International Journal of Economics, Management and Accounting 25, no. 3 (2017): 443-464

SHORT- AND LONG-TERM DETERMINANTS OF RESIDENTIAL ELECTRICITY DEMAND IN TURKEY

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ABSTRACT

The purpose of this study is to predict the factors affecting the residential electricity demand by using a multivariate econometric model. The variables of the model established in this context are net electricity consumption in the residential sector, the price of electricity, real income per capita, average air temperature showing the climatic conditions and the urbanization rate. Residential electricity demand was analyzed for short- and long-term with the ARDL-Bound Testing by using the annual data for the years 1990-2014 in Turkey. As a result of the analyses both short- and long-term residential electricity demand was found to be negatively and significantly affected by price of electricity and positively and significantly affected by income, average temperature and urbanization rate. The price elasticity of demand was estimated to be smaller than 1 in both short- and long-term. Although income elasticity of demand was estimated to be smaller than 1 in the short-term, income elasticity of demand was found to be higher than 1 in the long-term. In addition, climatic condition was found to be most effective variable affecting residential electricity demand.

JEL classifications: Q41; D12; C31

Key words: Residential electricity demand, Elasticity, Climatic conditions, ARDL bound testing

1. INTRODUCTION

Global warming is largely caused by human production and consumption behaviors. In particular, such over consumption behaviors of some developed countries have even more effect on global warming. As long as people meet their energy needs from fossil fuels, carbon dioxide (CO_2) gas released into the atmosphere adversely affects the environment. These gases lead to the greenhouse effect[1] and this is considered to be one of the most important causes of global warming. Each country's increasing use of fossil fuel affects lives of people on earth and future generations and resources to be utilized. The need for electricity has become an indispensable condition for people today. Electric energy is used in a wide range of activities including food production, individual communication and transportation, goods and services transportation, and educational services (Pimentel et al., 2006). Energy need of people is increasing every passing day with increasing population since people are using more and more energy in daily life and energy is used in producing goods and services. Energy production to meet increasing energy need of people leads to depletion of energy sources.

Residential electricity consumption corresponds to 30% of world electricity consumption (Xie, Ouyang and Gao, 2016). Due to increased demand and changed lifestyle, residential sector energy consumption is growing rapidly (Esmaeilimoakher et al., 2016). The overall residential electricity consumption depends on the lifestyles of household, weather, stock of appliances, number of rooms (Filippini and Pachauri, 2004; Franco and Sanstad, 2008; Halicioglu, 2007; Jones, Fuertes and Lomas, 2015) and household characteristics (Hirst and Goeltz, 1985; Liao and Chang, 2002; Pachauri, 2004).

In 2014, the share of natural gas-fired plants in electricity production in Turkey was 47.9%, while the shares of hydraulic, coal-lignite and imported coal power plants were 16.1%, 16% and 13.9%, respectively (Energy Market Regulatory Authority, 2014a). These data indicate that the share of not-so-ecofriendly fossil fuel in electricity production is higher. In recent years, energy consumption in Turkey has been gradually increasing in line with population growth. In 2014, electricity consumption increased by 3.6% compared to 2013 and the total number of customers reached approximately 38.55 million people in 2014 (Energy Market Regulatory Authority, 2014b).

More production is needed to meet this consumption. Thus, the environment is negatively affected and eco-friendly energy sources are depleted as a result of seasonal effects. To meet demand, natural gas has an important place in electricity production in Turkey. In fact, Turkey imported 49.231 million cubic meters of natural gas in 2015, an increase of 26.80% compared to 2010 (International Energy Agency, 2016). This import data shows that the electricity production cost is high, creating a foreign trade deficit burden. These statistics indicate that electric energy usage should be reduced or policies should be developed for effective use of electricity in Turkey, which is foreign-dependent on energy. This study is considered significant in developing policies in regard with high energy consumption and meeting increasing consumer demand. Therefore, it is important to investigate factors affecting residential electricity consumption, a major user of electricity in Turkey.

In this study, the effect of factors affecting residential electricity demand was analyzed by using the Autoregressive Distributed Lag (ARDL) method, which is widely used in the econometric literature, by using a multivariate demand model with new period of analysis. In this respect, it makes an important contribution to the literature. This study will also contribute to the policies to be developed on short-term and long-term residential electricity demand. In the study, using a multivariate demand model reduces the potential excluded variable bias. In this way, the factors affecting residential electricity demand are demonstrated more effectively. While determining factors affecting the residential electricity demand, using a small number of variables as data can affect determination of actual impact of factors. In this regard, this study will provide a significant contribution to the literature.

This study aimed at identifying the factors affecting residential electricity demand in Turkey by using the ARDL Bound Testing using annual data for the years 1990-2014.

In this context, first, previous studies on electricity demand in Turkey and other countries are reviewed; and then data and methodology are discussed and thirdly, analysis findings are presented. Finally, the findings are evaluated and relevant policies are recommended.

2. LITERATURE REVIEW

Considering the related literature, many studies have been conducted in both Turkey and the world on residential electricity demand by using different variables and methods. In studies conducted on residential electricity demand in other countries, two approaches were adopted in general. In the first approach, survey-based micro issues were analyzed in a cross-sectional way (Leth-Petersen, 2001; Filippini and Pachauri, 2004; Yoo, Lee and Kwak, 2007; Tso and Guan, 2014). In micro studies, the data were collected using survey technique and analyses were performed on these data. In the second one, residential electricity demand was analyzed at the national and regional level with micro and macro issues (Fisher and Kaysen 1962; Dimitropoulos, Hunt and Judge, 2005; Yoo, 2005; Reiss and White, 2005; Eltony and Al-Awadhi, 2007; Ciarreta and Zarraga, 2010; Athukorala and Wilson, 2010). Most of these studies have forecasted both the short- and the long-run residential demand for electricity using aggregate data.

In general, the factors affecting residential electricity demand are income, climate, energy prices and characteristics related to population and housing (Krigger and Dorsi, 2009). Holtedahl and Joutz (2004), Mohammadi (2009), Alberini, Gans and Velez-Lopez (2011) and Pessanha and Leon (2015) are some of the recent studies that have estimated both the short-and the long-run residential demand for electricity. For example, Hotedahl and Joutz (2004) investigated short- and long-term effects of urban electricity demand in Taiwan and determined that household disposable income, population growth, the electricity price and degree of urbanization are important factors affecting electricity demand. They have found that income elasticity in the long-term is unit elastic and that prices have a negative effect on the demand and are inelastic. According to the error correction model created, short-term income and price effects are estimated to be smaller than long-term effects. In addition, the number of cold days has a positive effect on short-term electricity demand. Alberini, Gans and Velez-Lopez (2011) determined the factors affecting residential electricity and natural gas consumption by using panel data of 50 cities for the period 1997-2007. The study found energy prices to be an important factor in both the short- and long-term and also found a strong correlation between energy prices and electricity demand.

Some studies using disaggregated data have forecasted that household characteristics and occupant behaviors affect energy consumption in their buildings. For example Sirichotpundit et al. (2013) conducted a study on 15 regions of city center of Bangkok in order to determine factors affecting the residential energy demand. Data obtained from a questionnaire were analyzed by multiple regression method. As a result of analysis, it was estimated that physical, social and economic factors positively and significantly affect the quality of residential energy use. Similarly, Jones and Lomas (2015) determined the social and economic factors affecting residential electricity consumption in Leicester, England and analyzed the data collected between 2009 and 2010 by odds ratio method. Their study found that residential properties and socio-economic factors are significant on high electricity demand.

Kavousian, Rajagopal and Fischer (2013) conducted a study by using data sets obtained from 1628 households to determine behavioral determinants of residential electricity demand. The data were analyzed by multiple regression method. Climate, location and area of the house were shown to be important determinants of residential electricity demand.

Halvorsen and Larsen (2001) conducted a study in order to identify the development of residential electricity demand for the period 1976 and 1993 in Norway, and estimate the effects of taxes on residential electricity consumption. The data were analyzed by a method based on pooled data. According to their study, increased electricity consumption per household was determined by electrical household goods (dryers and dishwashers), the area of the house and increase in real disposable income. Similarly, Nesbakken (1999) investigated the effect of energy prices on residential heating equipment and energy consumption for the period 1993-1995 in Norway. Energy prices were found to have a significant effect on residential heating equipment and energy consumption. In addition, high-income families were found to be more sensitive to energy prices compared to low-income families.

Tso and Guan (2014) conducted a study using micro-data to determine the residential energy demand in the US in 2009. According to the results of the analysis, factors such as type and size of the house, size of households, heating equipment and air conditioning use have a statistically significant effect on the residential energy demand. On the other hand, Lin et al. (2014) used panel data of residential energy consumption in 2011 to analyze differences in structure and amount of residential energy consumption in China at the provincial level. According to the econometric analyses conducted, population, economic development level, range of energy resources and climate conditions are factors significantly affecting residential energy consumption.

Studies conducted on energy demand in Turkey are similar to the studies conducted in other countries. These studies are mostly based on time series. For instance, Akbostanci, Tunc and Turut-Asik (2009) used the data from 1985-2004 to find the factors affecting energy demand in Turkey. In the study, co-integration analysis and vector error correction model were used. The study found that world prices are not effective on the service sector in total; however, world prices increase energy use in the long-term in terms of industry demand and lead to increase in domestic energy prices for industry and the service sector in particular.

Halicioglu (2007) estimated residential electricity demand in Turkey for the 1968-2005 period by using co-integration method. The analysis results show that income and prices flexibilities in the short-term are smaller than income and prices flexibilities in the long-term and urbanization significantly affects energy demand. As a result of the granger causality tests, the causality was found to be from income, price and urbanization toward residential energy demand in the long-term through error correction term in an interactive way.

Guloglu and Akin (2014) conducted a study on determinants of electricity demand using data from the Turkey Household Budget Survey 2008 published by the Turkey Statistics Institution. In the study, the data were analyzed by sequential logit method. The factors affecting household electricity consumption in Turkey were determined as monthly electric bill, properties of the house, structure of the household and family income.

Akan and Tak (2003) used annual time series data for the period 1970-2000 in order to determine the determinants of Turkey's electricity demand. In the study, short and long-term demand elasticities were estimated. Electricity demand was found to be more sensitive to income compared to price. In addition, income elasticities were estimated to be greater than one in sectors other than industry and housing, and price elasticities were estimated to be close to zero. Similarly, Dilaver and Hunt (2011) tried to determine residential electricity demand by using time series methods with annual data for the 1960-2008 period in Turkey. As a result of the analysis performed, total consumption of households, real energy prices and trend of the primary energy demand were found to be important determinants of residential electricity demand.

In their empirical study, Yaylali and Lebe (2013) forecasted residential electricity demand of Turkey by using data for the period 1978-2009. The variables of the study were net electricity consumption of Turkey's housing sector, income per capita and urbanization rate and electricity price. The data were analyzed by ARDL approach. According to the results, price elasticity was found to be lower than one in both short and long-term and income elasticity of demand in the short-term was found to be lower than income elasticity of demand in the long-term.

Considering the studies conducted on Turkey's residential electricity demand in the literature, no other study investigating the effect of climatic conditions on the residential electricity demand was found. Therefore, in this study, we examined the effect of climatic conditions on the residential electricity demand along with other factors. In this way, the effect of climatic conditions on the residential electricity demand is not ignored and the deviation caused by the neglected variable is reduced. Thus, in this study, a model including average temperature values representing climatic conditions in addition to some variables such as real GDP per capita, real house prices and urbanization rate was developed. This model was estimated in order to determine the factors affecting the residential electricity demand in the corresponding period.

3. DATA AND METHODOLOGY

In this section, information is provided regarding these four data sets which have been used to measure the correlation between Residential Electricity Consumption and GDP per capita, real residential electricity price, urbanization rate and mean temperature in Turkey. Short- and long-term correlations among the analysis data have been investigated using the ARDL method. Within this framework, explanations with regard to the content of data used, how they have been collected, their developments spanning years and analysis methods are made in this section.

3.1 DATA

While the correlation between REC, REP, GDP per capita, TEMP and URATE is investigated in this study, data calculated in the 1990-2014 period has been taken into account. Information on variables used in the study are presented in Table 1.

TABLE 1
Variables and Their Descriptions

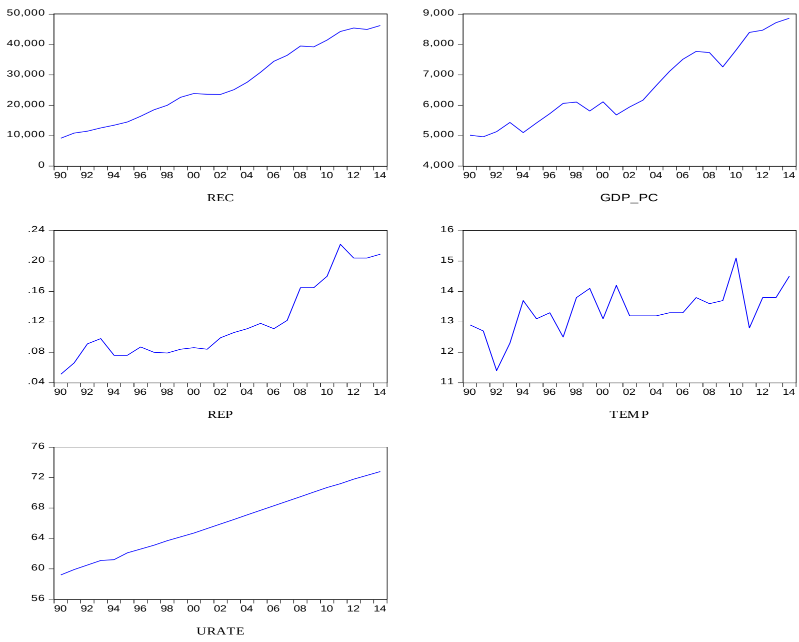
Variable	Description	Sources
REC	Residential Electricity Consumption in Turkey, KWh	General Directorate of Energy Affairs website
REP	Residential Electricity Price in Turkey, \$/KWh*	IEA
GDP_PC	Real GDP per capita in Turkey (constant 2005 \$)	World Bank Database
TEMP	Mean Temperature in Turkey (in Celsius)	Turkish State Meteorological Service
URATE	Urbanization Rate in Turkey	World Bank Database

Note: * The data were multiplied by the real exchange rate and then adjusted for inflation by comparing to GDP deflator.

Currently, as a result of technological innovations, the use of electricity saving devices in the home is rapidly increasing. When people's knowledge and understanding change, their saving behavior also changes. In this regard, the use of energy saving appliances and renewable energy sources (such as solar energy) in residential areas may increase. For this reason, electricity consumption in houses may decrease. In this context, a trend representing this matter is added to the econometric model.

In this study, all variables excluding urbanization rate were analyzed by taking their logarithms. In Figure 1, the time series of variables used in the study are indicated.

FIGURE 1
Time Series of Variables Used in the Study (1990-2014)



We display the time series of variables for Turkey in Figure 1. As seen in Figure 1, REC, GDP_PC, REP and TEMP data, generally, tend to increase by showing cyclical fluctuations over the years. However, URATE data tend to increase. Figure 1 shows the mean of temperature in Turkey that has risen from 12.9 to 14.5 °C during the past 24-year period (1990-2014).

3.2 METHODOLOGY

In the present study, the stationarity of the time series data were tested by using the Augmented Dickey-Fuller (ADF) (1979, 1981) methods. Later, existence of co-integration between series and short- and long-term analyses were conducted by using the ARDL-Bound Testing Approach.

Long-term correlations between economic variables were examined by means of a common Engle-Granger (1987) residual-based test and maximum likelihood, based on tests by Johansen (1988) and Johansen-Juselius (1990) tests. To be able to conduct these tests, all variables in the established model should not be stationary on the first level I(0) and should become stationary when first differences are taken (Pesaran, Shin and Smith, 2001). The Bound Testing Approach, which is used in the case that variables are I(0) or I(1), is not used when variables are integrated from a level of I(2) or more has been frequently used in econometric literature in recent years. This method named as the ARDL approach has been developed by Pesaran and Pesaran (1997), Pesaran and Smith (1998), Pesaran and Shin (1995) and Pesaran, Shin and Smith (2001). Various advantages of the ARDL analysis method are referred to in the literature. These advantages are expressed as providing robust and efficient results even in small samples and thanks to an error correction model, a long-term balance with short-term dynamics, it becomes integrated without losing long-term information (Narayan and Narayan 2004).

4. FINDINGS

In this part of the study, first unit root results of the used series are given and then results of co-integration and the ARDL-bounds test method are presented.

4.1 ADF UNIT ROOT TEST

The ARDL method, which is used to determine short- and long-term correlations between the dependent variable REC and independent variables REP, GDP_PC, TEMP and URATE can be used when the series belonging to variables are I(0) or I(1). However, in case variables are integrated from I(2) or a higher level, this method cannot be utilized. For this, to examine whether or not variables are integrated from I(2) or a higher level, the Dickey-Fuller (1979, 1981) test and unit root analysis have been conducted and results are given in Table 2.

TABLE 2
Unit Root Test Results

	With intercept only			With intercept and trend		
Var.	Level	First Diff.	Result	Level	First Diff.	Result
REC	0.162	-3.430*	I(1)	-2.755	-3.373***	I(1)
REP	-3.936***	-	I(0)	-3.657**	-	I(0)
GDP_PC	0.196	-4.803***	I(1)	-2.272	-4.771***	I(1)
TEMP	-3.485**	-	I(0)	-5.131***	-	I(0)
URATE	0.310	-7.676***	I(1)	-3.103	-7.521***	I(1)

Note: *, **, *** Significant at 10%, 5%, and 1%, respectively.

As seen in Table 2, the first difference of REC, GDP_PC and URATE is stationary, and level values of REP and TEMP are stationary. This result shows that study data can be analyzed by means of the ARDL approach.

4.2 CO-INTEGRATION AND ARDL-BOUNDS TEST

In accordance with the ARDL approach, first of all it is required to test whether or not there is a long-term correlation between variables in the model. Therefore, the Unconstrained Error Correction Model (UECM) is established first. According to this, the maximum number of lags has been determined as two since data is annual. The form of this test depending on the UECM, which has been adapted to the study, is as follows:

$$(1) \quad \Delta REC_t = \beta_0 + \beta_1 \, TREND + \sum_{i=1}^{m} \beta_{2i} \, \Delta REC_{t-i} + \sum_{i=0}^{m} \beta_{3i} \, \Delta REP_{t-1} + \sum_{i=0}^{m} \beta_{4i} \, \Delta GDP\_PC_{t-i} + \sum_{i=0}^{m} \beta_{5i} \, \Delta TEMP_{t-1} + \sum_{i=0}^{m} \beta_{6i} \, \Delta URATE_{t-i} + \beta_7 REC_{t-1} + \beta_8 REP_{t-1} + \beta_9 GDP\_PC_{t-1} + \beta_{10} REC_{t-1} + \beta_{11} URATE_{t-1} + \mu_t$$

where Δ in (1) describes first differences. The hypothesis, which examines the integration between first term delay of dependent and independent variables, are presented in Table 3.

TABLE 3
Hypothesis of F and t Statistics

	H_0 Hypothesis	H_1 Hypothesis
F_{III}	$H_0 : \beta_7=\beta_8=\beta_9=\beta_{10}=\beta_{11}=0$	$H_A : \beta_7\neq\beta_8\neq\beta_9\neq\beta_{10}\neq\beta_{11}\neq 0$
t_{III}	$H_0 : \beta_7=0$	$H_A : \beta_7\neq 0$

The null hypothesis and alternative hypotheses of trend model created to test the co-integration relationship between the variables in (1) can be established respectively, as H_0:$\beta_7=\beta_8=\beta_9=\beta_{10}=\beta_{11}=0$, H_A: $\beta_7\neq\beta_8\neq\beta_9\neq\beta_{10}\neq\beta_{11}\neq 0$. The co-integration relationship between variables is determined by testing significance of β_7, β_8, β_9, β_{10} *and* β_{11} coefficients in equation (1) with the *F* test. The value of *F* and *t*-statistics of delayed level value of a dependent variable is compared with critical limit values in Pesaran et al. (2001) in order to see whether there is a co-integration relationship between the variables. Since yearly data is used in this study, the model number (1) is estimated with maximum 2 delays with trend. The results of *F* statistics in regard with test of co-integration relationship are presented in Table 4.

TABLE 4
Co-integration Test Results

Model	*m*	*k*	*F*-statistic	*I*(0) and *I*(1) Critical Values
ARDL(1,0,0,1,1)	2	4	6.554	3.81-4.92*** 3.05-3.97** 2.68-3.53*

Note: *, ** and *** express respectively 10 %, 5 % and 1 % significance levels. m is number of maximum lags and k is the number of independent variables in the model. Critical values are obtained from Pesaran et al. (2001:300), Table CI(iii). The value in brackets expresses *p* (probability) value of the *F* statistic.

It is seen that the *F* statistic, calculated in Table 4, is greater than the upper critical value in all significance levels. Therefore, null hypothesis which hypothesizes that there is no long-term co-integration correlation between REC and REP, GDP_PC, TEMP and URATE is rejected. Correspondingly, it can be said that there is a long-term relationship between the aforementioned variables in the 1990-2014 period in Turkey.

After determining the long-term relationship between variables, the second step of the ARDL model should be to predict the short- and long-term relationship between variables. The form of the

ARDL model established to analyze the correlation between variables, which has been adapted for this study, is in (2):

$$REC_t = \beta_0 + \beta_1 TREND + \sum_{i=1}^{p} \beta_{2,i} REC_{t-i} + \sum_{i=0}^{q} \beta_{3,i} REP_{t-i} + \sum_{i=1}^{q} \beta_{4,i} GDP\_PC_{t-i} + \sum_{i=1}^{q} \beta_{5,i} TEMP_{t-i} + \sum_{i=1}^{q} \beta_{6,i} URATE_{t-i} + \omega_t \quad (2)$$

To determine the most suitable ARDL model by means of E-views software, first the equation with (2) is predicted by means of the OLS approach for all possible values of p and q = 1, 2, …, m and i =1, 2,…,k. In this prediction, the maximum length of the lag (m) has been taken into account as 2. Later, model selection is performed among predicted models according to one of R^2, Akaike Information Criterion (AIC), Schwartz Bayesian Criterion (SBC), or Hannan-Quinn Criterion (HQC) which are model selection criteria. The most suitable ARDL (1, 0, 0, 1,1) model for the equation with (2) has been predicted according to SBC. In case REC is the dependent variable, short- and long-term coefficient estimation results of the ARDL (1, 0, 0, 1, 1) model are given in Table 5.

When we look at the diagnostic test results of the ARDL (1,0,0,1,1) model in Table 5; p (probability) values belong to serial dependence, heteroscedasticity, model establishment error and normal distribution tests which are greater than whole α significance levels (1%, 5% and 10%) (Table 5).

Finally, to investigate structural fracture with regard to variables, CUSUM and CUSUM Q figures use recurrent residual squares and investigate structural fracture with regard to variables in the system. Respectively, the CUSUM and CUSUM Q figures are presented in Figure 2. When Figure 2 is examined, it is observed that residuals of both CUSUM test and CUSUMQ test model (which is more sensitive), remain within the boundaries - parameters are stable and there is no a structural change in the model.

TABLE 5
Short- and Long-Term Coefficients

Variables	Short-term Coefficients		Long-term Coefficients
lnREC (-1)	0.532 (4.347)***		
lnREP	-0.057 (-3.872)***		-0.122 (-5.088)***
lnGDP_PC	0.595 (4.144)***		1.273 (2.792)**
lnTEMP	0.282 (2.006)*		1.315 (2.509)**
lnTEMP (-1)	-0.333 (2.376)**		
URATE	0.150 (2.036)*		0.730 (2.800)**
URATE (-1)	0.191 (2.337)**		
Constant	-22.475 (-3.085)***		-48.081 (-2.867) **
Trend	-0.196 (-2.711)**		-0.420 (-2.695)**
ECM_{t-1}	-0.467 (-3.816)***		
Diagnostic Tests			
R^2	0.997	χ^2_{BG}	3.131 [0.209]
$\overline{R}^2$	0.996	χ^2_{RAMSEY}	0.001[0.999]
DW	2.232	χ^2_{NORM}	0.451 [0.798]
F-statistic	919.9 (0.000)	χ^2_{BPG}	1.400 [0.256]

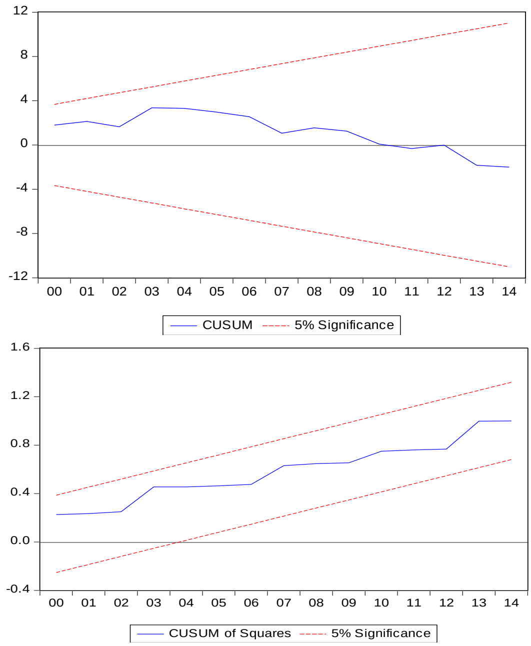
Note: Values within parentheses are *t* statistic values, and are the tests used for respectively, for Breusch-Godfrey serial dependence, the Ramsey model establishment error in regression, Jarque-Bera normality and Breusch-Pagan-Godfrey heteroscedasticity testing. Values in square brackets represent *p*-probability values belong to diagnostic tests. *, ** and *** indicate 10%, 5% and 1% significance levels, respectively.

If CUSUM and CUSUMQ figures, which have been developed by Brown, Durbin and Evans (1975) to the test stability of ARDL long-term coefficients, are within critical limits on a 5% significance level it means that estimated parameters are stable (or consistent). Therefore, when CUSUM and CUSUMQ figures in Figure 2 are considered, it can be explained that the long-term coefficients obtained as a result of estimation of the ARDL model are consistent.

The long-term coefficients calculated for ARDL (1,0,0,1,1) model can be written as in (3).

$$(3)\ REC_t = -48.081 - 0.420\,TREND - 0.122\,lnREP + 1.273GDP\_PC + 1.315\,lnTEMP + 0.730\,URATE$$

FIGURE 2
CUSUM and CUSUMQ Figures (1990-2014)



Source: Author's estimation.

In the long-term analysis, coefficients of all factors affecting the residential electricity demand were found to be statistically significant. In the time period covered, long-term residential electricity demand in Turkey was found to be negatively and significantly affected by electricity price and positively and significantly affected by average temperature and rate of urbanization. Accordingly, in this period, price elasticity of the long-term residential electricity demand was predicted as -0.122 and income elasticity of electricity demand was predicted as 1.273, respectively. It can be said that an increase (decrease) by 1% in the residential electricity prices in the period of 1990-2014 in Turkey leads to a decrease (or increase) by approximately 0.12% in long-term residential electricity consumption. In a similar way, an increase by 1% in the income per capita (or decrease) leads to an increase (or decrease) by 1.27% in the residential electricity demand. An increase by 1% in the average temperature, which shows the effect of climatic conditions on residential electricity consumption, is found to be increasing residential electricity demand by 1.31%. The urbanization rate coefficient was found to be 0.730, which is positive and significant. Accordingly, one unit increase in the rate of urbanization leads to an increase of 0.730 units in the residential electricity consumption.

Electricity consumption may be reduced by changing saving behaviors of people over time and the use of more efficient electrical appliances besides increasing use of renewable energy sources in residential buildings (solar power). In this context, a trend representing this matter is added to the econometric model. As a result of the analyses conducted, trend parameter was found to be negative at a significance level of 5% in both short- and long-term. The long-term coefficient of trend variable was estimated as 0.420, whereas the short-term coefficient was estimated to be 0.196, respectively (Table 5). Accordingly, residential electricity demand was increased by 0.420 in the long term and 0.196 in the short-term with the use of energy-saving appliances and renewable energy sources.

Given the predicted results of the short-term electricity demand in the housing sector, all of the coefficients were determined to be statistically significant and their signs were found to be consistent with expectations of statistical economic theories. In this context, in the short-term, residential electricity demand is significantly and positively affected by its deferred value. There is a negative and significant relationship between electric price and residential electricity demand in both short-term and long-term. In addition, in the relevant period, price elasticity of the electricity demand of housing sector in the short-term was estimated to be -0.057 and income elasticity of the electricity demand was estimated as 0.595, respectively (Table 5). A significant and positive relationship was found between real GDP and residential electricity demand in both short- and long-term (Table 5). A statistically significant and positive relationship was predicted between average temperature and residential electricity demand in the current period and a significant and negative relationship was predicted between these two variables in a deferred period (Table 5). A statistically significant and positive relationship was predicted between urbanization rate and residential electricity demand in the current period and a deferred period. Accordingly, residential electricity demand increases as the urbanization rate increases in the short-term.

On the other hand, error correction term of the model has been estimated as -0.474 and its sign is negative and is statistically significant on all significance levels as expected. Therefore, it can be explained that a deviation which will occur on residential electricity demand in the short-term may reach to long term balance by removing a portion of 47.4% in the next period. This also means that the established model is significant and that the model works.

5. DISCUSSION AND CONCLUSION

This study was conducted to reveal the factors affecting the residential electricity demand in Turkey. Factors that may affect residential electricity demand were predicted from a multi-dimensional perspective. Residential electricity demand was analyzed with the ARDL-Bound Testing developed by Pesaran, Shin and Smith (2001) using the annual data for the years 1990-2014 for Turkey.

As a result of the analysis, it was determined that electric price significantly and negatively affected residential electricity demand in both the short- and long-term. Similarly, real income per capita, urbanization rate and average temperature values significantly and positively affected residential electricity demand in both the short- and long-term.

The price elasticity value of residential electricity demand was found to be smaller than one in both the short- and long-term. Thus, considering the relationship between consumption and price elasticity, it can be suggested that an increase (or decrease) in the electricity prices when price elasticity of the demand is less than one, total consumption in the housing sector would decrease (or increase). Accordingly, it can be said that residential electricity demand in Turkey is inelastic.

In addition, similar to the related studies in the literature, price elasticity of demand in the long term was found to be higher than price elasticity of demand in the short-term. In this regard, the results of this study were consistent with that of Silk and Joutz (1997), Halvorsen and Larsen (2001), Akan and Tak (2003), Holtedahl and Joutz (2004), Halicioglu (2007), Filippini (2011) and Yaylali and Lebe (2013).

On the other hand, income elasticity of residential demand was estimated to be between zero and one ($0 < E_I < 1$) in the short-term and higher than one ($E_I > 1$) in the long-term. Accordingly, electricity can be considered as a normal good in the housing sector in Turkey. In the literature, the results of Silk and Joutz (1997), Akan and Tak (2003), Hotedahl and Joutz (2004), and Yaylali and Lebe (2013) support the results of our study.

Considering the relationship between urbanization rate and residential electricity demand, urbanization rate is observed to be significantly increasing residential electricity demand in both the short- and long-term. According to many studies in the literature, urbanization rate will significantly affect residential electricity demand (Lenzen, Dey and Foran, 2004; Halicioglu, 2007; Holtedahl and Joutz, 2004; Guta, Damte and Ferede, 2015).

In the long term, the most effective variable of residential electricity demand was found to be average temperature. This shows that residential electricity demand increases as average temperature increases in the long-term. Today, the average temperature values increase with the effects of global warming in Turkey. The average temperature was 12.9 degrees Celsius in 1990, rising to 14.5 degrees Celsius in 2014 in Turkey (Turkish State Meteorological Service, 2016). These increases in the temperature lead individuals to use more electricity for cooling purposes. Tserkezos (1992) and Lin et al. (2014) found a positive relationship between temperature and demand for electricity.

In Turkey, external resources are used in order to meet the electricity demand due to the increase in population and acceleration of urbanization. The use of external resources may have negative impacts on economic performance. Furthermore, increased demand for electricity leads to more production. Non-eco-friendly resources used for electricity production can cause adverse effects on the environment. These effects can lead to natural resource depletion. Hence, Turkey is required to develop policies oriented to reducing residential electricity consumption. In this context, the government should ensure effective electricity use and spend more effort on reducing residential electricity consumption in Turkey. For this purpose, policies promoting the use of energy saving machines and equipment in the residential areas should be developed. In addition, time tables can be developed for effective energy use by consumers using residential electric energy by determining their consumption patterns. Strategies encouraging renewable energy sources can be developed. For example, low-interest loans may be granted to enhance solar energy use in houses. Likewise, an incentive program for external insulation of buildings for energy saving can be created. Flexible pricing can also be implemented for different income groups.

ENDNOTES

1. The greenhouse effect is the effect of atmospheric gases like carbon dioxide absorbing energy from the sun and earth and trapping it near the Earth's surface, warming the Earth to a temperature range that is less hospitable for life. (For more details see http://climate.ncsu.edu/edu/k12/.greenhouseeffect)

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