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Electricity Consumption and Economic Growth: A Long-Term Co-integrated Analysis for Turkey

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Abstract

Energy and especially electricity consumption is a variable that can be also considered as the indication of the social development as far as economic growth is concerned. Energy, as the input of the industry and other production branches, is an indication for the production increase; and also for consumption with regards to raising the living standards of the consumers. In literature with its situation, it is argued that the electricity consumption is included the mutual causality relation with the growth data in a long-term. As there are several empirical studies that support this hypothesis, in some economies, especially it may sometimes be concluded that the data of the energy utilization in the production area can negatively affect growth in the long-term. Therefore, the literature does not come to the agreed results for the relation between these two variables. In this study, the causality relations have been analyzed by dividing the electricity consumption into three categories; residential, industrial and others, based on the data of the Turkish economy. In the lights of the obtained findings, it is concluded that in long term, there is at most one long-term co-integrating vector between GDP and electricity consumed in residential and industrial areas and also two-way causality relation between GDP and electricity consumed in these sectors. In this case, electricity consumption can be considered as an indicator for both growth and social development.

Keywords: economic growth, electricity consumption, industrial consumption, residential consumption

1. Introduction

Whereas the electricity is an economic value which is increasingly needed to improve human living conditions, some methods being used to meet this need, are facing the critique of being reached at such a level threatening these human living conditions. Energy consumption has a wide literature in terms of both aspects. While industrial demand for energy is directly proportional to economic growth; consumer demand is directly proportional to economic development. Dhungel (2008) defines these two issues together as "economic and social development of the nation". A similar point of view is expressed by Leug and Meisen (2005) that increase in electricity consumption by per capita may be an indication of social development and economic growth. Furhetmore, Ferguson, Wilkinson and Hill (2000), in their empirical studies, carried out for 100 countries, found that there is a high correlation between economic growth and electricity consumption. This discussion has been held since the study of Kraft and Kraft (1978). Continuity of logical relation between energy consumption an economic development is emphasized in their study and they concluded that energy saving is pointless and the causality between energy consumption and national income is from energy consumption and national income. However, later fundamental studies which are referred in almost every study can be listed as; Akarca and Long (1980), Yu and Choi (1985), Erol and Yu (1988), Abosedra and Baghestani (1989, 1991), Hwang and Gum (1991, 1992), Cheng (1995), Masih and Masih (1997), Glasure and Lee (1998), Soytaş, Sarı and Özdemir (2001), Soytaş and Sarı (2003), Lee (2005), Joyeux and Ripple (2007) and Joyeux and Ripple (2010) and in many studies like these different findings are obtained due to especially the direction of causality, the differences that may originated from different country and country groups and development levels of countries and their macroeconomic conjecture.

2. Theory and Literature

In theory, increase in the amount of energy consumption in a closed economy, as well as the increase either in household or industrial sectors, can be considered as the indicators of economic and social development. In a closed economy, an increase in energy prices may cause from not being able to supply the demanded energy so in a situation like this it can be said that economic growth has happened. An increase in energy amount in an open economy can be related to economic and social development as well as an increase in energy prizes may cause from foreign exchange rates (Agenor & Monteil, 1996), in sufficient global supply global conjecture (Harrop, 2000), and increase in the cost of importation and it may end up with the reflection of likely inflation in producer/exporter countries to importer country (Kibritcioglu & Kibritcioglu, 1999). Whereas theoretical relation between growth and energy consumption involves a linear relation especially in neo-classical economy (Hamilton, 1983; Burbridge & Harrison 1984; Ghali & Sakka, 2004); the point of view,named as biophysics dealing with energy as the most efficient factor on growth, considers labor and capital as collateral factor. This view deals economy as a sub-thermodynamics system (Cleveland & Aytaç, 2010 narrating from 1984).

In recent studies and in particular those made in 2010 and later on (refer to Aydin, 2010; Bildirici, Bakirtas, & Kayikci, 2012, for a literature of previous period), many of them made on causality relation between energy consumption and economic growth and direction of such causality. Results of some selected studies can shortly be provided. In their studies on selected 7 Asian countries, Lau, Chye and Choong (2011) determined a causality relation from GDP to energy consumption in long run; while this relation took place conversely in short run. In the study of Pradhan (2010) carried out for the countries of South Asian Association for Regional Cooperation (SAARC), he obtained proof for long-termed relation. As for Asafu-Adjaye (2000) on developing countries in Asia, relation is in a mutual causality between variables in long term; however, it is only from national income to energy consumption in short run.

In the study of Chontanawat, Hunt and Pierse (2006), on 30 OECD and78 Non-OECD countries, causality relation from GPD to energy consumption and vice versa is more common and clear in developed countries compared to that of developing countries. The lower the national income levels gets, causality with energy consumption shows decrease in its degree. By obtaining standard causality relation between variables, Constantini and Martini (2010) find evidence for sectoral differences of causality relation in OECD and Non-OECD countries. According to them, there is no any unidirectional causality relation at all in settles sectors of both developed and developing countries and policy evolutions and model adjustments should be applied with necessary precautions for bidirectional and endogenous causalities. In their study on France, Amiri and Zibaei (2012), in a similar manner, have shown the validity of long termed bidirectional relations.

In their analysis on relation between coil consumption and employment for USA, Apergis, Loomis and Payne (2010) have concluded that series are stationary and energy saving policies aiming decreasing coil consumption would be inefficient in long run but it may be efficient in the short run. Apergis and Payne (2010) did petroleum consumption analysis for the same states and concluded that among states, petroleum consumption and energy saving policies are heterogeneous. In another domestic study among states of Australia, Narayan, Narayan and Popp (2010), find out that energy shocks have temporary effects on energy consumption except south of the country. For the Group of Seven (G–7) countries, Balcilar, Ozdemir and Aslanturk (2010) determined Granger causality between energy consumption and growth data. Another significant finding of their study is that energy prices are rather affected in the fluctuation periods. It is observed that neutral connection between energy consumption and economic growth is especially caused by recession and increase in petroleum prices. For this reason, the most important effect energy saving policies may have surprising negative effects on economic growth later on. In another study about G–7, Lee and Chein (2010), concluded that there is a causality relation from real national income to energy consumption for Canada, Italy and England and that energy saving may hinder growth in those economies.

Based on the data of 17 countries, including G–7 countries, Soytaş and Sarı (2003) concluded that while there is causality relation form energy consumption to GDP for Turkey, France, Germany and Japan, there is bidirectional relation for Argentina and an opposite direction of causality relation for Italy and South Korea. An important finding is that in the long run, energy saving may bring damage to the growth rate in the case of bidirectional causality relation. Whereas, Omay, Hasanov and Uçar (2012) obtained poor statistical evidence for Granger, it can be effective on both expansion and recession periods for a short term. On the other hand, they concluded that production rate increases energy consumption in expansion and growth periods and that increased production increases energy consumption in the long run regardless of initial conditions of economy. Finally, it will also be beneficial to mention a study on government interventions on energy prices. Based on the data of 178 countries, Hasanov and Telatar (2011) showed that government interventions on energy prices have no effect in the long run.

Results of some studies on Turkey are as follows; Yanar and Kerimoglu (2011) concluded that there is causality from energy consumption to growth; Yaylali and Lebe (2012) concluded that theoretically anticipated crude oil import is an important factor for inflation. In their study on electricity consumption and growth, Karagol, Erbaykal and Ertugrul (2007) determined co-integration between variables and concluded that this relation is positive over the short run but negative in the long run. In the study on effect of input/output price model and energy prizes on industrial expenses, Aydin (2012) stated that any increase in petroleum prices affects production costs of mostly land, air and sea transportation respectively in a decreasing order; Ulusoy (2006) showed that any type of energy consumption has no direct effect but increases of the share of investments in the national income; Kar ve Kinik (2008) stated that there is a two-way causality between electricity consumption and economic growth and also one-way causality from total electricity consumption to economic growth; Terzi (1998) showed that energy demands in trade and industry sectors are inelastic from income. However, from the result that price elasticity is meaningful in only the trade sector, it can be said that price policies, aiming to reduce the demand of electricity in trade and industry sector, would not be effective and that policies to increase electricity supply of economic growth are required. Using electricity and growth data, Agir and Kar (2010) deduced that electricity consumption of provinces of Turkey contributes positively both for income and added-value levels and it is a potential constraint for growth; Bakirtas, Karbuz and Bildirici (2000) concluded that from being, growth and electricity variables are co-integrated in the long term and income elasticity of electricity consumption is quite high, electricity consumption will continue to increase rapidly in the future. Azgun (2011) tested relation of total electricity consumption and its sub-components with GDP and found a long term relation. As for Cetin and Seker (2012), they presented results regarding adverse effects of energy shortage on the economy. Consequently, there are many empirical studies indicating that electricity consumption is in a linear relation with economic growth and social development.

Studies presenting proofs for the linear relation between electricity consumption and growth and positive relation between them are as follows; Boran (2014), Kavalioglu (2014), Kula (2014) for Turkey; Javid and Qayyum (2014) for Pakistan; Magazzino (2014) for Italy; Cowan et al. (2010) for BRICS economies; Al-mulali et al. (2014) for 16 Ibero America countries; Apergis and Payne (2014a) for OECD countries; Apergis and Payne (2014b) for 16 developing countries. General emphasis of these studies is that rather than a saving policy to decrease the consumption, efficiency of the consumption should be increased. however still there is no common policy suggestion for all the countries, especially seen on the study of Cowan et al. (2014).

3. Data set and Method

Depending on economic data of Turkey, it is predicted that electricity demand which is up to 220,720 TWh in 2010 will increase the level of 452,477 TWh in 2020 (Yigit, 2011) and it is already known that especially electricity consumption of residential areas are increasing (Yamak & Gungor, 1998). In this paper, the question of how continuously increasing electricity consumption is related to economic growth can be answered by analyzing the relation between electricity consumption and economic growth with the use of time series.

Growth data of Turkey economy are taken from The Central Bank of Republic of Turkey (CBRT) and Electronic Data Delivery System (EDDS), total electricity consumption and its components are provided by Turkish Electricity Transmission Company (TETC). These are annual data belonging the period between 1970 and 2012. Growth data is the expenditure based GDP data in the in the currency of US Dollar. Electricity consumption data is in the unit of GWh and components are composed of percentage share of total electricity consumption. Total electricity consumption is divided into three categories; residential (RSD), industrial (IND) and other (OTH) consumptions (illumination, Public institutions, network losses, trade etc.)

Hypothesis that is putted in analysis is; “Thee is causality relation between electricity consumption and economic growth”. This main hypothesis is divided into two sub-components: “There is causality relation between residential electricity consumption and growth” and “There is causality relation between industrial electricity consumption and growth”. Hypotheses are subjected to time series analysis for short and long run. In the analysis, initially, introductory statistics about variables are presented and next stationarity test is performed with unit root tests of Dickey-Fuller (ADF) (1979), Phillip-Perron (PP) (1998) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (1992). Wald test is performed to see how coefficient affect dependent variable, thereby creating VAR models where each variable is taken as dependent variable and other variables as independent variable. Finally, for the long term relation Johansen-Juselius test (1990) is referred.

4. Findings

Unit root analysis for series is executed by using three different tests. It is initially carried out for Augmented Dickey-Fuller (ADF) test. By doing this stationarity of series is tested and findings are given in Table 1. Unit root existence in series is obtained with PP and KPSS tests. Results are indicated in Table 1.

Table 1. ADF, PP and KPSS unit root test results

	GDP (0)	GDP (-1)	RSD (0)	RSD (-1)	IND (0)	IND (-1)
ADF Test	2.979 738	-5.654 487	0.987 704	-5.894 409	-2.055 533	-2.429 787
	(-1.948 886)	(1.949 097)	(-1.948 886)	(-1.949 097)	(-1.948 886)	(-1.949 609)
	1.553 112	**-6.505 076**	**-1.706 041**	**-6.004 486**	**0.048 548**	**-5.964 103**
	(-2.933 158)	(-2.935 001)	(-2.933 158)	(-2.935 001)	(-2.933 158)	(-2.935 001)
	-0.647 342	*-7.301 912*	*-2.180 316*	*-6.032 341*	*-2.451 416*	*-5.965 028*
	(-3.520 787)	(-3.523 623)	(-3.520 787)	(-3.523 623)	(-3.520 787)	(-3.523 623)
PP Test	3.544 457	-5.860 955	0.968 976	-5.881 088	-2.0533 552	-5.548 644
	(-1.948 886)	(-1.949 097)	(-1.948 886)	(-1.949 097)	(-1.948 886)	(-1.949 097)
	1.939 396	**-6.535 308**	**-1.706 041**	**-6.004 486**	**0.102 907**	**-5.953 762**
	(-2.933 158)	(-2.935 001)	(-2.933 158)	(-2.935 001)	(-2.933 158)	(-2.935 001)
	-0.533 400	*-7.320 672*	*-2.322 447*	*-6.032 717*	*-2.433 009*	*-5.951 890*
	(-3.520 787)	(-3.523 623)	(-3.520 787)	(-3.523 623)	(-3.520 787)	(-3.523 623)
KPSS	**0.689 160**	**0.455 716**	**0.737 722**	**0.114 703**	**0.755 769**	**0.260 740**
	(0.463 000)	(0.463 000)	(0.463 000)	(0.463 000)	(0.463 000)	(0.463 000)
	0.190 231	*0.073 973*	*0.085 944*	*0.042 989*	*0.154 820*	*0.168 131*
	(0.146 000)	(0.146 000)	(0.146 000)	(0.146 000)	(0.146 000)	(0.146 000)

Note. The first line for ADF and PP are non intercept and trend. Bold typed values are intercept; values in italics are intercept and trend. All values in the parenthesis show critical values in 5 percent of significance level.

As a result of tests performed for each three series, although they include unit root as of their levels, series become stationary as a consequence of taking their first difference. All three levels become stationary at the same level. This situation indicates that series are integrated at I(1) level. Therefore, prerequisite is ensured for investigation of whether or not there is co-integration and long term relation between them. Lag length is calculated for LR, FPE, AIC, SC, and HQ criteria and 1 lag length is obtained to be the proper lag.

In order to determine long term relations of variables, two-staged Eangle-Granger (1987) co-integration test is performed. In first step, regression equations are constructed between variable pairs which are assumed to be related in long term. In second step, ADF, PP and KPSS unit root tests are performed for error terms of regressions and it is anticipated that level of value of error term series are stationary at [I(0)]. If these conditions are met, then it will be found that there is long term relation between variables.

Table 2. Engle-Granger co-integration test and unit root tests for error terms

(a) Regressions	coefficient	Std. Deviation	t-Stat.	Probability	Adj. R^2
dGDP=f(dRSD)	-9325.236	7894.287	-1.181 264	0.2445	0.009 551
dGDP=f(dIND)	7326.689	5519.255	1.327 478	0.1919	0.018 251
dGDP=f(dGDP)	5.76	4.34	1.327 478	0.1919	0.018 251
dRSD=f(dGDP)	-3.61	3.06	-1.181 264	0.2445	0.009 551
(b) Results of unit root test for error correction	ADF	PP	KPSS	Entegre	
dGDP=f(dRSD) →u	-6.221784	-6.250438	0.412148	I(0)	
dGDP=f(dIND) →u	-6.276844	-6.313129	0.497233	I(0)	
dIND=f(dGDP) →u	-5.753362	-5.723932	0.317177	I(0)	
dmesken=f(dgsyih) →u	-5.734796	-5.734796	0.064408	I(0)	

Note. "d" in front of each variable indicates that stationary series are used due to the fact that series are stationary by first difference. R^2 and DW (Durbin-Watson) introductory statistics belongs to integrated levels of series.

Created regressions are shown in part (a) of Table 2 and results of ADF unit root test for regression error term series are given in part (b). Considering data in part (b) for ADF test statistics, obtained result is that level of error terms is stationary. In this case, it is found that independent variables of regressions are Granger cause for independent variable. According to this, there is causality from the variables RSD and IND to GDP. In other words, each one of electricity consumption components are Granger cause for GDP in long run. Similarly, GDP variable is Granger cause for residential and industrial variables. So, the conclusion reached is that there is bidirectional causality between GDP and RSD variables and GDP and IND variables in long term.

Depending on long time relation between variables, augmented regressions are created and VAR model for relation between variables is created and findings are given in Table 3. In each model one variable is taken as dependent variable and others are taken as independent variable.

Table 3. VAR models (two lagged)

(a) Equations	GDP(-1)	GDP(-2)	RSD(-1)	RSD(-2)	IND(-1)	IND(-2)	u
GDP	0.744 178	0.204 198	-2396.420	-3631.964	3152.229	-8955.201	498 247
RSD		-1.10	0.774 922	0.103 644	-0.223 584	0.233 417	1.874 205
IND	-1.17	1.18	0.359 845	-0.429 049	1.329 158	-0.382 918	4.394 407
(b) Wald Test		GDP(-1)+GDP(-2)		RSD(-1)+RSD(-2)		IND(-1)+IND(-2)	
GDP		0.0000		0.5468		0.0928	
RSD		0.0002		0.0001		0.3286	
IND		0.3893		0.0531		0.4871	

Note. in part (a) VAR models are estimated. In (b) part, sum of 1 and 2 lagged coefficients of these models are taken.

For the dependent variable in each line of part (a) of Table 3, obtained variable coefficients are given by taking other variables independent. In part (b), Wald test is applied in order to prove the hypothesis that when the coefficient of lagged value of each independent variable in the equation is equal to zero, they affect dependent variable together. According to this, dependent variable is affected simultaneously by coefficient value of lagged variable of both 5% meaning the level of GDP in the first model and GDP and RSD in the second model.

Johansen-Juselius (JJ) is applied to determine long term co-integration relation. Results of JJ test applying long term relation for more than two variables are given in Table 4. Lag length is found as 1 for AIC and SC criteria.

Table 4. Johansen-Juselius co-integration test results

H0	H1	Eigenvalue	Trace Stat.	0,05	Max-Eigen Stat.	0,05
r = 0	r ≥ 1	0.462 095	40.115 83	24.275 96	24.802 90	17.797 30
r = 1	r ≥ 2	0.250 281	15.312 93	12.320 90	11.552 27	11.224 80
r = 2	r ≥ 3	0.090 415	3.790 658	4.129 906	3.790 658	0.0612 00

Table 4 shows the existence of long term relation in 5% significance level between variables. When Trace and Max-Eigenvalue statistics are analyzed, "There is co-integration" hypothesis will be true as long as such statistics are higher than 0.05 of significance level. According to this, at most, there is one co-integrating vector. Accordingly, there is a co-integration vector balancing the residential and industrial variables for GDP.

5. Conclusion

This analysis carried out for the Turkish economy using annual GDP, residential electricity consumption and industrial electricity consumption data of the period between 1970 and 2010, showed variables become stationary by taking their first difference. They are co-integrated according to Eangle-Granger tests; with the use of JJ co-integration test, at most there is one long term co-integrating vector and that all three variables contain mutual causality relation in long run. These results show that, due to its relation with residential electricity consumption, growth in Turkish economy contributes to social development. Similarly, increase of the quality of life in residential areas affects economic growth as well. The more electricity consumed in industry, the more GDP is and it is observed that increase in GDP increases the electricity consumption in industry. Therefore, it is observed that the anticipation of neo-classical economy that is growth and power consumption is related (Hamilton, 1983; Burbridge & Harisson, 1984; Ghali & Sakka, 2004) is verified. Further, the interrelation obtained by Constantini and Martini (2010) and Chontanawat, Hunt and Pierse (2006) in their studies for OECD countries coincides with the results of this study. Finally, when it is considered that similar results are obtained in the studies of Kar and Kinik (2008) and Bakirtas, Karbuz and Bildirici (2000) carried out on the Turkish economy. It is possible to say; (a) growth in the Turkish economy is experiencing increases electricity consumption. (b) Such increase is co-integrated in the long run with electricity consumption in both residential and industrial sectors. (c) And that such variables are in mutual causality relation in long run. These proofs are in an agreement with the general results of studies of Menegaki (2014) presented for 51 countries for last two years.

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