Open Journal of Business and Management, 2017, 5, 1-10
http://www.scirp.org/journal/ojbm
ISSN Online: 2329-3292
ISSN Print: 2329-3284

Causality Nexus of Electricity Consumption and Economic Growth: An Empirical Evidence from Ghana

Bismark Ameyaw[1], Amos Oppong[1], Lucille Aba Abruquah[1], Eric Ashalley[2]

[1]School of Management and Economics, University of Electronic Science and Technology of China, Chengdu, China
[2]Institute of Fundamental and Frontier Sciences, University of Electronic Science and Technology of China, Chengdu, China
Email: 3101153683@qq.com

How to cite this paper: Ameyaw, B., Oppong, A., Abruquah, L.A. and Ashalley, E. (2017) Causality Nexus of Electricity Consumption and Economic Growth: An Empirical Evidence from Ghana. *Open Journal of Business and Management*, **5**, 1-10.
http://dx.doi.org/10.4236/ojbm.2017.51001

Received: October 2, 2016
Accepted: November 15, 2016
Published: November 18, 2016

Abstract

Electricity plays a crucial role in the economic development of most economies. The causality nexus between electricity consumption and economic growth is important in enacting energy consumption policy and environmental policy. Many researchers have studied the causality between energy consumption and economic growth yet no consensus has emerged. Irrespective of the numerous researches conducted between these two variables, less evidence has been recorded in Ghana. Studies establishing the direction of causality between economic growth and energy consumption have concluded mixed result posing stern threat to Ghana's energy policy. It is therefore viable to investigate the direction of causality between electricity consumption and economic growth in Ghana. This study uses the Cobb-Douglas growth model covering time series data from 1970 to 2014. Vector Error Correction Model was also conducted in order to empirically ascertain the error correction adjustment. Granger Causality test was used to determine the direction of causality between electricity consumption and economic growth and the empirical findings obtained herein reveals that there exists a unidirectional causality running from GDP to electricity consumption. This line of causality obtained from the data supports Growth-Led-Energy Hypothesis. Therefore, it is evident that Ghana is a less energy-dependent economy.

Keywords

Electricity Consumption, Real GDP Per Capita, Granger Causality Test, Co-Integration, Ghana

1. Introduction

Energy is considered a spine to production worldwide. The causality between energy consumption and economic growth has attracted much attention of economists and policy makers. The petroleum crisis in 1970s outlined the importance of energy as a factor of production [1]. Also the abnormal prices of oil in the 1990s and 2000s cemented the importance of energy in our daily activities. Countless studies have examined the causality nexus between electricity consumption and economic growth. Reports from such studies have been seemingly contradictory and different. Reference [2] ascribes the variation in results to variable selection, time periods for conducting the study, economics policies implemented etc. Occurrence of economic events may impact the behavioral characteristics or trends of energy consumption and Gross Domestic Product (GDP) of a country [3]. Flouting the importance of structural shifts in a causality nexus may produce misleading results. Therefore, parameter stability is important in identifying whether or not there is an existence of structural breaks in the time series data.

The primary conversion of energy resources and wind energy leads to the generation of electricity. Coal is the largely used resource for the generation of electricity. Furthermore, the use of natural gas and nuclear power is gradually gaining share in electricity generation whiles the use of oil is fast declining due to the burgeon increment in stock prices over the years [4]. It is reported that the demand for electricity in OECD counties is minimizing than that of the non OECD countries [5]. Most academic think tanks have been thinking deeply about sustainable energy. The establishment of a causality nexus between electricity consumption and economic growth is of colossal relevance to countries that bank on electricity as the primary source of energy. The causality between electricity consumption and economic growth might cause various challenges that need to be addressed with meticulous measures. For example, if economic growth Granger causes electricity, then the implementation of policies for the conservation of electricity needs to be tackled with extreme care [6]. However, the stipulation of enough evidence that electricity-Granger-causes economic growth poses threat of detrimental consequences of economic policies to economic growth which intrinsically shrinks the creation of jobs as well as enhancing poverty [7].

The causality between electricity consumption and economic growth can take three forms namely: unidirectional, bidirectional or non-existent. Studies conducted have documented results on causality relationships into four hypotheses named: Growth, Conservation, Feedback and Neutrality [2]. Unidirectional causality exists when electricity consumption causes economic growth and *vice versa*. Growth hypothesis is evident if the direction of causality runs from the consumption of electricity to economic growth [8] [9]. Furthermore, if the direction of causality runs from economic growth to electricity consumption which is also known as Conservation hypothesis, then policies on conservation will have little impact on economic growth [10]. The interdependency between electricity consumption and economic growth (feedback hypothesis) depicts bidirectional causality. This means that policies enacted on saving energy may adversely impact economic growth. Finally, the absence of relationship between electricity consumption and economic growth (neutrality hypothesis) has no bearing on economic growth [11]. The causality nexus between electricity consumption and economic growth cautions countries about policies concerning electricity comprising power networks, the development of expansion capacities etc. Determining the causality between these two variables and their flow of direction is imperative to the economic growth sustainability of every country [12].

The Ghanaian economy is over-reliant on the consumption of hydro-electricity. There exists correlation between the transformation of the Ghanaian economy and the consumption of electricity. The consumption of electricity has considerably increased as each year passes by. In this regard, [13] has opined that electricity is a multitalented energy currency that supports an extensive variety of goods and services that improve life quality, productivity and empower entrepreneurial actions. This makes power utilization to be emphatically and exceptionally correlated to per capita GDP. Statistics in Ghana between 2000 and 2008 suggest that while real per capita GDP averaged 5.5% for per annum, yearly electricity utilization growth averaged 1.21%. Again, an estimation by IEA in 2002 depicted an approximately 45% rate of electrification. During the periods of 1971 and 2010, inflation rate, electricity consumption as well as Real GDP (per capita) was 32.9%, 277.88 kWh and $300.9 respectively. In recent times, electricity generation from the Aboadze Thermal Plant and the Akosombo Dam which is the main source of power for electricity generation have attracted numerous concern over its inability to provide adequate supply of electricity to Ghanaians. However, irrespective of the inability to match the consumption needs of citizens, Ghana continues to supply energy to neighboring countries such as Togo and Burkina Faso. The Government of Ghana has inundated the Ghanaian media with promises of taking steps to eradicate this challenge but such challenge still persists. Recently, the Government of Ghana is investing heavily in the construction of a new dam called the Bui Dam but the construction of the dam is on a dawdling pace thereby leading to the surge in load shedding and intermittent blackouts in the country. Based on the challenge Ghana face in electricity production and consumption, it is therefore imperative to determine the direction between the two variables under consideration.

2. Research Significance

Ghana is currently experiencing power outages all over the country. These frequent power outages have prompted researches into the effect of this power outages on the economy. Most manufacturing firms in the country have experienced declines in their onputs due to this challenge. This had led to the derivation of a popular name for power outages in Ghana as "dumsor". The word dumsor scares many production firms and companies as well as most citizens because daily life operations are always halted when they experience dumsor.

The existence of dumsor prompted investigation into the causality nexus between electricity consumption and economic growth. This research work anticipates to help the Electricity Company of Ghana as well as the Ministry of Energy to know the idle energy policy to adopt in order to boost the economic growth of Ghana thereby curbing dumsor in Ghana.

3. Brief Literature Review

The causal relationship between energy consumption and economic growth has attracted an impressive literatures investigating between these two variables. Researches relating to these two factors aim at proposing policy frameworks in ensuring efficient policies regarding energy conservation. Following the pioneering work by [14] who found a unidirectional causality running from national product to energy consumption, research into this subject is flourishing in both develop and developing countries. However, the results on studies between these two variables are inconclusive concerning the nature and direction of causality between energy and economic growth. The differences in authors work concerning energy consumption and economic growth may stem from the time period under consideration, different countries economic growth, the type of analysis and probably the data differences among different countries [15].

Empirical evidence testing the causality nexus between economic growth and energy consumption can be divided into four hypotheses namely growth hypotheses, conservation hypothesis, feedback hypothesis and neutrality hypothesis [16] (see **Table 1**).

3.1. Brief Literature Review

The growth hypothesis asserts that energy consumption leads to economic growth. Thus, there is evident of unidirectional causality from energy consumption to economic growth. This implies that a surge in electricity consumption may boost economic growth whiles restrictions in energy usage may negatively impact the economic growth of a country. This means that energy conservation measures are not a feasible option because crisis in energy may retard economic growth. This hypothesis is backed by researches from [17]-[25].

3.2. Conservation Hypothesis

This hypothesis asserts that economic growth may lead to energy consumption. This means that there exists unidirectional causality running from economic growth to electricity consumption. This hypothesis implies that sever energy crisis wouldn't have an adverse impact on economic growth thus energy conservation strategies and measures are a viable option. In other words, policies in relation to energy conservation can be enacted without any effect on economic growth. This hypothesis is demonstrated by [26] [27] [28] [29] [30].

Table 1. Selected studies on electricity consumption and economic growth.

Study	Country (s)/Periods	Method	Findings
Kraft and Kraft (1978)	United States (1947-1974)	Sims causality test	Unidirectional causality
Yu and Hwang (1984)	United States (1947-1979)	Sims causality test	No causality
Ferguson *et al.* (2000)	110 countries (1971-1995 and 1960-1995)	Correlation analysis	Unidirectional causality
Shiu and Lam (2004)	China (1971-2000)	Johansen co-integration and Granger causality test	Unidirectional causality
Aktas and Yilmaz (2008)	Turkey (1970-2004)	Granger Causality	Unidirectional causality
Atif and Siddiqi (2010)	Pakistan (1971-2007)	Granger Causality and modified WALD test	Unidirectional causality
Adom (2011)	Ghana (1971-2008)	Toda and Yamamoto Granger causality test	Unidirectional causality
Aslan (2014)	Turkey (1968-2008)	ARDL bond test and Granger causality test	Bidirectional causality
Ogundipe and Apata (2013)	Nigeria (1980-2008)	Bound testing co-integration, linear and no-linear Granger causality tests	Bidirectional causality

3.3. Feedback Hypothesis

This hypothesis asserts that there exists a bidirectional causality between energy consumption and economic growth. This hypothesis implies that energy conservation policy will negatively affect economic growth whereas an increase in economic growth will also increase energy consumption. This causal relationship between energy consumption and economic growth is illustrated by [31] [32] [33] [34] [35].

3.4. Neutrality Hypothesis

Neutrality hypothesis asserts that there is no causal relationship between energy consumption and economic growth. It implies that economic growth is autonomous from energy usage and that energy conservation policies will not affect economic growth. Manu studies such as [36] [37] [38] [39] [40] supports the neutrality hypothesis.

4. Research Methodology

In order to avoid spurious relationship among the variables, two different unit root test, namely Phillips-Perron (PP) and Augmented Dickey-Fuller (ADF) are conducted on the time series variables for gross domestic product, stock capital labor and the consumption of electricity. After the unit root testing, it is important to test for the existence of co-integration among the variables by using the Johansen co-integration analysis. Lastly, the causality nexus between electricity consumption and gross domestic product is analyzed by employing the pairwise Granger causality test. The econometric views were used to carry out this analysis.

4.1. Research Model

The Cobb-Douglas production function is given by:

$$Y = AK^{a}L^{\beta} \tag{1}$$

where Y is the sum of production, L is labor, A is the total factor productivity and K is the capital, and α and β are considered the elasticities for labor and capital respectively.

GDP can also be illustrated as

$$GDP = \beta_0 K^{\beta 1} L^{\beta 2} E^{\beta 3} \tag{2}$$

The linearized log form of Equation (2) can be presented as:

$$LogGDP_t = \beta_0 + \beta_1 LogK_t + \beta_2 LogL_t + \beta_3 LogE_t + \varepsilon_t \tag{3}$$

where GDP represents Gross Domestic product, E is the electricity consumption, L is total labor force, K is the capital (stock), t is time, and ε is the error term.

The equation for the Granger Causality Test is deduced as follows:

$$LogGDP = \sum \varnothing_i LogE_{t-1} + \sum \varnothing_j LogGDP_{t-1} + \varepsilon_{t1} \tag{4}$$

$$LogE = \sum \alpha_i LogE_{t-1} + \sum djLogGDP_{t-1} + \varepsilon_{t1} \tag{5}$$

4.2. Data Sources

Data obtained for this research in Table 2 was sourced from the World Bank development indicators, the Bank of Ghana and the Ghana Statistical Service Bulletin.

5. Empirical Findings

5.1. Stationarity Test

The PP and ADF was used to examine the unit root property with the inclusion trends and intercepts at both level and first difference. The two test unanimously reveals that all the variables are non-stationary in their level data. The results depict in Table 3 that all variables are stationary after first differencing, suggesting that all the variables are integrated of order 1(1). The stationarity property is found in the first difference of variables at 5%.

5.2. Johansen Co-Integration Test

The study seeks to test the existence of co-integration among the variables under consideration. The Johansen co-integration examines the long-run relationship among the variables. Table 4 depicts the empirical results of the co-integration analysis by comparing the trace and maximum statistics with the critical values and the findings suggest an evidence in favor of a long-run equilibrium relationship among the observed variables.

Table 2. Variables and sources of data.

Variable	Description	Source of Data	Data Measurement
GDP	Gross Domestic Product	World Bank Development Indicators (2014)	Constant 2000 US$
K	Fixed Capital	Ghana Statistical Service and Bank of Ghana Bulletin (2014)	Constant 2000 US$
L	Labor Force	World Bank Development Indicators (2014)	Numbers
E	Electricity Consumption	World Bank Development Indicators (2014)	Kwh

Table 3. Unit root test.

Variable	Level		First difference	
	ADF	PP	ADF	PP
GDP	−3.702**	−3.425**	−5.542*	−5.591*
K	−1.412	−1.523	−3.896**	−3.974**
L	−2.892	−2.964	−5.313*	−4.564*
E	−1.759	−1.421	−7.041*	−7.241*

*, **indicates 1% and 5% levels of significance.

Table 4. Co-integration test.

H_0	Trace Statistics	Critical Value (5%)	Maximum Statistics	Critical Value (5%)
None*	68.3352	47.2451	49.2154	27.1743
At most 1	28.9567	29.7143	18.7497	22.3516
At most 2	15.7486	17.9937	12.3857	15.8956
At most 3	9.21674	11.6356	7.65342	5.00031

5.3. Vector Error Correction Model

The estimated lagged error correction term of growth is illustrated in Table 5. The absolute value of the error correction term is within zero and one and its magnitude is negative implying that the error correction term is statistically significant. The results indicate that the model will converge with time, if there is existence of external shocks in the model. This further depicts that there is a long-run convergence in the model. Finally, the model speed of error further indicates that 96% of the model's present error would be corrected in the long-run.

5.4. Granger Causality Test

Examining the causal relationship between electricity consumption and GDP was analyzed using pairwise Granger causality test. It is evident from the empirical results in Table 6 that electricity consumption does not Granger cause GDP with F-statistic figure of 1.3457 and a probability of 0.372. The F-statistic of 4.4294 and the probability of 0.005 from the empirical results fully support the existence of unidirectional causality running from GDP to electricity consumption. This implies that a reduction in electricity consumption does not adversely affect GDP. Additionally, it is evident that capital and labor Granger causes GDP.

6. Conclusion

This paper investigates the direction of causality between electricity consumption and

Table 5. VECM.

Variable	D(LGDP)	D(LK)	D(LL)	D(LE)
ECT_1	−0.95772	6.92342	−0.00567	−2.74523
	−0.4125	−7.5755	−0.1953	−2.8076
	[−4.0371]	[0.7746]	[−0.0374]	[−0.9767]

Table 6. Pairwise Granger causality test.

Null Hypothesis	*F-Statistic*	*Probability*	*Results*
L does not Granger cause GDP	3.1567	0.017	Reject
GDP does not Granger cause L	1.0315	0.398	Do not reject
L does not Granger cause K	7.6532	0.005	Reject
K does not Granger cause L	1.0154	0.567	Do not reject
E does not Granger cause K	2.9715	0.074	Do not reject
K does not Granger cause E	4.8952	0.001	Reject
E does not Granger cause L	3.9745	0.003	Reject
L does not Granger cause E	0.9564	0.326	Do not reject
K does not Granger cause GDP	4.8956	0.024	Reject
GDP does not Granger cause K	1.1946	0.573	Do not reject
E does not Granger cause GDP	1.3457	0.372	Do not reject
GDP does not Granger cause E	4.4294	0.007	Reject

GDP in Ghana during 1970-2014 based on the Cobb-Douglas growth model. Unit root testing was conducted to depict the stationarity status of the data and the data series are non-stationary at level, hence necessitating the incorporation of first differencing. The time series data for the variables were found to be stationary at first differencing. The study found the existence of long-run equilibrium co-integration among output, labor, capital and electricity consumption. The VECM shows a likelihood of a long-run convergence with high speed of error correction. The Granger causality test indicates that there exists Granger causality running from GDP to electricity consumption implying that the conservation hypothesis is appropriate for the Ghanaian data. The policy implication is that electricity consumption is not a limiting factor to economic growth of Ghana. In other words, electricity consumption has no adverse impact on economic growth. Therefore, electricity conservation policy is favorable for the Ghanaian economy.

7. Limitation of Research and Future Research

It would have been idle if a survey is done concerning individual's subjective opinions on the causality nexus between electricity consumption and economic growth so that comparative analysis can be drawn on the causality nexus between these two variables. Also, in the future, the causality nexus between electricity consumption and economic growth on continental basis is worth exploring.

References

[1] Erbaykal, E. (2008) Disaggregate Energy Consumption and Economic Growth: Evidence from Turkey. *International Research Journal of Finance and Economics*, **2008**. 172-179.

[2] Payne, J.E. (2010) A Survey of the Electricity Consumption-Growth Literature. *Applied Energy*, **87**, 723-731. https://doi.org/10.1016/j.apenergy.2009.06.034

[3] Esso, L.J. (2010) Threshold Co-Integration and Causality Relationship between Energy Use and Growth in Seven African Countries. *Energy Economics*, **32**, 1383-1391. https://doi.org/10.1016/j.eneco.2010.08.003

[4] IEA (2012) Energy Balances of OECD Countries (2013 Preliminary Edition) and Energy Balances of Non-OECD Countries. http://wds.iea.org/WDS/Common/Login/login.aspx

[5] U.S. Energy Information Administration (2013) International Energy Outlook 2013. http://www.eia.gov/forecasts/ieo/pdf/0484(2013).pdf

[6] Narayan, P.K. and Smyth, R. (2005) The Residential Demand for Electricity in Australia: An Application of the Bounds Testing Approach to Cointegration. *Energy Policy*, **33**, 467-474. https://doi.org/10.1016/j.enpol.2003.08.011

[7] Ghosh, S. (2002) Electricity Consumption and Economic Growth in India. *Energy Policy*, **30**, 125-129. https://doi.org/10.1016/S0301-4215(01)00078-7

[8] Ciarreta, A. and Zarraga, A. (2010) Economic Growth-Electricity Consumption Causality in 12 European Countries: A Dynamic Panel Data Approach. *Energy Policy*, **38**, 3790-3796. https://doi.org/10.1016/j.enpol.2010.02.058

[9] Shahbaz, M. and Lean, H.H, (2012) The Dynamics of Electricity Consumption and Economic Growth: A Revisit Study of Their Causality in Pakistan. *Energy*, **39**, 146-153. https://doi.org/10.1016/j.energy.2012.01.048

[10] Ozturk, I. and Acaravci, A. (2011) Electricity Consumption and Real GDP Causality Nexus:

Evidence from ARDL Bounds Testing Approach for 11 MENA Countries. *Applied Energy*, **88**, 2885-2892. https://doi.org/10.1016/j.apenergy.2011.01.065

[11] Chen, S.T., Kuo, H.I. and Chen, C.C. (2007) The Relationship between GDP and Electricity Consumption in 10 Asian Countries. *Energy Policy*, **35**, 2611-2621. https://doi.org/10.1016/j.enpol.2006.10.001

[12] Shui, A. and Lam, P.L. (2004) Electricity Consumption and Economic Growth in China. *Energy Policy*, **32**, 47-54. https://doi.org/10.1016/S0301-4215(02)00250-1

[13] Adom, P.K. (2011) Electricity Consumption-Economic Growth Nexus: The Ghanaian Case. *International Journal of Energy Economics and Policy*, **1**, 18-31.

[14] Kraft, J. and Kraft, A. (1978) On the Relationship between Energy and GNP. *Journal of Energy Development*, **3**, 401-403.

[15] Inglesi-Lotz, R. and Pouris, A. (2013) On the Causality and Determinants of Energy and Electricity Demand in South Africa: A Review. Department of Economics Working Paper Series, University of Pretoria, Working Paper: 2013-14.

[16] Chang, C.C. and Soruco, C.C.F. (2011) Energy Conservation and Sustainable Economic Growth: The Case of Latin America and the Caribbean. *Energy Policy*, **39**, 4215-4221. https://doi.org/10.1016/j.enpol.2011.04.035

[17] Damette, O. and Seghir, M. (2013) Energy as a Driver of Growth in Oil Exporting Countries? *Energy Economics*, **37**, 193-199. https://doi.org/10.1016/j.eneco.2012.12.011

[18] Javid, A.Y., Javid, M. and Awan, Z.A. (2013) Electricity Consumption and Economic Growth: Evidence from Pakistan. *Economics and Business Letters*, **2**, 21-32. https://doi.org/10.17811/ebl.2.1.2013.21-32

[19] Ouedraogo, N.S. (2013) Energy Consumption and Economic Growth: Evidence from the Economic Community of West African States (ECOWAS). *Energy Economics*, **36**, 637-647. https://doi.org/10.1016/j.eneco.2012.11.011

[20] Shahiduzzaman, M. and Alam, K. (2012) Co-Integration and Causal Relationship between Energy Consumption and Output: Assessing the Evidence from Australia. *Energy Economics*, **34**, 2182-2188. https://doi.org/10.1016/j.eneco.2012.03.006

[21] Kouakou, A.K. (2011) Economic Growth and Electricity Consumption in Cote d'Ivoire: Evidence from Time Seies Analysis. *Energy Policy*, **39**, 3638-3644. https://doi.org/10.1016/j.enpol.2011.03.069

[22] Odhiambo, N. (2009) Energy Consumption and Economic Growth Nexus in Tanzania: An ARDL Bounds Testing Approach. *Energy Policy*, **37**, 617-622. https://doi.org/10.1016/j.enpol.2008.09.077

[23] Ang, J.B. (2007) CO_2 Emissions, Energy Consumption and Output in France. *Energy Policy*, **35**, 4772-4778. https://doi.org/10.1016/j.enpol.2007.03.032

[24] Yoo, S.H. (2005) Electricity Consumption and Economic Growth: Evidence from Korea. *Energy Policy*, **33**, 1627-1632. https://doi.org/10.1016/j.enpol.2004.02.002

[25] Ghali, K.H. and El-Sakka, M.I.T. (2004) Energy Consumption and Output Growth in Canada: A Multivariate Co-Integration Analysis. *Energy Economics*, **26**, 225-238. https://doi.org/10.1016/S0140-9883(03)00056-2

[26] Baranzini, A., Weber, S. and Mathys, N.A. (2013) The Causal Relationship between Energy Use and Economic Growth in Switzerland. *Energy Economics*, **36**, 464-470. https://doi.org/10.1016/j.eneco.2012.09.015

[27] Azlina, A.A. (2012) Energy Consumption and Economic Development in Malaysia: A Multivariate Co-Integration Analysis. *Procedia—Social and Behavioral Sciences*, **65**, 674-681. https://doi.org/10.1016/j.sbspro.2012.11.183

[28] Jamil, F. and Ahmad, E. (2010) The Relationship between Electricity Consumption, Energy

Prices and GDP in Pakistan. *Energy Policy*, **38**, 6016-6025. https:/doi.org/10.1016/j.enpol.2010.05.057

[29] Mehara, M. (2007) Energy Consumption and Economic Growth: The Case of Oil Exporting Countries. *Energy Policy*, **35**, 2939-2945. https:/doi.org/10.1016/j.enpol.2006.10.018

[30] Jumbe, C.B.L. (2004) Co-Integration and Causality between Electricity Consumption and GDP: Empirical Evidence from Malawi. *Energy Economics*, **26**, 61-68. https:/doi.org/10.1016/S0140-9883(03)00058-6

[31] Hu, X. and Lin, X. (2013) A Study of the Relationship between Electricity Consumption and GDP Growth in Hainan International Tourism Island of China. *Research in World Economy*, **4**, 109-115. https:/doi.org/10.5430/rwe.v4n1p109

[32] Tang, C.F. and Tan, E.C. (2013) Exploring the Nexus of Electricity Consumption, Economic Growth, Energy Prices and Technology Innovation in Malaysia. *Applied Energy*, **104**, 297-305. https:/doi.org/10.1016/j.apenergy.2012.10.061

[33] Zhang, W. and Yang, S. (2012) The Influence of Energy Consumption of China on Its Real GDP from Aggregated and Disaggregated Viewpoints. *Energy Policy*, **57**, 76-81. https:/doi.org/10.1016/j.enpol.2012.10.023

[34] Lee, C., Chang, C. and Chen, P. (2008) Energy-Income Causality in OECD Countries Revisited: The Key Role of Capital Stock. *Energy Economics*, **30**, 2359-2373. https:/doi.org/10.1016/j.eneco.2008.01.005

[35] Zhou, G. and Chau, K.W. (2006) Short and Long-Run Effects between Oil Consumption and Economic Growth in China. *Energy Policy*, **34**, 3644-3655. https:/doi.org/10.1016/j.enpol.2005.08.009

[36] Apegris, N. and Payne, J. (2009b) Energy Consumption and Economic Growth in Central America. Evidence from a Panel Co-Integration and Error Correction Model. *Energy Economics*, **31**, 211-216. https:/doi.org/10.1016/j.eneco.2008.09.002

[37] Halicioglu, F. (2009) An Econometric Study of CO_2 Emissions, Energy Consumption, Income and Foreign Trade in Turkey. *Energy Policy*, **37**, 1156-1164. https:/doi.org/10.1016/j.enpol.2008.11.012

[38] Jobert, T. and Karanfil, F. (2007) Sectoral Energy Consumption by Source and Economic Growth in Turkey. *Energy Policy*, **35**, 5447-5456. https:/doi.org/10.1016/j.enpol.2007.05.008

[39] Soytas, U. and Sari, R. (2006b) Energy Consumption and Income in G-7 Countries. *Journal of Policy Modelling*, **28**, 739-750. https:/doi.org/10.1016/j.jpolmod.2006.02.003

[40] Soytas, U. and Sari, R. (2003) Energy Consumption and GDP: Causality Relationship in G7 Countries and Emerging Markets. *Energy Economics*, **25**, 33-37. https:/doi.org/10.1016/S0140-9883(02)00009-9