Assessment of Housing Energy Consumption in Turkey

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Abstract. In this study, we analyze housing energy consumption in Turkey. The energy consumption is evaluated by using the multivariate techniques such as cluster analysis and multidimensional scaling (MDS) analysis. The number of clusters for housing energy consumption was selected as five years. Finally, cluster and MDS analysis results show that the 2009 and 2010 was the most similar consumption years in housing energy consumption. Finally, this paper present that the usefulness of cluster and MDS analysis for assessment in the energy consumption.

1. Introduction

Energy is essential to economic and social development and improved quality of life in all countries as in the case of Turkey [1]. Turkey has a dynamic economic development and rapid population growth [2]. The country is situated at the meeting point of three countries (Asia, Europe and Africa) and stand as a bridge between Asia and Europe [3-5]. Turkey is one of the largest countries in Europe, covering an area of ~780,000 km2. Average population density is ~80 persons per square kilometer. Annual rate of increase in population is 1.6%, the highest among IEA countries [6,7].

The main energy resources of Turkey are hard coal, lignite, asphalt, petroleum, natural gas, hydroelectric energy, and geothermal energy. These resources are produced and consumed in the country [8].

In this paper, multivariate statistical techniques such as cluster analysis and multidimensional scaling (MDS) analysis were introduced. After, a case study presenting the multivariate statistical techniques used on a housing energy consumption dataset.

2. Materials and Methods

2.1. Dataset

The energy consumption of housing comparing five years were obtained from the World Energy Council Turkish National Committee in Turkey. The selected parameters are; coal, lignite, asphaltite, wood, animal and plant residuals, oil, natural gas, electric, geothermal and sun. All multivariate statistical computation was made using by statistical software.

2.2. Cluster Analysis

Cluster analysis is an exploratory data analysis tool for solving classification problems. Its objective is to sort cases into clusters, so that the degree of association is strong between members of the same

cluster and weak between members of different clusters [9]. In the case of cluster analysis, the similarities or dissimilarities are quantified through Euclidean distance measurements [10,11].

2.3. Multidimensional Scaling (MDS) Analysis

MDS provides a visual representation of dissimilarities (or similarities) among objects, cases or, more broadly, observations. In other words, the technique attempts to find structure in data by rescaling a set of dissimilarities measurements into distances assigned to specific locations in a spatial configuration [12-14]. The input of the procedure is proximity matrix of the objects under investigation. It contains the values of a quantitative measure of the pair wise dissimilarities among the observations [15,16]. The final step is interpretation of the meaningful dimensions of the MDS analysis solution [17,18].

3. Results and discussions

In this study housing energy consumption was evaluated by the use of cluster analysis. The number of clusters for housing energy consumption data set was selected as five years such as 2009, 2010, 2011, 2012 and 2013. Then, for each cluster pair, Euclidean distances were calculated and Euclidean distance matrices were constructed. Using the matrices, similarity matrices were formed. Cluster pairs that have the highest similarity were chosen and were joined to composed a new cluster. The cluster analysis resulting from single linkage method is presented in Table 1 and Figure 1. The table and figure presented that the firstly 2009 joined 2010 and formed new cluster called 1. The steps repeated until all clusters is composed in one cluster.

Table 1. Cluster analysis results.

Step	Number of cluster	Clusters joined		Similarity level	New Cluster	Number of observation in new cluster
1	4	2009	2010	70.4561	1	2
2	3	1	2011	64.0001	1	3
3	2	1	2012	50.3448	1	4
4	1	1	2013	49.5921	1	5

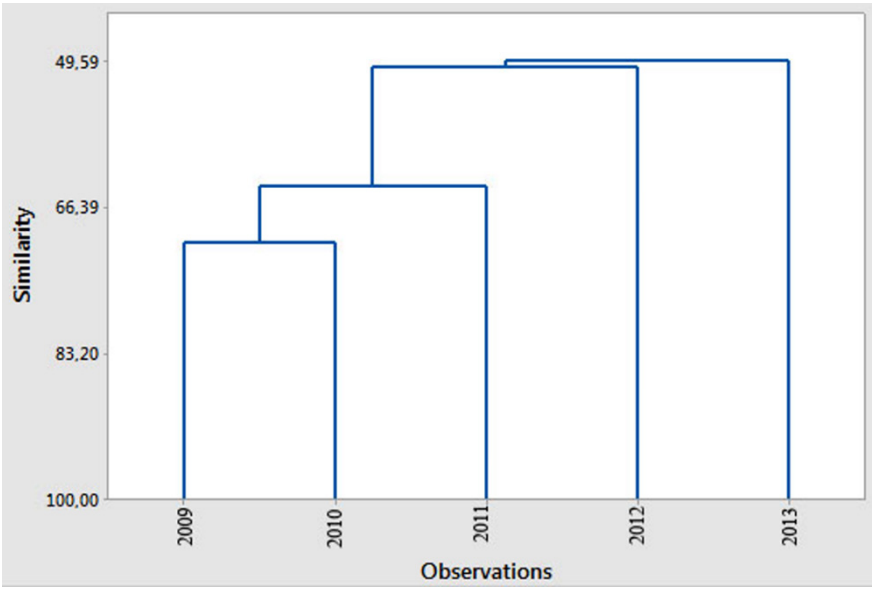

Figure 1. Dendrogram for the years

The MDS analysis coordinate values can be seen in Table 2. The similarities among the five years (2009, 2010, 2011, 2012 and 2013) were found Dimension-1 and Dimension-2. Figure 2 show that the 2009 and 2010 was the most similar consumption year according to Dimension-1 and Dimension-2.

Table 2. MDS analysis coordinate values

Year	Dimensions	
	1	2
2009	1.8791	0.0145
2010	0.9573	-0.468
2011	0.0122	-0.1390
2012	-1.2675	0.9252
2013	-1.5810	0.7539

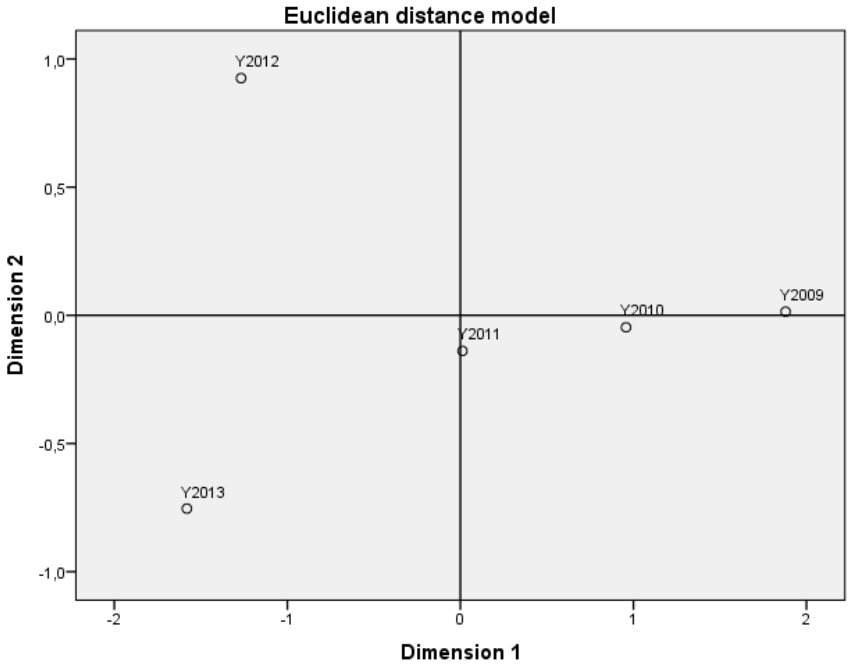

Figure 2. MDS plot for the years

4. Conclusions

This paper show that the usefulness of multivariate techniques such as cluster and MDS analysis of large and complex dataset. In this study, multivariate statistical analyze techniques can be used to acquire the information from the housing energy consumption. The study enabled us to show similarities among the housing energy consumption years that were not clearly visible from an examination of dataset. Cluster analysis grouped five years into one clusters of similar housing energy consumption. MDS analysis results is supported cluster analysis. Finally, this study show that the energy consumption of housing is similar by 2009 and 2010.

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