INTERNATIONAL REVIEW OF ECONOMICS AND MANAGEMENT

ISSN: 2148-3493 IREM

DOI: 10.18825/irem.51747 Volume 3, Number 2, 2015, 109-122.

THE RELATIONSHIP BETWEEN ELECTRICITY ENERGY CONSUMPTION AND INCOME: EVIDENCE FROM ARDL BOUNDS TESTING FOR KYRGYZ REPUBLIC

Muhsin Halis *

Levent Korap†

Abstract

The potential links between energy consumption and real income have a critical role in designing discretionary macroeconomic policies for stabilization purposes. In this paper, we try to examine such a relationship for Kyrgyz Republic, and utilize some contemporaneous time series estimation techniques to obtain policy-based conclusions. In light of a methodological discussion, the results indicate that there exists a long run relationship if the real income is chosen as the dependent variable. We found that the larger the electricity consumption the larger would be the real income. Also, the causality analyses carried out in a Granger sense do not support the so-called neutrality hypothesis which means no causal relations between the variables. Instead, we give evidence supporting a one-way causality running from changes in electricity consumption to changes in real income. All in all, the paper emphasizes that policies in favor of energy conservation can lead to harm the economic growth in Kyrgyz Republic.

Key words: Energy Consumption, Real Income, ARDL Bounds Testing, Causality, Kyrgyz Republic

I. INTRODUCTION

Causal linkages between energy consumption and economic growth constitute one of the controversial issues in economic policy debates. The long-run course of these policies and the dynamics of adjustment to this process should be considered elaborately in designing discretionary purposes. Such analyses would have serious implications to assess how these policies can be successful in attaining *ex-ante* targets. For instance, if a unidirectional causality can be attributed to the energy consumption and economic growth relationship, running from the latter to the former, this would mean that no significant adverse causal

* Kastamonu University, mimhalis@gmail.com

† Kastamonu University, lkorap@hotmail.com

effect of energy conservation policies must be expected on economic growth. On the other side, if such a causality runs from energy consumption to economic growth, policies aiming at reducing energy consumption may deteriorate the real income growth process since this indicates the energy dependent characteristic of the economy. If no causality is found between energy consumption and economic growth, referred to as *neutrality* hypothesis due to Yu and Choi (1985), this implies that energy consumption is not correlated with economic growth, and that energy conservation policies may be pursued without adversely affecting the economy (Jumbe, 2004). Therefore, inferences obtained from energy consumption and economic growth analyses would enable policy makers to carry out appropriate energy policies.

Following the energy crises occurred in the 1970s, there has been an extensive research area on this issue of interest for various country cases. The literature follow clearly the developments in modern time series estimation techniques and examine the direction of this relationship. Kraft and Kraft (1978) using Sims causality tests find a unidirectional causality running from gross national product (GNP) to energy consumption for the US economy over the period 1947-1974. However, Akarca and Long (1980) indicate that the results in this paper suffer from temporary sample instability affecting the estimation results when the data sample is shortened. Yu and Hwang (1984) also using the US data for the 1947-1979 period estimate no causal relationship between energy consumption and GNP, supporting the *neutrality* hypothesis. Yu and Choi (1985) examine such a relationship with Granger causality tests for a group of countries and find a causality from GNP to energy consumption for South Korea and from the latter to the former for Philippiness over the period 1954-1976, while no causality is observed for the cases of US, UK and Poland. Likewise, Erol and Yu (1987) apply to Sims and Granger causality tests, and find unidirectional causality from energy consumption to income for West Germany, bidirectional causality for Italy and Japan and no causal relations for UK, Canada and France.

Given the initial contribution of these studies, some other papers search for cointegrating properties between these aggregates. Yu and Jin (1992) investigating the relationships between energy consumption, industrial output and employment for the US over the period 1974-1990 reveal no long run relationship between the variables and give support to the *neutrality* hypothesis for energy consumption. Masih and Masih (1996, 1998) examine the relation between total energy consumption and real income for a group of Asian economies over the period of 1955-1991. They find no causal relation for Malaysia, Singapore, and Philippines, a unidirectional causality from energy consumption to GNP for India, Sri Lanka and Thailand, a reverse causal relationship for Indonesia, and a mutual causality for Pakistan. Masih and Masih (1997) test for cointegration between total energy consumption, real income and price level for Korea and Taiwan. Their results indicate that there exists a jointly interactive causal chain between the variables in line with the estimation results of Hwang and Gum (1992) yielding bidirectional causality for the case of Taiwan. Glasure and Lee (1997) examine the causality issue between energy consumption and gross domestic product (GDP) for South Korea and Singapore with the aid of cointegration and error correction modelling over the period of 1961-1990 and find a bidirectional causality between GDP and energy consumption. Hondroyiannis et al. (2002) with Greece data of the 1960-1996 period support the endogeneity of energy consumption with real output and emphasize the existence of a bidirectional relationship. Asafu-Adjaye (2000) employing a vector error correction (VEC) approach estimates that for the period of 1973-1995 there exists unidirectional short-run causality running from energy to income for India and Indonesia, while bidirectional Granger causality runs from energy to income for Thailand and Philippines. Soytas and Sari (2003) analyze the causal relationship between GDP and energy consumption for the top ten emerging markets except China and for G-7 countries. They discover bidirectional causality in Argentina and causality from energy consumption to GDP in Turkey, France, Germany and Japan, which is attributed to that energy conservation may harm economic growth for these countries. The causal relation appears to be reversed for Italy and Korea.

Based on a production function approach considering output, capital, labor and energy use, Ghali and Sakka (2004) discuss the causal relations between energy use and output growth in Canada for the period 1961-1997. They indicate that energy is a significant component of the long run relationship constructed between these variables. Moreover, a bidirectional causality is found. Oh and Lee (2004) use demand and production side models in a VEC model to investigate the causal relations between GDP and energy for Korea and find a unidirectional causality running from GDP to energy in the long-run. They emphasize that energy conservation policy may be feasible without compromising economic growth in the long-run.

Finally, employing recently developed panel unit root and heterogeneous panel causality and cointegration tests, Lee (2005) investigates co-movement and causality relationship between energy consumption and GDP in 18 developing countries for the period 1975-2001. Results indicate that the long- and the short-run causality run from energy consumption to GDP, leading to the conclusion that energy conservation may harm economic growth in developing countries. However, Al-Iriani (2006) using data from the countries of Gulf Cooperation Council (GCC) and Mehrara (2007) using data from 11 oil exporting countries estimate a unidirectional causality from GDP to energy consumption and suggest that energy conservation policies may be adopted without much concern about their adverse effects on the economic growth. Thus, no clear cut inference can be drawn for the causality between energy consumption and real income, and this relation is highly sensitive to the time periods and estimation techniques.

The paper aims to analyze the long- and the short-run relations between energy consumption and real income for the Kyrgyz Republic. To the best of our knowledge, a recent paper in this line comes from Halis and Korap (2014) that examine the effects of electricity revenues on socio-economic development in Kyrgyzstan, and our paper aims to be complementary to this study. The next section gives a brief knowledge of estimation methodology used in the paper, while the third section conducts an empirical model for the Kyrgyz Republic. The last section summarizes our main findings in the study and concludes the paper.

II. ESTIMATION METHODOLGY: ECONOMETRIC BASE

In this paper, to detect the existence of a long-run relationship between energy consumption and income we tend to follow the methodologies developed in Pesaran and Shin (1999) and Pesaran et al. (2001), namely ARDL bounds testing procedure. Bounds testing allows the researcher to consider both $I(0)$ and $I(1)$ variables together in a cointegrating equation to perpetuate the analysis and avoids the pre-testing problems related with the unit roots and cointegration analysis. The test uses an error correction (EC) equation with long-run multiplier coefficients and short-run dynamic structure of the model. The significance of the lagged levels in the EC form of the underlying ARDL model is examined by an F -statistic by considering all possible combinations of the estimated EC models and rejection of the null hypothesis of non-existence of a stationary relationship yields a long-run characteristic between the variables. Let us consider the VEC model below:

$$\Delta Y_t = \mu + \lambda Y_{t-1} + \sum_{j=1}^{p-1} \gamma_j \Delta Y_{t-j} + \varepsilon_t \tag{1}$$

$Y_t = \left[y_t \; x_t \right]'$ is defined as the variable vector in which y_t represents the endogeneous and x_t the explanatory variable *a priori* assumed. $\mu = \left[\mu_y \; \mu_x \right]'$ is a vector of constant terms and $\Delta = (1-L)$ indicates the difference operator. The vector of error terms is assumed to satisfy $\varepsilon_t = \left[\varepsilon_y \; \varepsilon_x \right]' \sim N(0,\Omega)$, and Ω is positive definite. The variance matrice of error terms can be given as follows:

$$\Omega = \begin{bmatrix} \omega_{yy} \, \omega_{yx} \\ \omega_{yy} \, \omega_{xx} \end{bmatrix} \tag{2}$$

In Eq. (2), λ is the long run multiplier matrix and γ is the shortrun reaction matrix, shown in Eq. (3) and Eq. (4):

$$\lambda = \begin{bmatrix} \lambda_{yy} \lambda_{yx} \\ \lambda_{xy} \lambda_{xx} \end{bmatrix} = -\left(I - \sum_{j=1}^{p} \phi_j \right) \tag{3}$$

$$\gamma_j = \begin{bmatrix} \gamma_{yy,j}\gamma_{yx,j} \\ \gamma_{xy,j}\gamma_{xx,j} \end{bmatrix} = -\sum_{k=j+1}^{p} \phi_k \tag{4}$$

I is an identity matrix and ϕ is the vector autoregression model coefficient matrix. The diagonal elements of matrix λ are left unrestricted. Such a case allows for the possibility that the time series used can be either $I(0)$ or $I(1)$. For instance, $\lambda_{yy} = 0$ would imply that the variable y is $I(1)$ and $\lambda_{yy} < 0$ expresses that the variable is $I(0)$. One of the non-diagonal elements of the long run multiplier matrix, λ_{yx} or λ_{xy}, can take zero value. In light of these explanations, the following equation is estimated.

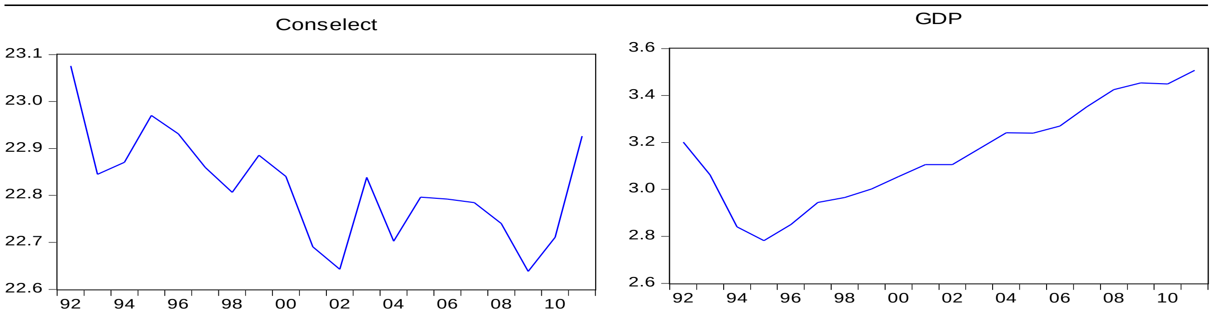
$$\Delta y_t = \alpha + \varphi y_{t-1} + \delta x_{t-1} + \omega \Delta x_t + \sum_{j=1}^{p-1} \beta_{P,j} \Delta y_{t-j} + \sum_{j=1}^{q-1} \beta_{x,j} \Delta x_{t-j} + u_t \tag{5}$$

where φ and δ are the long run multiplier coefficients, while Δy_{t-j} and Δx_{t-j} express the short run dynamic structure of EC model. This approach requires the OLS estimation of Eq. (2) with most appropriate lag specification, and then the absence of a long run relationship between the levels of y_t and x_t is tested by use of F-statistics in line with the hypotheses $H_0 : \varphi = 0, \delta = 0$ versus $H_1 : \varphi \neq 0, \delta \neq 0$. The rejection of H_0 hypothesis gives evidence in favour of a long-run relationship. That the F-statistic exceeds upper CVs means rejection of the null hypothesis, but if it is found below CV bounds we cannot reject non-existence of a cointegrating relationship. No conclusive inference can be made when the estimated statistic lies between the bounds which requires to know the order of integration of the underlying regressors.In addition to this estimation procedure, if we find that the value of the t-statistic of the ne period lagged coefficient of the dependent variable (φ) in Eq. 5 is greater than the CVs reported by Pesaran et al. (2001), this would also reflect the exitence of a cointegrating relationship between the variables. Note that Pesaran and Shin (1999) bring out that the ARDL based bound testing approach is able to yield consistent long run coefficient estimators even in small samples. Having tested the existence of a potential cointegration relationship between the variables, the most appropriate lag specification of the variables in the ARDL model must be determined through the widely used lag selection information criteria, so that the long-run equilibrium and the short-run dynamic EC model coefficients can be estimated by employing the standard OLS methodology.

III. RESULTS

In estimation process, two data sets are considered as variables, one for electricity consumption in terms of kWh ($Cons_{elect}$) and the other for gross domestic product in constant prices with the base 1995 (GDP). The data are compiled from International Monetary Fund (IMF) World Economic Outlook Database and National Statistical Office of Kyrgyz Republic and are in their natural logarithms. The sample in annual frequency is 1992-2011. The time series graphs can be seen below.

Figure 1. **Time Series**



Prior to proceeding to the estimation procedure, we first give the unit root knowledge of the variables. This paper follows Ng and Perron (2001) tests that construct four test statistics based upon generalized least squares trended data. The results including a linear trend under the null hypothesis of a unit root are summarized in Table 1. The test statistics assume HAC corrected variance (Spectral GLS – detrended AR). Following the recommendation of Ng and Perron (2001), the choice of optimum lag was decided on the basis of minimizing a modified version of the Schwarz information criterion. In Table 1, we see that the findings are unable to reject the null hypothesis of a unit root in estimations and the variables seem to be driven by a $I(1)$ process.

Table 1. Ng-Perron (2001) Modified Unit Root Tests

Variable	$Cons_{elect}$				GDP			
Level form	MZa	MZt	MSB	MPT	MZa	MZt	MSB	MPT
Test stat.	-7.76	-1.62	0.21	12.40	-8.30	-1.65	0.26	13.40
Differenced form	MZa	MZt	MSB	MPT	MZa	MZt	MSB	MPT
Test stat.	-18.21	-3.10	0.17	4.34	-18.50	-3.20	0.15	4.80
5% CV	-17.30	-2.91	0.17	5.48	-17.30	-2.91	0.17	5.48

Table 2. Bounds Testing (* and ** denotes 5% and 10% significance, respectively)

Dependent variable: $Cons_{elect}$

	without deterministic trend							with deterministic trend					
Lag	AIC	SC	$AC(1)$	$FF(1)$	$N(2)$	$H(1)$	AIC	SC	$AC(1)$	$FF(1)$	$N(2)$	$H(1)$
1	**-2.08**	**-1.78**	**0.24**	**0.20**	**0.23**	**0.09**	-1.97	-1.62	0.28	0.24	0.23	0.12
2	-1.87	-1.47	2.13	0.51	0.13	0.43	-1.83	-1.39	0.46	1.48	0.25	0.01
3	-1.75	-1.27	1.52	1.50	0.48	0.55	-1.79	-1.25	9.35*	3.27	1.53	0.05
4	-1.57	-1.01	21.0*	0.02	0.06	4.66**	-1.83	-1.22	3.04	0.73	0.26	0.92

lag	F_{IV}	F_V	t_V
1	4.45	5.90	-2.90
0.05 CV			
$I(0)$	4.68	6.56	-3.41
$I(1)$	5.15	7.30	-3.69

Dependent variable: GDP

	without deterministic trend							with deterministic trend					
Lag	AIC	SC	$AC(1)$	$FF(1)$	$N(2)$	$H(1)$	AIC	SC	$AC(1)$	$FF(1)$	$N(2)$	$H(1)$
1	-3.36	-3.06	0.04	17.29*	0.75	0.27	-4.78	-4.44	0.18	1.94	0.27	0.12
2	-3.94	-3.55	0.57	1.74	0.43	1.11	-4.60	-4.16	4.85**	1.04	1.09	0.49
3	-3.72	-3.23	0.40	4.85**	1.08	2.95	**-5.25**	**-4.72**	**1.57**	**1.33**	**0.96**	**0.03**
4	-3.87	-3.40	8.26**	3.46	0.58	4.14**	-4.48	-3.87	0.95	2.01	1.07	3.03

lag	F_{IV}	F_V	t_V
1	4.45	5.90	-2.90
0.05 CV			
$I(0)$	3.38	4.01	-3.41
$I(1)$	4.23	5.07	-4.16

Selected ARDL model (3,3) (SEs beneath coefficients and ‘D’ indicates the difference operator)

$$\underset{(4.58)}{DGDP_t = 11.87} + \underset{(0.23)}{0.58} DGDP_{t-1} + \underset{(0.13)}{0.16} DGDP_{t-2} - \underset{(0.14)}{0.09} DGDP_{t-3} - \underset{(0.08)}{0.04} DCons_{elect,t} - \underset{(0.09)}{0.11} DCons_{elect,t-1} - \underset{(0.06)}{0.17} DCons_{elect,t-2}$$

$$-\underset{(0.07)}{0.17} DCons_{elect,t-3} - \underset{(0.35)}{1.61} GDP_{t-1} + \underset{(0.10)}{0.18} Cons_{elect,t-1} + \underset{(0.02)}{0.07} trend$$

Conditional parsimonious ARDL model (2,1) (SEs beneath coefficients)

$$DGDP_t = \underset{(3.61)}{11.83} + \underset{(0.15)}{0.32} DGDP_{t-1} - \underset{(0.16)}{0.07} DGDP_{t-2} + \underset{(0.105)}{0.05} DCons_{elect,t-1} - \underset{(0.31)}{0.98} GDP_{t-1} + \underset{(0.04)}{0.11} Cons_{elect,t-1} + \underset{(0.01)}{0.04} trend$$

$F-stat$ 7.62

Then, we apply to the ARDL bounds testing to search for a cointegrating relationship between the variables. For this purpose, we examine both $(Cons_{elect}\ GDP)'$ and $(GDP\ Cons_{elect})'$

variable vectors to test the endogeneity of the variables in cointegration analysis. The results are given in Table 2. $AC(1), FF(1), \chi^2_N(2), H(1)$ are the F-statistics for the lack of Breusch-Godfrey residual autocorrelation, Ramsey RESET functional form mis-specification, ARCH heteroskedasticity and Jarque-Bera non-normality with χ^2 distribution. The existence of a potential cointegration relationship between the variables has been examined by comparing the estimates with the CVs reported in Table CI(iv), Table CI(v) and Table CII(v) of Pesaran et al. (2001). F_{IV} and F_V indicate asymptotic CV bounds and estimated statistics for the cases of unrestricted intercept & restricted trend and unrestricted intercept & unrestricted trend, respectively. t_V indicates the t-statistic of the coefficient of one period lagged dependent variable. Since there is no reason why p and q in Eq. (5) should have the same value, both variables are taken into account with different lag structures from one to four, yielding estimation of too many ARDL models and running regressions for all the possible lag lengths of variables to obtain a parsimonious model. Assuming Schwarz criterion, the results obtained by a program written in EViews language propose to use ARDL(2,1) model. Following Bårdsen (1989), the long run coefficient will be considered by dividing one period lagged level value of independent variable to the one period lagged level value of dependent variable and then multiplied with minus one, that is, - (δ/ φ) in Eq. 5.

The selected equation in the possible ARDL models that passes all the diagnostics are given in bold characters. It is observed that there exists a one-way cointegration relationship running from the variable $Cons_{elect}$ to the variable GDP. Indeed, the null hypothesis of no cointegration cannot be rejected when the dependent variable is selected as the variable $Cons_{elect}$. However, in the case that the variable GDP is assigned to be the dependent variable, we find a long run equation that yields a normalized coefficient of 0.11 which means that the larger the electricity consumption the larger the real GDP growth, as well. This equation in a conditional parsimonious ARDL model is presented at the bottom of the table and can be considered in a way that fits well with actual data representation.

Following the construction of a long-run model, the study now tests the possible causality relationships between the change in energy consumption and real income growth through the Granger causality tests considering the knowledge of cointegrating relationship included into the causality analysis. In this way, both the long-run causality captured by the significance of the error correction term and the short-run causality derived by testing the significance of the sum of the lags of explanatory variables are tried to be examined empirically. Such a variable system can be written in a VEC form as follows:

$$DCons_{elect,t} = \phi_i + \sum_{i=1}^{n} \gamma_{1i} DGDP_{t-i} + \sum_{i=1}^{n} \eta_{1i} DCons_{t-i} + \sum_{i=1}^{r} \lambda_{1i} ECT_{r,t-1} + \varepsilon_{1t} \qquad (6)$$

$$DGDP_t = \varphi_i + \sum_{i=1}^{n} \gamma_{2i} DGDP_{t-i} + \sum_{i=1}^{n} \eta_{2i} DCons_{t-i} + \sum_{i=1}^{r} \lambda_{2i} ECT_{r,t-1} + \varepsilon_{2t} \qquad (7)$$

where n is the chosen lag length for the order of autoregressive models and ε_{it}'s for i = 1,2 are the disturbance terms assumed whitening the error structure of the models with $N\left(0, \sigma_{\varepsilon}^{2}\right)$process. ECT stands for the error correction terms taken from the long-term cointegrating space. Eq. 6 and Eq. 7 are used to evaluate the causality analysis between the changes in energy consumption and real income growth. In Eq. 6, it is search for whether there exists a causal relationship running from the change in real income to the change in energy consumption, while in Eq. 7 causality running from change in energy consumption to real income growth is considered. Error correction mechanisms included in the autoregressive models given above provide researches with the additional knowledge of causal relations between the variables ignored by the initial Granger (1969) and Sims (1972) tests, which allow to distinguish both the short- and the long-run causality from each other. The $Wald$ or F tests applied to the joint significance of the sum of the lags of each explanatory variable and the t tests of the lagged error correction terms will highlight us for the knowledge of Granger exogeneity or endogeneity of each dependent variable in a statistical sense. If the dependent variables can be driven by the error term yielded in the cointegrating vector which explains the speed of feedback effects towards the long-run steady state relationship, this implies the existence of a long-run causal relationship. Such a finding is equivalent to saying that the variable considered has not been found weakly exogenous with respect to the cointegrating variable space. This can be done by testing $H_0 : \lambda_{ti} = 0$ through the t tests of the lagged error correction terms. If the non-significance of the error correction terms is accepted, this means that the dependent variable responds only to the short-term shocks to the stochastic environment (Masih and Masih, 1997; Oh and Lee, 2004). In this sense, the rejection of the non-significance of the differenced explanatory variables by $Wald$ or F tests will be referred to as the short-term causality. This can be done by testing the null hypothesis of the non-significance of γ_i and η_i in Eq. 6 and Eq. 7. Finally, the paper tests jointly the non-significance of all the explanatory variables including both the differenced stationary variables and the lagged error correction terms in the VEC mechanism for the absence of Granger causality, that is what Hondroyiannis et al. (2002) call "strong exogeneity of the dependent variable".

In Table 3, causal relationships derived from the Granger causality tests are examined by assuming both the exogeneity of each variable with lagged dynamic structure and the block exogeneity of all the variables under the null hypothesis in each equation. In the upper part of the tables, we examine separately the statistical significance of the sum of the lags of each explanatory variable as an indicator of short-run causality as well as the significance of one period lagged ECT taken from the long-term co-integrating relationship, while lower part of the table tests both the block exogeneity of all the differenced explanatory variables plus the significance of the lagged ECT. For the latter case, we test the strong exogeneity of dependent variable under the null hypothesis. The numbers in parentheses are probability ($Prob$) values of relevant statistics, for which we accept that $Prob$ values lower than 0.05 would indicate the rejection of the null hypothesis in favor of the statistical significance of the restrictions applied for causality tests.

Table 3. Granger Causality Analysis (F-stats.)

Individual causality

Dep. Var.	H$_0$: there is no causal relation (source of causation is independent variables)		
	$DCons_{elect}$	$DGDP$	ECT
$DCons_{elect}$	------	1.43 (0.32)	1.74 (0.24)
$DGDP$	5.92 (0.04)	------	20.87 (0.00)

Joint tests of short run dynamics and ECT

Dep. Var.	H$_0$: there is no causal relation (source of causation is independent variables)
$DCons_{elect}$	$DGDP$ and ECT
	2.32 (0.17)
$DGDP$	$DCons_{elect}$ and ECT
	1.17 (0.01)

In Tab. 3, it is observed that there exists a one-way causality running from changes in electricity consumption to changes in real GDP. Indeed, the null hypothesis is rejected for both the individual causality and the strong exogeneity when the dependent variable is chosen as $DGDP$. However, no clear evidence can be found in the opposite direction of causality. Such a finding is an indicator of the endogenous characteristic of the real income growth in our empirical model, and also gives support to the long-run findings. The results indicate that economic policies in favor of energy conservation can possibly lead to harm the economic growth in Kyrgyz Republic. Thus, the main policy conclusion extracted from the analysis can be summarized such that energy policies *ex-ante* designed have the power of affecting the real income growth in the economy, because we find that the main endogenous factor upon which the macroeconomic variable system is constructed has been estimated as the real income.

IV. CONCLUDING REMARKS

The potential links between energy consumption and real income have a critical role in designing discretionary macroeconomic policies for stabilization purposes. Revealing the direction of causal relations between these macroeconomic aggregates gives economic agents and policy makers a significant knowledge in policy design and implementation process so as to assess the long-run course of the energy policies. In our paper, we try to examine the long- and the short-run relations between energy consumption, represented by electric power consumption, and real income for the Kyrgyz Republic. Based on the ARDL-based cointegration methodology to detect long-run relations, our estimation results indicate that there exists a long-run relationship if the dependent variable is chosen as the real income. We found that the larger the electricity consumption the larger would be the real income. The study also tries to test the causality relationships between the change in energy consumption and real income growth. In this way, both the long-run causality captured by the significance of the error correction term and the short-run causality derived by testing the significance of the sum of the lags of explanatory variables are tried to be examined empirically. Our results do not support the so-called neutrality hypothesis between the variables, and give evidence in favor of a one-way causality running from changes in electricity consumption to changes in real GDP. We infer that economic policies in favor of energy conservation can lead to harm the economic growth in Kyrgyz Republic. Of course, what is a critical point to be considered here is the small sample characteristic of the empirical model constructed, although Pesaran and Shin (1999) report that the ARDL based bound testing approach is able to yield consistent long-run coefficient estimators even in small samples. Thus, the estimation results in this paper should be appreciated cautiously, and need to be re-considered with a longer term data in future studies.

Acknowledgement

This paper is a revised version of an unpublished study named ‘Kırgızistan’da Sosyo-İktisadi Gelişme Üzerinde Elektrik Gelirlerinin Etkisi’ and was presented at the International Congress on Economics, Finance and Energy (EFE´2014), Hoca Ahmet Yesevi International Turkish-Kazakh University, June 12-14, 2014, Almaty / KAZAKHSTAN. The authors are very grateful to the participants of the conference for their invaluable criticism and suggestions that lead us to re-organize this paper. In this sense, the special thanks go to the Prof. Recep Kök of the Dokuz Eylül University Department of Economics.

REFERENCES

Akarca, A.T. and Long, T.V. (1980). “On the Relationship between Energy and GNP: A Reexamination”, *Journal of Energy and Development*, 5, 326-331.

Al-Iriani, M. (2006). “Energy-GDP Relationship Revisited: An Example form GCC Countries Using Panel Causality”, *Energy Policy*, 34, 3342-3350.

Asafu-Adjaye, J. (2000). “The Relationship between Energy Consumption, Energy Prices and Economic Growth: Time Series Evidence from Asian Developing Countries”, *Energy Economics*, 22, 615-625.

Erol, U. and Yu, E.S.H. (1987). “On the Causal Relationship between Energy and Income for Industrialized Countries”, *Journal of Energy and Development*, 13, 113-122.

Ghali, K.H. and El-Sakka, M.I.T. (2004). “Energy Use and Output Growth in Canada: A Multivariate Cointegration Analysis”, *Energy Economics*, 26, 225-238.

Glasure, Yong U. and Lee, Aie-Rie (1997). “Cointegration, Error-correction, and the Relationship between GDP and Energy: The Case of South Korea and Singapore”, *Resource and Energy Economics*, 20, 17-25.

Granger, C.W.J. (1969). “Investigating Causal Relations by Econometric Modelsand Cross Spectral Methods”, *Econometrica*, 37, 424-438.

Halis, M. and Korap, L. (2014). Effects of Electricity Revenues on Socio-Economic Development in Kyrgyzstan, *Paper presented at the International Congress on Economics, Finance and Energy (EFE’2014)*, Hoca Ahmet Yesevi International Turkish-Kazakh University, June 12-14, 2014, Almaty / KAZAKHSTAN.

Hondroyiannis, G., Lolos, S. and Papapetrou, E. (2002). “Energy Consumption and Economic Growth: Assessing the Evidence form Greece”, *Energy Economics*, 24, 319-336.

http://www.imf.org/external/pubs/ft/weo/2014/02/weodata/weoselser.aspx?c=917&t=1

Hwang, D.B.K. and Gum, B. (1992). “The Causal Relationship between Energy and GNP: The Case of Taiwan”, *Journal of Energy and Development*, 16, 219-226.

Jumbe, C.B.L. (2004). “Electricity Consumption and GDP: Empirical Evidence from Malawi”, *Energy Economics*, 26, 61-68.

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

Lee, C.-C. (2005). “Energy Consumption and GDP in Developing Countries: A Cointegrated Panel Analysis”, *Energy Economics*, 27, 415-427.

Masih, A.M.M. and Masih, R. (1996). “Energy Consumption, Real Income and Temporal Causality: Results from a Multi-country Study Based on Cointegration and Error-correction Modelling Techniques”, *Energy Economics*, 18, 165-183.

Masih, A.M.M. and Masih, R. (1997). “On the Temporal Causal Relationship between Enegy Consumption, Real Income and Prices: Some New Evidence from Asian-Energy Dependent NICs Bsed on a Multivariate Cointegration / Vector Error Correction Approach”, *Journal of Policy Modeling*, 19/4, 417-440.

Masih, A.M.M. and Masih, R. (1998). “A Multivariate Cointegrated Modelling Approach in Testing Temporal Causality between Energy Consumption, Real Income and Prices with an Application to Two Asian LDCs”, *Applied Economics*, 30, 1287-1298.

Mehrara, M. (2007). “Energy Consumption and Economic Growth: The Case of Oil Exporting Countries”, *Energy Policy*, 35, 2939-2945.

National Statistical Office of Kyrgyz Republic. Statistical Bulletins, Various Issues.

Ng, Serena and Perron, P. (2001). “Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power”, *Econometrica*, 69/6: 1519-1554.

Oh, W. and Lee, K. (2004). “Energy Consumption and Economic Growthin Korea: Testing the Causality Relation”, *Journal of Policy Modeling*, 26, 973-981.

Pesaran, M.H., and Shin, Y. 1999. An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. Chapter 11 in Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium, Strom S.(ed.), Cambridge: Cambridge University Press.

Pesaran, M.H, Shin, Y. and Smith, R.J. 2001. Bounds Testing Approaches to the Analysis of Level Relationships. Journal of Applied Econometrics, 16, 289-326.

Sims, C. (1972). “Money, Income and Causality”, *American Economic Review*, 62, 540-552.

Soytas, U. and Sarı, R. (2003). “Energy Consumption and GDP: Causality Relationship in G-7 Countries and Emerging Markets”, *Energy Economics*, 25, 33-47.

Yu, E.S.H. and Jin, B.K. (1984). “The Relationship between Energy and GNP: Further Results”, *Energy Economics*, 6, 168-190.

Yu, E.S.H. and Choi, J.Y. (1985). “The Causal Relationship between Energy and GNP: An International Comparison”, *Journal of Energy and Development*, 10, 249-272.

Yu, E.S.H and Jin, J.C. (1992). “Cointegration Tests of Energy Consumption, Income and Employment”, *Resources and Energy*, 14, 259-266.