Electric Consumption, Urbanization and Ruralization in Turkey: Long-run Analysis

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Abstract: In this study we analyze the long-run nexus between electric consumption, urbanization and ruralization in Turkey by means of ARDL estimation method for a time period of 1970- 2014. Owing to the fact that demand for electricity in urban area is relatively higher than rural area, we anticipate to get a positive association between urbanization and electric consumption and a negative association between ruralization and electric consumption in Turkey in the long-run.

According to the findings of co-integration test, electric consumption, urbanization and ruralization series are co-integrated and thus they move together in the long-run in Turkey. The long-run coefficient estimations reveal that an increase in urban population by 1% ends up with a rise of electric consumption by 2.62% and a rise in rural population by 1% leads to a drop of electric consumption by 2.42% in Turkey in the long-run. Moreover diagnostic test findings point out that the models used in long-run analyses do not suffer from any econometric problem in terms of non-normality, autocorrelation, heteroscedasticity, and model misspecification.

Key Words: Urbanization, Ruralization, Electric Consumption

Türkiye’de Elektrik Tüketimi, Kentleşme ve Kırsallaşma: Uzun Dönemli Analiz

Özet: Bu çalışmada Türkiye'de elektrik tüketimi, kentleşme ve kırsallaşma arasındaki uzun dönemli ilişki ARDL tahmin yöntemiyle 1970-2014 dönemi için analiz edilmiştir. Türkiye'de uzun vadede kentleşme ile elektrik tüketimi arasında pozitif, kırsallaşma ile elektrik tüketimi arasında ise negatif bir ilişki olmasını bekliyoruz.

Eşbütünleşme testinin bulgularına göre Türkiye'de elektrik tüketimi, kentleşme ve kırsallaşma serileri eşbütünleşik olup, uzun vadede birlikte hareket etmektedirler. Uzun dönem katsayı tahminleri, Türkiye'de kentsel nüfustaki %1'lik bir artışın elektrik tüketiminde %2,62'lik bir artışla sonuçlandığını ve kırsal nüfustaki %1'lik bir artışın Türkiye'de elektrik tüketiminde %2,42'lik bir düşüşe yol açtığını ortaya koymaktadır. Ayrıca, tanısal test bulguları, uzun dönemli analizlerde kullanılan modellerin normal olmama, otokorelasyon, değişen varyans ve model yanlış tanımlaması açısından herhangi bir ekonometrik sorun yaşamadığına işaret etmektedir.

Anahtar Kelimeler: Kentleşme, Kırsallaşma, Elektrik Tüketimi

1. INTRODUCTION

Urbanization is the period through which cities, grow, and higher and higher percentages of the population comes to live in city (National Geographic Society, 2019). Ruralization, on the other hand, can be defined as people moving away from large towns or cities and settling in smaller towns with less population (Ruralization, 2020).

Although urbanization is one of the most important key of economic development and is often perceived as an essential aspect in assessing the development level of countries (Li and Yao, 2009: 1994), however, rapid urbanization can have some negative consequences on environment like air pollution, industrial pollution, water pollution, solid waste and carbon emission. Although urbanization supports economic development but it causes pollution (Al-mulali, Sab, and Fereidouni, 2012: 156). Another negative situation created by urbanization is electricity consumption. Electricity crises can also be seen in regions where urbanization is intense due to the emergence of more energy need than in rural areas (Wang, 2014: 332).

Energy consumption has increased rapidly in developing countries as a result of economic growth. Like the developing countries in the world, Turkey’s energy demand has increased as a result of social and economic development (Balat, 2018: 118).

Energy is both a basic source of livelihood and an input used in production. The structure of energy consumption in rural areas has a big impact on the economy and on the well being of rural residents (Wang and Jiang, 2017: 452). The energy consumption in rural and urban areas differs. In rural areas, energy is generally used in housework and agriculture. However, in urban areas, energy use is seen in very different ways. Energy is needed in many different areas, from homes where people live to industry.

Urbanization is a very important development indicator besides the development and modernization in the industry. (Ghosh and Kanjilal, 2014). The World Bank draws attention to the fact that the share of cities in GDP is 80% in the world. The share of cities in GDP is increasing year by year. This shows that urbanization is an important phenomenon. Economists consider the increase in the share of cities in GDP as a success in increasing the level of wealth and welfare. Economists also welcome this increase, as urbanization is supporting development in growing economies. (Bloom, Canning and Fink, 2008).

The transition process from agriculture-based economy to industry and service-based economy causes the transfer of workforce from rural areas to urban areas. (Liddle, 2014). As a result of this transformation, people in rural areas migrate to cities and the population of cities increases. (Henderson, 2003). This transformation process has led to great changes in the use of natural resources and energy and is called urbanization. (Salim and Shafiei, 2014). The increase in economic activities in urban areas brings with it large increases in energy demand. (Shahbaz and Lean, 2012).

2. RELATED LITERATURE

Some researches finds that urbanization increases energy consumption. One of these studies used the Factor Decomposition Model and autoregressive distributed lag tests. As a result, there is causal evidence that urbanization increases energy consumption both in the short term and in the long term (Liu, 2009). Another study examining the relationship between urbanization and energy consumption examines the long-term impact of urbanization on energy consumption, using data from countries in seven regions over the period 1980-2008 (Al-mulali et al., 2008). Another study in this area empirically examines the effects of China's urbanization on residential energy consumption and manufacturing energy consumption through a time series. The results of the study show that, compared to rural areas, urbanization slows the growth of residential energy consumption per capita due to economies of scale and technological advantages associated with urbanization (Wang, 2014).

When we examine the energy consumption in rural areas, we see that is different than in urban areas. In the field of energy consumption, a survey was conducted in Bangladesh using a strafied random sampling technique of 120 households. This article focuses on household energy consumption and a result of this study, biomass, kerosene, electricity, LPG and candles emerged as the most used energies in rural households (Miah et al., 2010). Another study related to energy consumption in rural areas is a study based on a village energy survey. This study includes a field survey with a sample of 6000 households. When we examine the results of this study, while the use of natural gas is more common in the economically developed region, most of the people living in rural area use coal and electricity for heating (Wang and Jiang, 2017).

Chun-sheng et al., who have worked in this area, used SPIRPAT model to analyze the impact of population and income factors on the ecological footprint of energy use. Their study have shown that rural areas are generally ahead in energy consumption. However, it is seen that difference generally arises from coal and biomass fuels. As for electricity consumption, at this point, we can see that urban areas consume eight times more electricity than rural areas.

Zhang and Li investigated the effect of urbanization on energy consumption in Jiangsu Region, one of the most developed regions of China, and tried to reveal the relationship between energy consumption and urbanization. According to the results obtained in this study; Urbanization has accelerated the production energy consumption during the working period. They say that because of rapid urbanization, the gap between residential energy consumption for urban and rural areas has been widening since 2002.

According to another study that analyzed the econometric relationship between urbanization and energy consumption in China from 1990 to 2010 with cointegration theory and error correction model, we can see that there is a long-term equilibrium relationship between urbanization and total energy consumption. In addition, urbanization has different effects in terms of consumption of different energy sources (coal, electricity, natural gas). In addition, they also revealed that improving the level of urbanization will lead to an increase in the energy levels in the short term (Yan, Dong, and Yao, 2013).

Using a panel dataset covering the period 1975-2010 for 99 countries, Poumanyvong and Kaneko (2010) revealed that urbanization reduces energy demand in low-income economies, while urbanization increases energy demand in middle-income and high-income countries.

Parikh and Shukla (1995) investigated the effects of urbanization on energy consumption for 78 developed and developing countries during the 1965-1987 periods using panel data analysis and revealed that urbanization has positive effects on energy consumption.

L Liu (2009), Mishra et al. (2009) and Shahbaz et al. (2015) reveal that there is a unidirectional causality
In this study we examine the long-run relationship between electric consumption, urban and rural population in Turkey. Analyses are implemented by using ARDL estimation technique for an annual data running from 1970 to 2014. Demand for electricity in urban area is relatively higher than rural area since daily life in urban area requires to consume more electric power for the purposes of like cooking, heating, cooling, lighting, commuting, charging etc.. Given this fact, we have two hypotheses: i.) urbanization increases electric consumption in the long-run in Turkey and ii.) ruralization decreases electric consumption in the long-run in Turkey. Electric power consumption measured as kWh per capita is employed for electric

running from urbanization to energy consumption in both the short and long run. In addition, Salim and Shafiei (2014) and Ghosh and Kanjilal (2014) do not reach a causal relationship between urbanization and energy consumption, thus confirming the neutrality hypothesis.

3. DATA AND METHODOLOGY

consumption (ELCONPC). Urbanization (URBPOP) is represented by urban population in terms of percentage of total population whereas ruralization (RURPOP) is represented by rural population in terms of percentage of total population. All series are collected from the WDI database of World Bank and their logarithmic transformations are utilized in all analyses.

In order to determine if the series move together in the long-run we firstly need to conduct co-integration tests. Co-integration tests are implemented by using ARDL boundary test approach and for this purpose the following ARDL models are estimated:

$$\Delta \text{ELCONPC}_t = \alpha_0 + \sum_{i=1}^{p} \gamma_i \Delta \text{ELCONPC}_{t-i} + \sum_{i=0}^{q} \beta_i \Delta \text{URBPOP}_{t-i} + \vartheta_0 \text{ELCONPC}_{t-1} + \vartheta_1 \text{URBPOP}_{t-1} + \varepsilon_t \quad (1)$$

$$\Delta \text{ELCONPC}_t = \alpha_0 + \sum_{i=1}^{p} \gamma_i \Delta \text{ELCONPC}_{t-i} + \sum_{i=0}^{q} \beta_i \Delta \text{RURPOP}_{t-i} + \vartheta_0 \text{ELCONPC}_{t-1} + \vartheta_1 \text{RURPOP}_{t-1} + \varepsilon_t \quad (2)$$

In Equation 1 and 2, ϑ_0 and ϑ_1 notations stand for long-run coefficients; γ_i and β_i notations show short-run coefficients; Δ represents first degree difference operator; α_0 is intercept term of the model, and ε_t displays white noise error term of the model.

After the co-integration analyses, in order to obtain both short-run and long-run coefficient estimations we estimate the following error correction:

$$\text{ELCONPC}_t = \lambda_0 + \sum_{i=1}^{p} \delta_i \Delta \text{ELCONPC}_{t-i} + \sum_{i=0}^{q} \theta_i \Delta \text{URBPOP}_{t-i} + \phi ECM_{t-1} + \varepsilon_t \quad (3)$$

$$\text{ELCONPC}_t = \lambda_0 + \sum_{i=1}^{p} \delta_i \Delta \text{ELCONPC}_{t-i} + \sum_{i=0}^{q} \theta_i \Delta \text{RURPOP}_{t-i} + \phi ECM_{t-1} + \varepsilon_t \quad (4)$$

In Equation 3 and 4 above, δ_i and θ_i stand for the dynamic coefficients which bring the model back to the balance in the long-run; ECM shows error correction term in the model; ϕ represents adjustment speed which brings the series back to
Since ARDL boundary test requires to have series with an integration order no more than two we should examine the stationarity levels of the series. In other words, series stationary at more than second differences cannot be used in ARDL boundary test. Hence we checked stationarity levels of the series by employing Phillips-Perron (PP) unit

the long-run path in response to a shock taken place in the short-run. Meantime the coefficient of adjustment speed must be statistically significant and have a negative sign.

4. EMPIRICAL RESULTS

root test for three models, namely none, constant, and constant and trend models. The null hypothesis of PP unit root test claims the non-stationarity of the series against to the alternative hypothesis claims the stationarity of the series. Table 1 below shows the results of PP unit root tests.

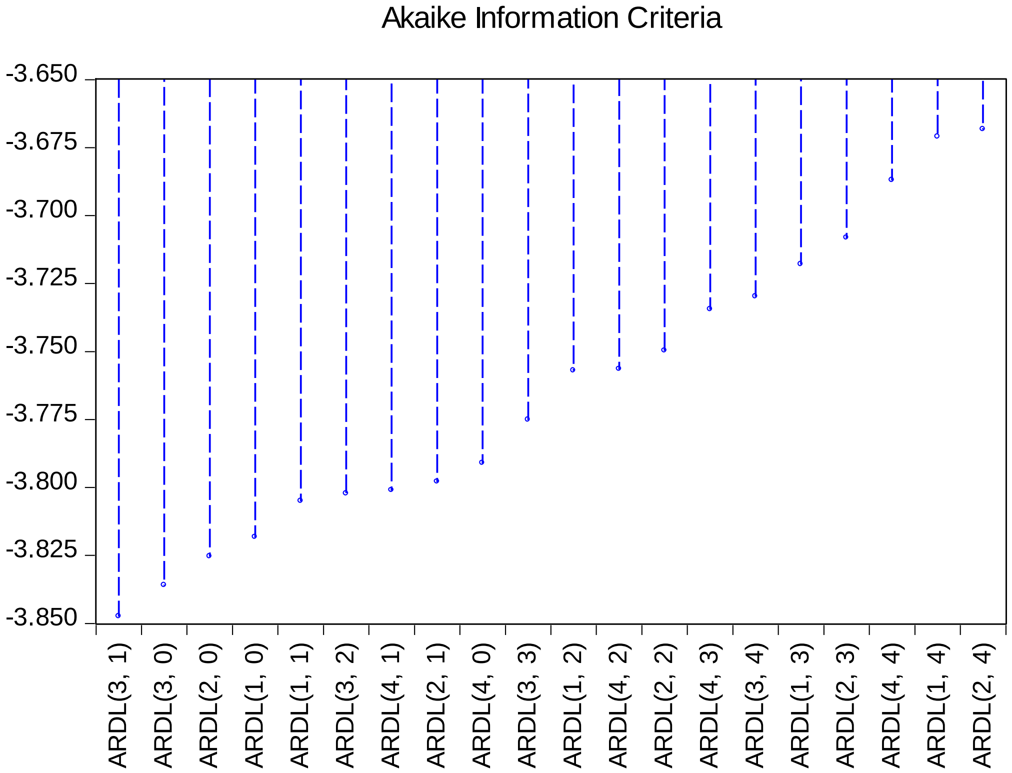
Table 1: Phillips-Perron Unit Root Test Results

Variable	Model	Test Statistic (P-value)
ELCONPC	None	6.746779 (1.0000)
	Constant	-3.186438(0.0275)
	Constant&Trend	-2.078258 (0.5432)
1. Diff. of ELCONPC	None	-2.123356 (0.0338)
	Constant	-4.434460 (0.0009)
	Constant&Trend	-4.847791(0.0017)
2. Diff. of ELCONPC	None	-14.75945 (0.0000)
	Constant	-
	Constant&Trend	-
RURPOP	None	-7.113784(0.0000)
	Constant	0.181653 (0.9683)
	Constant&Trend	-2.087280(0.5383)
1. Diff. of RURPOP	None	-
	Constant	-1.962537 (0.3017)
	Constant&Trend	-1.914902 (0.6295)
2. Diff. of RURPOP	None	-
	Constant	-4.361219 (0.0012)
	Constant&Trend	-4.260514 (0.0084)
URBPOP	None	4.641987 (1.0000)
	Constant	-1.709656 (0.4194)
	Constant&Trend	-0.639617 (0.9713)
1. Diff. of URBPOP	None	-1.179803(0.2139)
	Constant	-4.498185 (0.0008)
	Constant&Trend	-2.075584 (0.5443)
2. Diff. of URBPOP	None	-4.544615 (0.0000)
	Constant	-
	Constant&Trend	-4.453213 (0.0050)

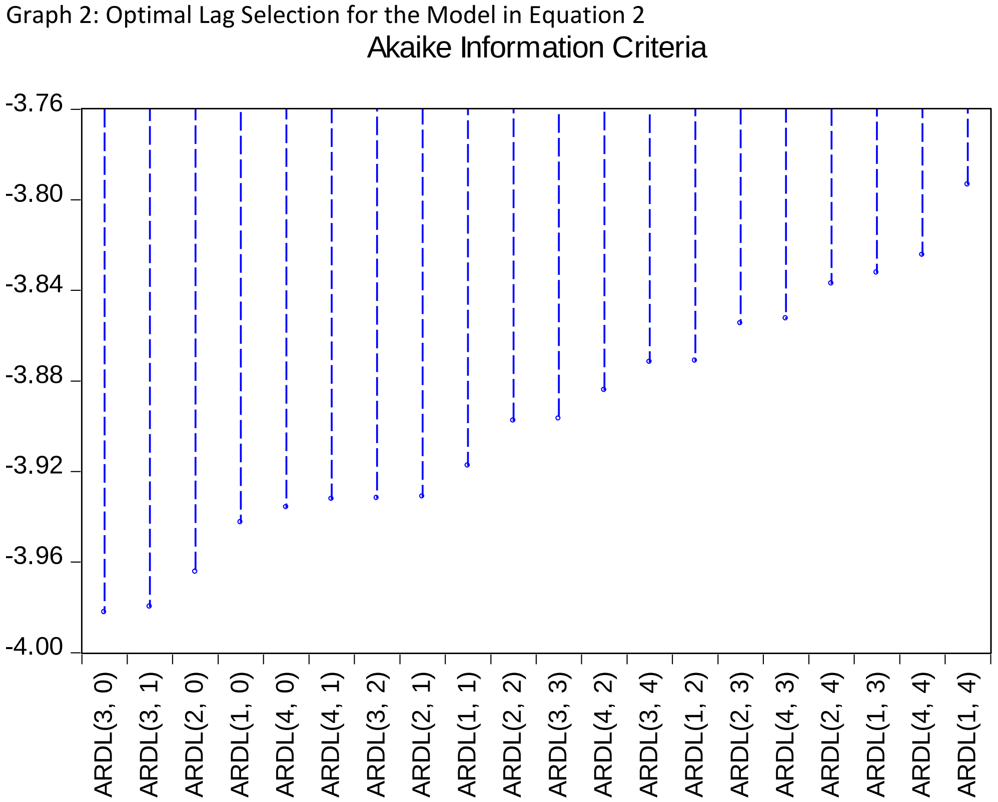
As can be seen from Table 1, ELCONPC variable is stationary at second difference for the model of none and is stationary at first difference for the models of constant and constant&trend. RURPOP variable is stationary at level for the model of none and is stationary at second difference for the models of constant and constant&trend. URBPOP variable is stationary at first difference for the model of constant and is stationary at second difference for the models of none and constant&trend. In overall, at 1% significance level, we can conclude that ELCONPC variable is I(1), RURPOP variable is I(2), and URBPOP variable is I(2). Thus since none of our variables is integrated order of more than two, we are able to conduct ARDL boundary test to examine the co-integration association between ELCONPC, URBPOP, and RURPOP variables.

By utilizing Akaike information criterion (AIC), optimal lag lengths for the models given in Equation 1 and 2 were chosen and the findings of optimal lag selection are provided in Graph 1 and 2 below. According to Graph 1 and 2, out of the evaluation of twenty different models, ARDL(3,1) model is the optimal model for the model given in Equation 1 and ARDL(3,0) model is the optimal model for the model given in Equation 2. Therefore we employ ARDL(3,1) model and ARDL(3,0) model in our analyses.

Graph 1: Optimal Lag Selection for the Model in Equation 1



Graph 2: Optimal Lag Selection for the Model in Equation 2



Co-integration test findings of ARDL boundary test are obtained in Table 2. Panel A, which shows the co-integration test result of ARDL(3,1) model, points out that URBPOP and ELCONPC series are co-integrated at 1% significance level. Panel B, which shows the co-integration test result of ARDL(3,0) model, hints that RURPOP and ELCONPC series are co-integrated at 1% significance level. Finally we can state that per capita electric power consumption, urban and rural population move together in the long-run in Turkey.

Table 2: Results of Co-integration Test

Panel A: Co-integration Test Results for ARDL(3,1) Model		
F-statistic: *5.731719*	**Critical Values**	
Significance	***Lower Bound***	***Upper Bound***
10%	3.02	3.51
5%	3.62	4.16
2.5%	4.18	4.79
1%	4.94	5.58
Panel B: Co-integration Test Results for ARDL(3,0) Model		
F-statistic: *10.69212*	**Critical Values**	
Significance	***Lower Bound***	***Upper Bound***
10%	3.02	3.51
5%	3.62	4.16
2.5%	4.18	4.79
1%	4.94	5.58

Table 3 displays long-run coefficient estimations for ARDL(3,1) and ARDL(3,0) models in Panel A and B respectively.

As seen from Panel A, urbanization has a positive significant long-run impact on per capita electric power consumption at 1% significance level. An increase in urban population by 1% causes to a rise of electric power consumption by 2.62% in Turkey. As implied by Panel B, ruralization possesses a negative significant long-run impact on per capita electric power consumption at 1% significance level. A rise in rural population by 1% leads to a drop of electric power consumption by 2.42% in Turkey.

Table 3: Long-run Coefficient Estimations

Panel A: Results for ARDL(3,1) Model			
Variable	*Coefficient*	*t-statistic*	*Prob.*
URBPOP	2.623951	6.174098	0.0000
C	-2.958151	-1.522247	0.1367
Panel B: Results for ARDL(3,0) Model			
Variable	*Coefficient*	*t-statistic*	*Prob.*
RURPOP	-2.429126	-14.186903	0.0000
C	16.243475	29.481794	0.0000

Short-run coefficient estimation are reported in Table 4 where Panel A and B provide the short-run coefficient estimations for ARDL(3,1) and ARDL(3,0) models respectively. Among the short-run coefficient estimations of ARDL(3,1) model, only second lag of ELCONPC variable is significant and takes a negative sign. Moreover, for ARDL(3,0) model, we have significant short-run coefficient estimations for first and second lags of ELCONPC variable with positive and negative signs respectively. URBPOP and RURPOP variables do not possess statistically significant short-run coefficient estimation. The coefficient estimations of error correction terms for ARDL(3,1) and ARDL(3,0) models, as anticipated, get statistically significant negative signs. As can be inferred from diagnostic test findings of Panel A and B, ARDL(3,1) and ARDL(3,0) models do not have any problem in the context of autocorrelation, heteroscedasticity, model specification error, and non-normal distribution at least at 5% significance level.

Table 4: Short-run Coefficient Estimations

Panel A: Short-run Coefficients for ARDL(3,1) Model			
	Coefficient	*t-Statistic*	*Prob.*
$\Delta ELCONPC_{t-1}$	0.234643	1.630662	0.1117
$\Delta ELCONPC_{t-2}$	-0.305481	-2.084939	0.0442
ΔURBPOP	-0.778136	-1.199115	0.2383
ECM_{t-1}	-0.099654	-4.260334	0.0001
ECM = ELCONPC - (2.6240*URBPOP -2.9582)			

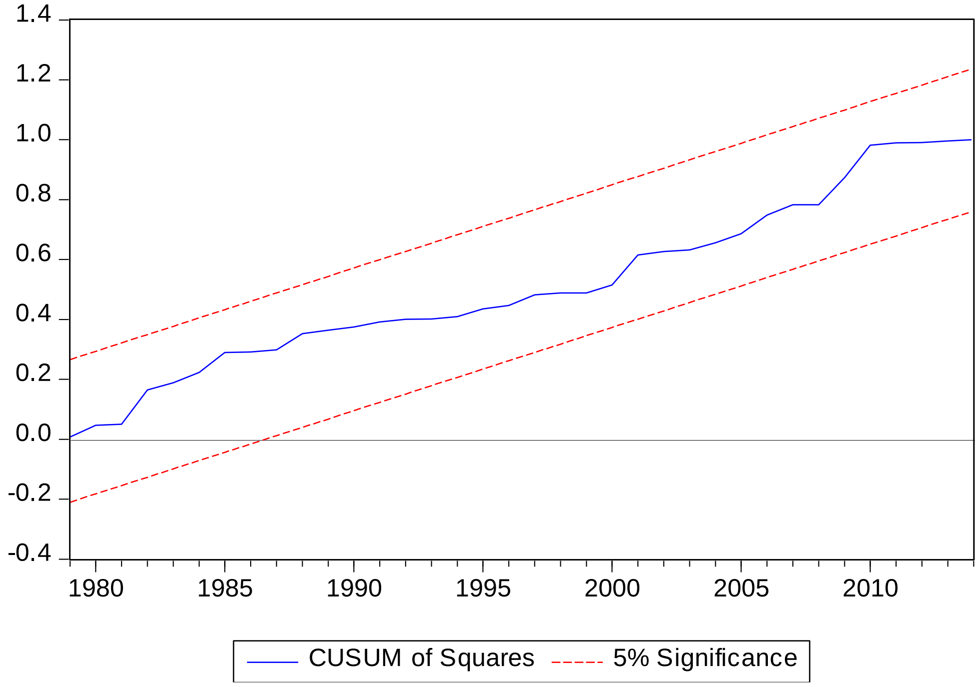
Diagnostic Tests	
Tests	Test Value (Prob.)
Breusch-Godfrey Serial Correlation LM Test	0.011675 *(0.9884)*
Breusch-Pagan-Godfrey Heteroskedasticity Test	0.422479 *(0.8299)*
Ramsey RESET Test	1.941317 *(0.1723)*
Jarque-Bera Normality Test	0.321767*(0.851391)*

Panel B: Short-run Coefficients for ARDL(3,0) Model			
	Coefficient	*t-Statistic*	*Prob.*
$\Delta ELCONPC_{t-1}$	0.258758	1.890817	0.0665
$\Delta ELCONPC_{t-2}$	-0.252863	-1.882970	0.0676
ΔRURPOP	-0.056626	-0.130412	0.8969
ECM_{t-1}	-0.176302	-4.546340	0.0001
ECM = ELCONPC - (-2.4291*RURPOP +16.2435)			

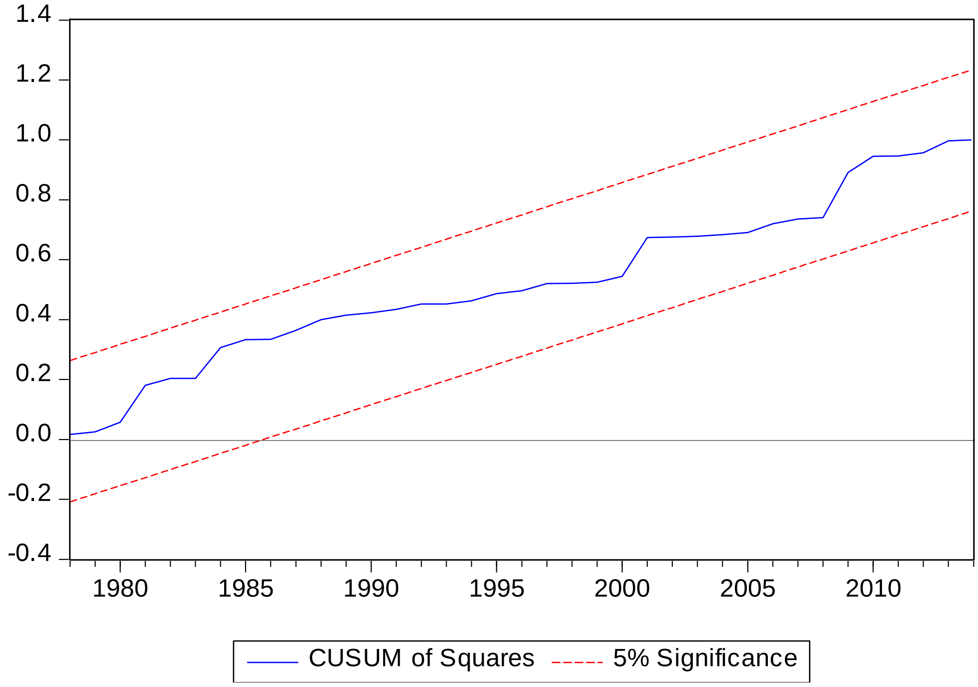
Diagnostic Tests	
Tests	Test Value (Prob.)
Breusch-Godfrey Serial Correlation LM Test	2.721391 *(0.0797)*
Breusch-Pagan-Godfrey Heteroskedasticity Test	0.098400 *(0.9823)*
Ramsey RESET Test	0.193945 *(0.6623)*
Jarque-Bera Normality Test	0.871900 *(0.646650)*

Cusum-square test results given in Graph 3 and 4 disclose that neither ARDL(3,1) model nor ARDL(3,0) model experience model instability problem. Therefore ARDL(3,1) and ARDL(3,0) models are stable.

Graph 3: Cusum-square Test for ARDL(3,1) Model



Graph 4: Cusum-square Test for ARDL(3,0) Model



5. CONCLUSION

The long-run association between per capita electric consumption, urbanization and ruralization in Turkey is addressed in this study by utilizing ARDL estimation technique for a time period of 1970-2014. Since demand for electricity in urban area is relatively higher than rural area, it is expected to see a positive relationship between urbanization and per capita electric consumption and a negative relationship between ruralization and per capita electric consumption in Turkey.

Co-integration test results indicate that electric consumption, urbanization and ruralization series are co-integrated and hence they act together in the long-run in Turkey. The long-run coefficient estimations show that urbanization has a positive statistically significant effect on electric consumption while ruralization has a negative statistically significant effect on electric consumption. In other words, a rise in urban population by 1% results in an increase of electric consumption by 2.62% and an increase in rural population by 1% causes to a decrease of electric consumption by 2.42% in Turkey. Also according to the diagnostic test results, our models used in long-run analyses do not face to any econometric problem in terms of non-normality, autocorrelation, heteroscedasticity, and model misspecification.

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