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The Electricity Consumption, Real Income, Trade Openness and Foreign Direct Investment: The Empirical Evidence from Turkey

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ABSTRACT

This study aims to explore both the long-run and causal relationships between electricity consumption per capita, real gross domestic product (GDP) per capita, trade openness and foreign direct investment inflows per capita in Turkey during the time period 1974-2013. The study employs the autoregressive distributed lag model and the augmented Granger causality model. The bounds F-test for cointegration test yields evidence of a long-run relationship between variables. The overall results from the three error-correction based Granger causality models show that there is an evidence of unidirectional short-run, long-run and strong causalities running from the electricity consumption per capita to real GDP per capita. But, there is no causal evidence from the real GDP per capita to electricity consumption per capita. This result also support that, "growth hypothesis" is confirmed in Turkey. As a policy implication, the energy growth policies regarding electricity consumption should be adopted in such a way that the development of this sector stimulates economic growth.

Keywords: Electricity Consumption, Economic Growth, Causality
JEL Classifications: C32, C52, Q43

1. INTRODUCTION

Energy consumption and economic growth relationship has been widely discussed in the energy economics literature since the seminal work of Kraft and Kraft (1978) who found evidence in favour of causality running from gross national product (GNP) to energy consumption in the United States, using data for the period 1947-1974. This issue has been analyzed by many academicians and become popular in the last two decades. The relationship between electricity consumption, foreign direct investment (hereafter, FDI), trade openness, and economic growth has lately started to be discussed in energy economics literature. Often in the literature, the impact of energy consumption and FDI on economic growth has been studied separately. It is important to empirically investigate whether there is a causal link between electricity consumption and economic growth, and identify the way of causality if there is a causal relationship. The direction of causality has significant policy implications for designing and implementing energy policies. There are four testable hypotheses related energy-growth nexus in the literature which are as follows (Jumbe, 2004): (1) Neutrality hypothesis: The neutrality hypothesis is supported by the absence of a causal relationship between electricity consumption and real gross domestic product (GDP). Neutrality hypothesis states: That electricity conservation policies will have no effect on economic growth. (2) Conservation hypothesis: It is also called unidirectional causality running from economic growth to electricity consumption. If such is the case, electricity conservation policies designed to reduce electricity consumption and waste will have a little or no effect on economic growth. (3) Growth hypothesis: It implies that causality runs from electricity consumption to economic growth. The growth hypothesis suggests that electricity consumption plays an important role on the economic growth. In this case, the reduction in electricity consumption due to electricity conservation-oriented policies may have a detrimental impact on economic growth. (4) Feedback hypothesis: It implies that there is two-way (bidirectional) causality between electricity consumption and economic growth.

On the other hand, the theoretical and empirical literature on the relationship between FDI and economic growth is quite extensive. FDI is often seen as an important catalyst for economic growth (Le and Suruga, 2005). FDI inflows contribute to economic growth through increasing productivity by providing new investment, better technologies and managerial skills to the host countries. Thus, the causal link from FDI to growth has been popular in the relevant literature. However, as also mentioned by Chakraborty and Basu (2002), the causal link goes from economic growth to FDI.

Turkey has abandoned import-substitution economic model through regulation which includes adopting export-orinted economich model. Afterwards, capital movements liberated by abolishing exchange control system in 1989. Some changovers have experienced in Turkey's economy by replacing of enegy-dense industrial products instead of agricultural products. On the one hand; rural population has decreased, on the other hand urban population have increased and this case has fostered development of industry and service sector. Therefore, energy consumption has influenced by in terms of two cases: (i) The amount of energy has increased which used in industry, (ii) energy demand has increased at urban areas by raising of population. In 2012; electricity consumption per capita has occured approximately 2789 kwh while approximately 496 kwh in 1980 (World Bank, 2015). In one hand; high increases in the amount of enegry demand and Turkey's energy importer position, on the other hand; financial needs for investment and economical transformation have stimulated current account deficit problem in Turkish economy. These conditions have brought the FDIs to strategic position.

Turkey has experienced an increase on GDP with export-oriented growth model. Besides increasing prosperity; energy consumption has increased through becoming of industry as prominent sector in economy and rising prosperity in Turkey. The World Bank's ESMAP Report (2000) has shown that since the 1980s electricity consumption has been growing at an approximate average rate of 7.7% annually and the real GNP by 4.2% in Turkey. The relation between GDP and electricity consumption is presented in Figure 1. It shows that: (i) Both series are moving smoothly with an upward trend, but (ii) electricity consumption has a higher growth rate than GDP. This means that the higher demand for electricity in Turkey is growing rapidly due to the technical, social and economic development.

Most previous studies have shown that higher economic growth requires more energy consumption. It has also been found that FDI is often a key determinant of economic growth. It is therefore worthwhile to investigate the nexus between energy consumption, FDI and economic growth by considering them simultaneously in a modeling framework. Also, for developing countries which have high current account deficit and limited resources FDI such as Turkey, trade openess and electricity consumption have serious significance. Therefore, in this study effects of FDI, trade openess and electricity consumption on economic growth will be examined with autoregressive distributed lag (hereafter ARDL) bounds testing approach of cointegration by Pesaran and Shin (1999) and Pesaran et al. (2001), and error-correction based Granger causality models for Turkey.

The rest of the paper is organized as follows: The Section 2 presents the literature review on the electricity consumption – economic growth nexus in Turkey. The Section 3 explains the methodology and data; the Section 4 reports the empirical results and the Section 5 concludes the paper.

2. LITERATURE REVIEW

The empirical results have yielded mixed results in terms of the four hypotheses (neutrality, conservation, growth, and feedback) and electricity consumption - economic growth nexus is an unresolved issue. There exist the contractionary results and no concensus about the existence of relationship and direction of causality in the literature and Turkey has no exception. Ozturk (2010) emphasizes that using different data sets, alternative econometric methodologies and different countries' characteristics are the main reasons of this conflicting result. The empirical results of related studies on electricity consumption-growth nexus for Turkey are summarized in Table 1.

3. MODEL, DATA DESCRIPTION AND METHODOLOGY

In empirical literature on electricity consumption - economic growth, it can be seen that most of the studies are using only GDP and energy or electricity consumption variables in their models (Payne, 2010) (Table 1). In other words, bivariate models were used in many of these empirical studies. Since the question of whether electricity consumption causes economic growth or economic growth causes electricity consumption is an unresolved issue, this paper may be considered as a complementary study to the previous studies. Because most of the earlier studies on the electricity consumption - growth nexus were using only two variables. In other words, they were employed bivariate models which cause an omitted variable problem. Thus, to avoid this problem, we used a multivariate model in this study by adding also trade openness and FDI variables into model. Following the empirical literature, the standard log-linear functional specification of long-run relationship between the real GDP, electricity consumption, trade openness and FDI may be expressed as:

$$y_t = \alpha + \beta elc_t + \varphi tr_t + \gamma\, fdi_t + \varepsilon_t \qquad (1)$$

Where y is real GDP per capita (constant 2005 US$), elc is electric power consumption per capita (kWh), tr is trade openness (%), fdi is FDI inflows per capita (constant 2005 US$), ε_t is the error term. The annual Turkish time series data (except fdi) are taken for 1974-2013 from the world development indicators (WDI) online database. FDI inflows data from WDI is converted into per capita (constant 2005 US$) values. All variables are employed with their natural logarithms form to reduce heteroscedasticity and to obtain the growth rate of the relevant variables by their differenced logarithms.

The relationship between the electricity consumption and economic growth will be performed in two steps. First, we will define the long-run relationships among the variables by using the ARDL bounds

Figure 1: The electricity consumption, real gross domestic product, trade openness and foreign direct investments (a) In log-levels (b) In growth rates

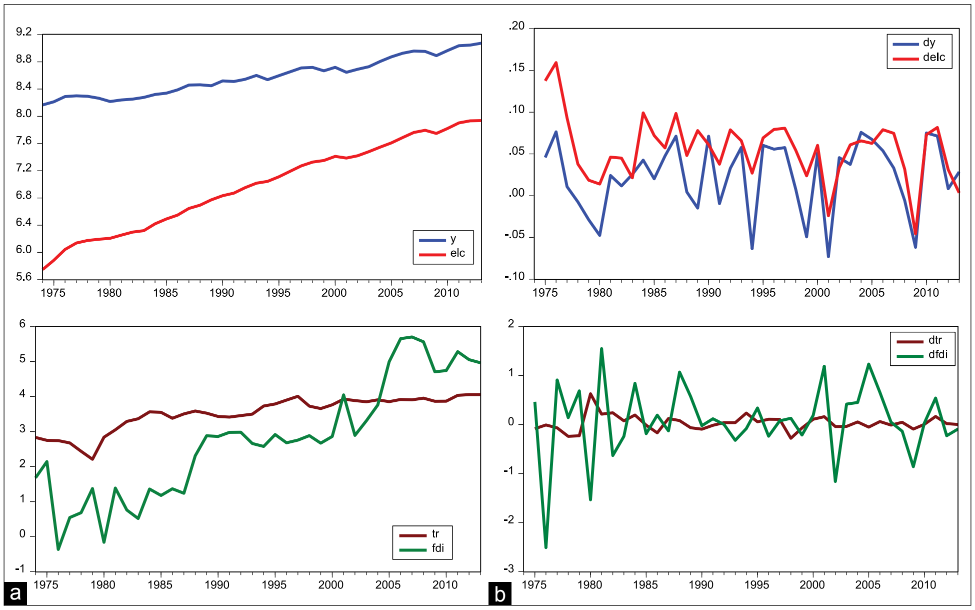


Table 1: Summary of empirical studies on electricity consumption-growth nexus for Turkey

Authors	Period	Variables	Methodology	Conclusion
Murray and Nan (1996)	1950-1970	Electricity consumption, GDP	Granger causality, VAR	*ELC→GDP*
Altinay and Karagol (2005)	1950-2000	Electricity consumption, GDP	Granger-causality, Dolado–Lutkepohl causality	*ELC→GDP*
Halicioglu (2007)	1968-2005	Residential electricity consumption, GDP, residential electricity price, the urbanization rate	Granger causality, ARDL cointegration	*GDP→ELC*
Aktas and Yılmaz (2008)	1970-2004	Electricity consumption, GDP	Granger causality tests	*ELC→GDP* (SR) *GDP→ELC* (LR)
Erbaykal (2008)	1970-2003	Real income, electricity consumption, petroleum consumption	ARDL cointegration	*ELC, P→GDP*
Narayan and Prasad (2008)	1960-2002	Electricity consumption, GDP	Bootstrapped Granger-causality	*ELC≠GDP*
Soytas and Sari (2007)	1968-2002	Industry electricity consumption, value added-manufacturing, manufacturing employment, manufacturing real fixed investment	Granger-causality, VEC, JJ cointegration	*IELC→MVA*
Acaravci (2010)	1968-2005	Electricity consumption, GDP	Johansen cointegration test, Granger Causality	*ELC→GDP*
Acaravci and Ozturk (2012)	1968-2006	Electricity consumption, employment ratio GDP	ARDL Granger causality	*ELC→GDP*
Aslan (2013)	1968-2008	Electricity consumption, GDP	ARDL model and VECM Granger causality tests	*ELC≠GDP* (SR) *ELC↔GDP* (LR)
Nazlioglu et al. (2014)	1967-2007	Electricity consumption, GDP	ARDL model and VECM Granger causality tests	*ELC↔GDP* (LA) *ELC≠GDP* (NLA)
Pempetzoglou (2014)	1945-2006	GNP, total electricity consumption (TC), residential and commercial electricity consumption (RC), government electricity consumption (GO), Street electricity consumption (SI) and industrial electricity consumption (IC)	Diks and Panchenko causality test	*GNP→RC, SI, IC* *RC→GNP*
Aslan (2014)	1980-2008	Electricity consumption, employment ratio GDP	ARDL Granger causality	*ELC↔GDP* (SR) *ELC→GDP* (LR)
Dogan (2015)	1990-2012	Electricity consumption from renewable sources electricity consumption from non-renewable sources, GDP, capital, labor	ARDL Granger causality Gregory–Hansen cointegration test with structural break, the Johansen cointegration test	*RELC≠GDP* (SR) *NRELC≠GDP* (SR) *RELC→GDP* (LR) *NRELC↔GDP* (LR)

→, ↔ and ≠ represent unidirectional causality, bidirectional causality and no causality, respectively. VAR: Vector autoregressive model, VEC: Vector error correction model, JJ: Johansen–Juselius, ARDL: Autoregressive distributed lag, ELC: Electricity consumption, GDP: Real gross domestic product, IELC: Industrial electricity consumption, MVA: Manufacturing value added, RELC: Electricity consumption from renewable sources, NRELC: Electricity consumption from renewable sources, SR: Short-run, LR: Long-run, LA: Li near analyses, NLA: Non-linear analyses, GNP: Gross national product.

testing approach of cointegration. Secondly, we will test causal relationships by using the error-correction based causality models.

3.1. ARDL Cointegration Analysis

The ARDL bounds testing approach of cointegration is developed by Pesaran and Shin (1999) and Pesaran et al. (2001). The ARDL cointegration approach has numerous advantages in comparison with other cointegration methods such as Engle and Granger (1987), Johansen (1988), and Johansen and Juselius (1990) procedures: (i) It is efficent estimator even if samples are small and some of the regressors are endogenous, (ii) it allows that the variables may have different optimal lags, and (iii) it employs a single reduced form equation and thus it has less loss in degree of freedom, (iv) no need for all the variables in the system be of equal order of integration, therefore it does not require the pre-testing of the variables, included in the model, for stationary analysis (Pesaran and Shin,1999; Pesaran et al., 2001).

However, if the order of integration of any of the variables is <1, for example an I(2) variable, then the critical bounds provided by Pesaran et al. (2001) and Narayan (2005) are not valid. They are computed on the basis that the variables are I(0) or I(1). For this purpose, it is necessary to test for unit root to ensure that all the variables satisfy the underlying assumption of the ARDL bounds testing approach of cointegration methodology before proceeding to the estimation stage. In order to overcome the low power problems associated with conventional unit root tests especially in small samples, we therefore prefer the weighted symmetric augmented Dickey–Fuller test (ADF-WS) of Park and Fuller (1995), and the generalized least squares version of the Dickey–Fuller test (ADF-GLS) proposed by Elliot et al. (1996). These tests require much shorter sample sizes than conventional unit root tests to attain the same statistical power. Leybourne et al. (2005) have recently noted that ADF-WS has good size and power properties compared to other tests.

Basically, the ARDL approach involves two steps for estimating long-run relationship. The first step is to investigate the existence of long-run relationship among all variables in the equation. The ARDL model for the standard log-linear functional specification of long-run relationship between the real GDP per capita, electricity consumption per capita, trade openness and FDI per capita may follows as:

$$\Delta y_t = \alpha_1 + \sum_{i=1}^{a1}\phi_{1i}\Delta y_{t-i} + \sum_{p=0}^{b1}\beta_{1p}\Delta elc_{t-p} + \sum_{q=0}^{c1}\varphi_{1q}\Delta tr_{t-q} + \sum_{r=0}^{d1}\gamma_{1r}\Delta fdi_{t-r} + \delta_1 y_{t-1} + \delta_2 elc_{t-1} + \delta_3 tr_{t-1} + \delta_4 fdi_{t-1} + \varepsilon_{1t} \quad (2)$$

Where ε_{1t} and Δ are the white noise term and the first difference operator, respectively. An appropriate lag selection based on a criterion such as Akaike information criterion and Schwarz Bayesian criterion (SBC). The bounds testing procedure is based on the joint F-statistic or Wald statistic that is tested the null of no cointegration, H_0: $\delta_i = 0$, against the alternative of H_1: $\delta_i \neq 0$, $i = 1, 2, 3, 4$.

Two sets of critical values that are reported in Pesaran et al. (2001) provide critical value bounds for all classifications of the regressors into purely I(1), purely I(0) or mutually cointegrated. If the calculated F-statistics lies above the upper level of the band, the null is rejected, indicating cointegration. If the calculated F-statistics is below the lower critical value, we cannot reject the null hypothesis of no cointegration. Finally, if it lies between the bounds, a conclusive inference cannot be made without knowing the order of integration of the underlying regressors. If there is evidence of long-run relationships (cointegration) between the variables, the second step is to estimate the following long-run and short-run models that are represented in Equations (3) and (4):

$$y_t = \alpha_2 + \sum_{i=1}^{a2}\phi_{2i} y_{t-i} + \sum_{p=0}^{b2}\beta_{2p} elc_{t-p} + \sum_{q=0}^{c2}\varphi_{2q} tr_{t-q} + \sum_{r=0}^{d2}\gamma_{2r} fdi_{t-r} + \varepsilon_{2t} \quad (3)$$

$$\Delta y_t = \alpha_3 + \sum_{i=1}^{a3}\phi_{3i}\Delta y_{t-i} + \sum_{p=0}^{b3}\beta_{3p}\Delta elc_{t-p} + \sum_{q=0}^{c3}\varphi_{3q}\Delta tr_{t-q} + \sum_{r=0}^{d3}\gamma_{3r}\Delta fdi_{t-i} + \psi ect_{t-1} + \varepsilon_{3t} \quad (4)$$

Where, Ψ is the coefficient of error correction term (hereafter *ect*). *ect*, defined as:

$$ect_t = y_t - \alpha_2 - \sum_{i=1}^{a2}\phi_{2i} y_{t-i} - \sum_{p=0}^{b2}\beta_{2p} elc_{t-p} - \sum_{q=0}^{c2}\varphi_{2q} tr_{t-q} - \sum_{r=0}^{d2}\gamma_{2r} fdi_{t-r} \quad (5)$$

It shows how quickly variables converge to equilibrium and it should have a statistically significant coefficient with a negative sign.

3.2. Causality Analysis

ARDL cointegration method tests the existence or absence of long-run relationships between real GDP per capita, electricity consumption per capita, trade openness and FDI per capita. It doesn't indicate the direction of causality. We use the two-steps procedure from the Engle and Granger (1987) model to examine the causal relationship between the variables. Once estimating the long-run model in Equation (3) in order to obtain the estimated residuals, the next step is to estimate error-correction based Granger causality models. As opposed to the conventional Granger causality method, the error-correction based causality test allows for the inclusion of the lagged error-correction term derived from the cointegration equation (Odhiambo, 2009).

This approach allows us to distinguish between "short-run" and "long-run" Granger causality. Non-significance or elimination of any of the "lagged error-correction terms" affects the implied long-run relationship and may be a violation of theory. The non-significance of any of the "differenced" variables reflects only short-run relationship (Masih and Masih, 1996). Thus, the following models may employ to explore the causal relationships between the variables:

$$\begin{bmatrix}\Delta y_t\\ \Delta elc_t\\ \Delta tr_t\\ \Delta fdi_t\end{bmatrix} = \begin{bmatrix}\mu_1\\ \mu_2\\ \mu_3\\ \mu_4\end{bmatrix} + \begin{bmatrix}\pi_{11,1} & \pi_{12,1} & \pi_{13,1} & \pi_{14,1}\\ \pi_{21,1} & \pi_{22,1} & \pi_{23,1} & \pi_{24,1}\\ \pi_{31,1} & \pi_{32,1} & \pi_{33,1} & \pi_{34,1}\\ \pi_{41,1} & \pi_{42,1} & \pi_{43,1} & \pi_{44,1}\end{bmatrix}\begin{bmatrix}\Delta y_{t-1}\\ \Delta elc_{t-1}\\ \Delta tr_{t-1}\\ \Delta fdi_{t-1}\end{bmatrix} + \ldots + \begin{bmatrix}\pi_{11,k} & \pi_{12,k} & \pi_{13,k} & \pi_{14,k}\\ \pi_{21,k} & \pi_{22,k} & \pi_{23,k} & \pi_{24,k}\\ \pi_{31,k} & \pi_{32,k} & \pi_{33,k} & \pi_{34,k}\\ \pi_{41,k} & \pi_{42,k} & \pi_{43,k} & \pi_{44,k}\end{bmatrix}\begin{bmatrix}\Delta y_{t-k}\\ \Delta elc_{t-k}\\ \Delta tr_{t-k}\\ \Delta fdi_{t-k}\end{bmatrix} + \begin{bmatrix}\psi_1\\ \psi_2\\ \psi_3\\ \psi_4\end{bmatrix} ect_{t-1} + \begin{bmatrix}\varepsilon_{4t}\\ \varepsilon_{5t}\\ \varepsilon_{6t}\\ \varepsilon_{7t}\end{bmatrix} \quad (6)$$

Residual terms, ε_{4t}, ε_{5t}, ε_{6t} and ε_{7t}, independently and normally distributed with zero mean and constant variance. Using Equation (6), causal relationships can be examined in three ways: (i) Short-run or weak Granger causalities are detected through the F-statistics or Wald test for the significance of the relavant π coefficients on the first differenced series, (ii) another possible source of causation is the *ect* in equations; the long-run causalities are examined through the t-test or Wald test for the significance of the relavant ψ coefficient on the lagged error-correction term, (iii) strong Granger causalities are detected by joint testing of significance of the relavant π and ψ coefficients (Table 2).

4. EMPIRICAL RESULTS

Results of the ADF-WS and the ADF-GLS are presented in Table 3. The null hypotesis is unit root and the alternative hypothesis is level stationarity for both tests. The Dickey–Fuller regressions include an intercept and a linear trend in the levels, and include an intercept in the first differences. The numbers of optimal lags are based on SBC. 95% simulated critical values for 38 observations computed by stochastic simulations. The results indicate that all variables in model are I(1) and thus we can confidently apply the ARDL methodology to that model.

According to Pesaran and Shin (1999), the SBC is generally used in preference to other criteria because it tends to define more parsimonious specifications. With the limited observations, this study used the SBC to select an appropriate lag for the ARDL model. Table 4 presents the estimated ARDL (1,1,0,0) model that has passed several diagnostic tests that indicate no evidence of serial correlation and and heteroskedasticity. Besides this, the ADF unit root test for the residuals revealed that they are stationary.

The bounds F-test for cointegration test yields evidence of a long-run relationship between electricity consumption per capita and real GDP per capita at 1% significance level in Turkey. The estimated log-linear long-run coefficient of the electricity consumption per capita is about 0.537 and positive. This coefficient implies the elasticity of electricity consumption and an increase in electricity consumption per capita will raise the real GDP per capita by 54%. The estimated *ect* is also negative (-0.326) and statistically significant at 1% confidence level. *ect* indicates that any deviation from the long-run equilibrium between variables is corrected about 33% for each period and takes about 3 periods to return the long-run equilibrium level.

Due to the structural changes in the Turkish economy it is likely that macroeconomic series may be subject to one or multiple structural breaks. For this purpose, the stability of the short-run and long-run coefficients is checked through the cumulative sum (CUSUM) and CUSUM of squares (CUSUMSQ) tests proposed by Brown et al. (1975). Unlike Chow test, requires break point(s)

Table 2: The null hypotheses for Granger causalities

Variables	Short-run causality			
	Δy	Δelc	Δtr	Δfdi
Δy	-	$\pi_{12,1}=\ldots=\pi_{12,k}=0$	$\pi_{13,1}=\ldots=\pi_{13,k}=0$	$\pi_{14,1}=\ldots=\pi_{14,k}=0$
Δelc	$\pi_{21,1}=\ldots=\pi_{21,k}=0$	-	$\pi_{23,1}=\ldots=\pi_{23,k}=0$	$\pi_{24,1}=\ldots=\pi_{24,k}=0$
Δtr	$\pi_{31,1}=\ldots=\pi_{31,k}=0$	$\pi_{32,1}=\ldots=\pi_{32,k}=0$	-	$\pi_{34,1}=\ldots=\pi_{34,k}=0$
Δfdi	$\pi_{41,1}=\ldots=\pi_{41,k}=0$	$\pi_{42,1}=\ldots=\pi_{42,k}=0$	$\pi_{43,1}=\ldots=\pi_{43,k}=0$	-

Variables	Long-run causality	Strong causality
Δy	$\psi 1=0$	$\pi_{12,1}=\ldots=\pi_{12,k}=\pi_{13,1}=\ldots=\pi_{13,k}=\pi_{14,1}=\ldots=\pi_{14,k}=\psi_1=0$
Δelc	$\psi 2=0$	$\pi_{21,1}=\ldots=\pi_{21,k}=\pi_{23,1}=\ldots=\pi_{23,k}=\pi_{24,1}=\ldots=\pi_{24,k}=\psi_2=0$
Δtr	$\psi 3=0$	$\pi_{31,1}=\ldots=\pi_{31,k}=\pi_{32,1}=\ldots=\pi_{32,k}=\pi_{34,1}=\ldots=\pi_{34,k}=\psi_3=0$
Δfdi	$\psi 4=0$	$\pi_{41,1}=\ldots=\pi_{41,k}=\pi_{42,1}=\ldots=\pi_{42,k}=\pi_{43,1}=\ldots=\pi_{43,k}=\psi_4=0$

Table 3: Unit roots test results

Variables	In levels		1st differences	
	ADF-GLS	ADF-WS	ADF-GLS	ADF-WS
y	−2.7122 (0) c+t	−2.8111 (0) c+t	−6.0457 (0) c	−6.3978 (0) c
elc	−2.0639 (1) c+t	−1.9372 (1) c+t	−3.2459 (0) c	−3.9031 (0) c
tr	−2.1693 (0) c+t	−2.3794 (0) c+t	−4.8997 (0) c	−5.4511 (0) c
fdi	−2.9962 (1) c	−2.7133 (1) c+t	−2.7133 (1) c	−5.0839 (1) c
Critical values	−3.3379 (0)	−3.4561 (0)	−3.2459 (0)	−2.4860 (0)
	−3.3715 (1)	−3.5550 (1)	−2.3131 (1)	−2.6078 (1)

Model c+t has the Dickey–Fuller regressions include an intercept and a linear trend, model c has the Dickey–Fuller regressions include an intercept but not a trend. Numbers of lags are in ( ). CV is the 95% simulated critical value using 38 observations and computed by stochastic simulations for relevant numbers of lags are in ( ) using 1000 replications. CV: Coefficient of variation, ADF-GLS: Generalized least squares version of the ugmented Dickey–Fuller test, ADF-WS: Weighted symmetric augmented Dickey–Fuller test to be specified, the CUSUM and CUSUMSQ tests are quite general tests for structural change in that they do not require a prior determination of where the structural break takes place. Figure 2 presents the plot of CUSUM and CUSUMSQ tests statistics that fall inside the critical bounds of 5% significance. This implies that the estimated parameters are stable over the period of 1974-2013.

This study also explores causal relationship between the variables in terms of the three error-correction based Granger causality models (Weak [short-run] Granger causality, long-run Granger causality, and strong Granger causality). The results from three kinds of Granger causality may follow as (Table 5 and Figure 3):

Table 4: Estimated short-run and long-run coefficients using the ARDL (1,1,0,0)

Variables			Short-run		Long-run
y(-1)			0.680 [0.000]		
elc			1.023 [0.000]		0.537 [0.000]
elc(-1)			−0.851 [0.000]		
tr			−0.027 [0.215]		−0.085 [0.148]
fdi			0.001 [0.944]		0.001 [0.943]
Constant			1.606 [0.015]		5.022 [0.000]
R^2	0.9925	NORM	0.225 [0.636]	*ect*	−0.320 [0.004]
Adjusted R^2	0.9913	LM	1.842 [0.175]	ADF	−5.913 (−5.176)
RSS	0.0248	HET	0.252 [0.616]	F	5.1664

RSS is residual sum of squares. NORM, LM and HET are the lagrange multiplier statistics for normality, serial correlation and heteroskedasticity of residuals, respectively. These statistics are distributed as χ^2 distribution with two degree of freedom for NORM and one degree of freedom for LM and HET. ECT is the estimated coefficient of error correction term. P values for the estimated coefficients and statistics are in [ ]. ADF is unit root test statistics for residuals and its 5% critical value is in ( ). F is the ARDL bounds test. The critical values for the lower I (0) and upper I (1) bounds are 3.5603 and 4.7918 for 5% significance level, respectively.The critical value bounds are computed by stochastic simulations using 20,000 replications. ARDL: Autoregressive distributed lag.

i. There is evidence of a unidirectional short-run causality running from the electricity consumption per capita to the real GDP per capita
ii. There is evidence of a unidirectional short-run causality running from the trade openness to FDI per capita
iii. There are evidences of long-run and strong causalities running from the electricity consumption per capita, trade openness, and FDI per capita to the real GDP per capita.

These results confirms "growth hypothesis" for Turkey which suggest that electricity consumption plays an important role in economic growth. Thus, any reducing (increasing) in electricity consumption could lead to a fall (rise) in growth of Turkish economy.

5. CONCLUSION

There is a growing literature that examines the causality relationship between electricity consumption and real GDP. Yet, the empirical results have yielded mixed results in terms of the four hypotheses (neutrality, conservation, growth, and feedback) related to the causal relationship between electricity consumption and economic growth. This study may be considered as a complementary study to the previous studies about the causal relationship between energy consumption and economic growth for Turkey.

This paper investigates both the long-run and causal relationships between real GDP per capita, electricity consumption per capita, trade openness and FDI per capita in Turkey for 1974-2013 period by using Granger causality models augmented with a lagged error-correction term. The bounds F-test for cointegration test

Table 5: Granger causalities

Variables	Short-run causality			
	Δ*y*	**Δ*elc***	**Δ*tr***	**Δ*fdi***
Δ*y*	-	7.0601 (0.0293)	1.1016 (0.5765)	1.2994 (0.5220)
Δ*elc*	2.7398 (0.2541)	-	0.9262 (0.6293)	1.2245 (0.5366)
Δ*tr*	1.1036 (0.5759)	3.3651 (0.1859)	-	0.7831 (0.6760)
Δ*fdi*	0.5133 (0.7736)	0.0759 (0.9628)	4.6077 (0.0999)	-
Variables	**Long-run causality**	**Strong causality**		
Δ*y*	15.1418 (0.0005)	25.0652 (0.0015)		
Δ*elc*	0.8150 (0.6653)	3.6357 (0.8884)		
Δ*tr*	2.1521 (0.3409)	12.7571 (0.1205)		
Δ*fdi*	0.1613 (0.9225)	8.4155 (0.3940)		

The null hypothesis is that there is no causal relationship between variables. Values in parentheses are P values for Wald tests with a χ^2 distribution. Δ is the first difference operator

Figure 2: Plot of cumulative sum of squares and cumulative sum test

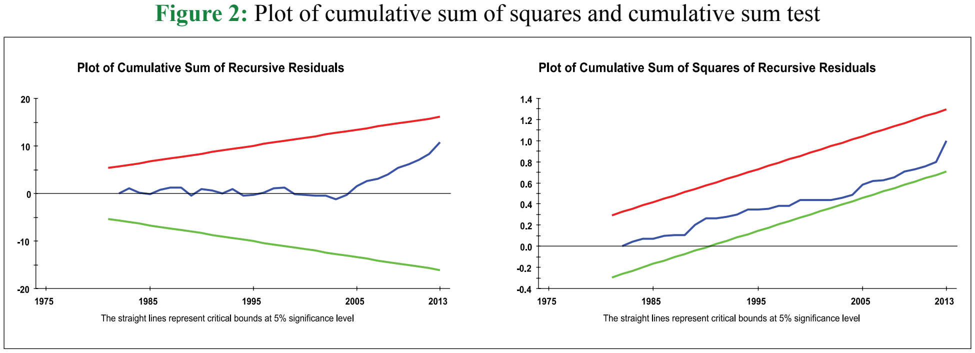
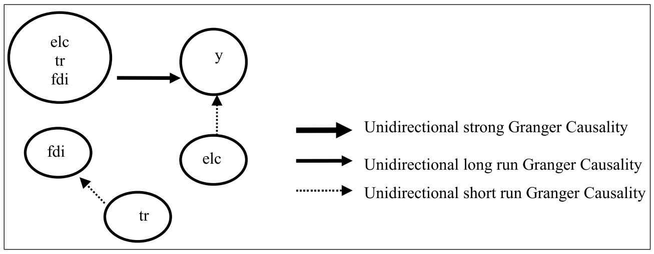


Figure 3: Granger causality relationships



yields evidence of a long-run relationship between electricity consumption per capita and real GDP per capita at 1% significance level in Turkey. The estimated log-linear long-run coefficient of the electricity consumption per capita is about 0.537 and positive. This coefficient implies that any reducing in electricity consumption will negatively affect the economic growth. According to three kinds of Granger causality results, the electricity consumption per capita weakly and strongly causes real GDP per capita in both short-run and long-run. The results also show that: (i) There is evidence of a unidirectional short-run causality running from the electricity consumption per capita to the real GDP per capita, (ii) there is evidence of a unidirectional short-run causality running from the trade openness to FDIs per capita, (iii) there are evidences of long-run and strong causalities running from the electricity consumption per capita, trade openness, and FDIs per capita to the real GDP per capita. Thus, "growth hypothesis" is confirmed in Turkey. This implies that high electricity consumption tends to have high economic growth, but not the reverse case in Turkey.

As a conclusion, energy conservation policies, such as rationing electricity consumption, are likely to have an adverse effect on real GDP of Turkey. As a policy implication, the energy growth policies regarding electricity consumption should be adopted in such a way that the development of this sector stimulates economic growth. In order to prevent electricity any shortage to satisfy the higher energy demand at the next decades, new electricity power plants must be planned in Turkey.

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