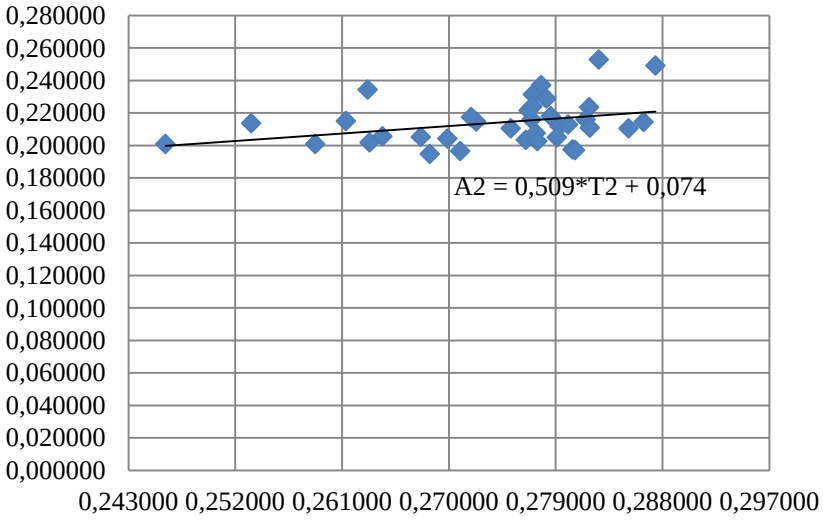

Figure 4.2. Argentina - Turkey Energy Intensity Comparison.

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