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Influential Role of Energy Sources on the Economic Development of Pakistan; A Comparative Analysis of Renewable and Non-Renewable Energy Consumptions

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Abstract
The purpose of this study is to analyze the empirical effects of renewable and non-renewable energy consumptions on economic growth of Pakistan. To achieve this objective, time series data for the period of 1986 to 2015 is considered using Autoregressive Distributed Lag (ARDL) approach of cointegration with error correction model that offer short run and long run estimations. Results indicate that renewable energy consumptions along with dry natural gases turned out to be more prominent factors in effecting the economic growth positively for short and long run. However, kerosene oil and liquid petroleum gases have insignificant effects on economic development for both periods. Therefore, this study suggests that Pakistan should lower the intake of non-renewable energy consumptions sources to achieve and sustain higher economic proficiency.
Keywords: Renewable energy consumption; non-renewable energy consumption; gross domestic product; Autoregressive Distributed Lag; error correction model

1. Introduction

Environmental issues are expanding threat because of poisonous gas emanation from various nonrenewable energy resources that brought anxiety in an entire world. Discharge of these gases causes ecological exploitation and their outcomes are different among distinct regions; especially south Asian region might be extra affected due to those variations (Tiwari, 2011). Stern (2006) called an attention toward the causes of excessive amount of reliance on non-sustainable power source utilizations. He emphasizes that without legitimate arrangement of activity to decrease greenhouse gases (GHG) release could expand the temperature level quickly in future. This suggests that probably more than 50 percent worldwide temperatures could ascend from 2 to 5 Celsius in short-run and long-run. These fluctuations in temperature could have an effect on all nations, in particular modest ones and with larger populations, even though they supplied minimum share to GHG outflows.

To accommodate the complications of non-renewable resources and transformation into modern renewable energy resources instantly is not an easy task to accomplish because of huge economic growth dependency of most of the economies on these traditional sources. Therefore, without compromising the economic undertakings; a coherent strategy needed to limit the utilization of current energy consumptions.

In this scenario, energy from renewable sources is acknowledged as a key constraint to replace the non-renewable energy and to achieve ecological development. Since sustainable energy has been proposed as a popular expression in the global energy administration; investments in its share are mounting hastily and it is also anticipated to be the most flourishing energy source. Renewable Global Status Report (2015) reveals that; although, total investments of developed countries are large but major portion of that investment currently comes from developing countries. During the year of 2015, total investment in renewable energy was estimated US$ 312 billion; the shares of developed and developing countries were 145 and US$167 billion respectively.

At present, more than 80 percent of the world's total energy is obtained from traditional non-renewable energy consumption sources. However, according to the International Energy Outlook (2010), growth rate of electricity generation using world renewable energy will rise up to 3% per annum and usage of renewable energy will grow by 2.6% annually for the time period of 2007-2035. Consequently, share of renewables in power production sources globally will enhance from 18% to 23% for the same time period.

Pakistan realized the impact of global climate changes due to excessive usage of non-renewable energy (leading towards global warming) and has started several projects based on hydro, solar and other renewables. In 2011, Pakistan set the target to obtain 5% of its energy needs from renewable sources by 2030; which will be expected to rise at least 15% in upcoming years due to China Pakistan Economic Corridor initiative (CPEC)[1]. Furthermore, Pakistan became a billion-dollar market in renewable energy along with Philippines and Turkey in the Asian region in 2015. Figure 1 shows the current energy mix of Pakistan by sources.

[1] Under the project of China Pakistan Economic Corridor (CPEC), China will likely to invest $62 billion in Pakistan. More than 30 energy projects are planned and proceeding under this project.

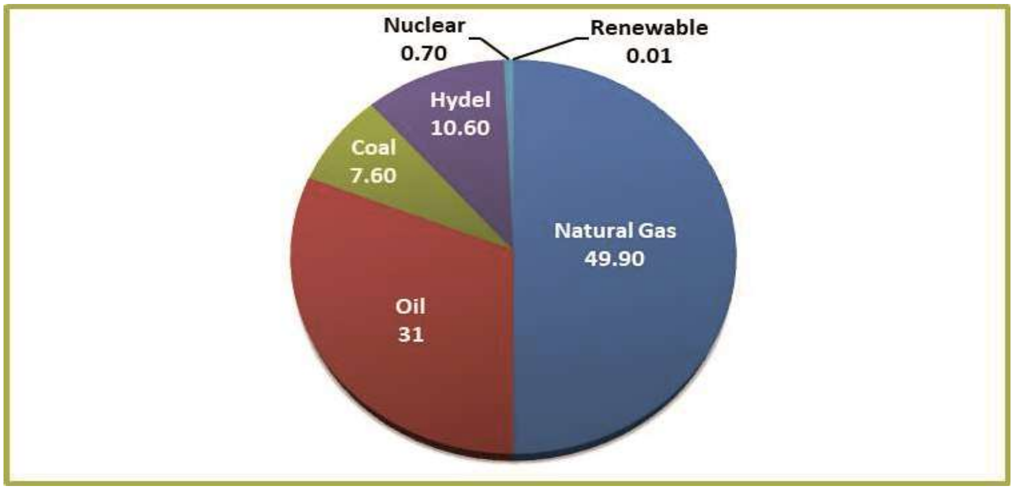

Figure 1. Energy mix of Pakistan

The dependency of energy needs of country is still on nonrenewable resources but in past 2 decades renewable energy has attempted to grab some of that portion. Although, the transition is not happening briskly to gain immediate benefits of green energy but it still maintains good pace. Currently, Pakistan expects 1 billion dollars investment in the sector of renewables, out of which 500 million dollars are to be expected from China through different projects being operated under CPEC (Pakistan's Alternative Energy Development Board, 2015). The renewable resources (conventional and non-conventional) bear impressive capability and a very broad range which have not yet been adequately explored or developed in the country. Therefore, current supplies of primary energy are not sufficient to meet even the present demand. Moreover, majority of rural areas in the country doesn't have the access to electrification facilities because of remoteness or high expenditure to connect them with the national grid. Thus, like some other countries in the region, Pakistan also faces the scarcity of energy. However, Pakistan is in a good position to build up these power resources and expansion of these sources will bring new era in the energy sector (Energy Information Administration, 2005).

Although, most of the previous studies on energy-growth link made an effort to explore the long-run behavior of energy use and economic growth but majority of those studies was based on panel data analysis which generates identical results beyond countries within panel. Therefore, literature lacked in single country analysis provides an opportunity to investigate this relationship further to assist in the formulation and implementation of better strategy for single country.

To the best of authors' knowledge, very few studies have been undertaken to determine such causal relationship comprehensively in the context of Pakistan, which is in dire need of such investigation. Furthermore, this study used autoregressive distributed lag approach to cointegration with error correction model to get short-run and long-run assessments. Additionally, the problems of autocorrelation, heterosecedasticity and specification of the model are also extensively considered in the study to avoid any misleading results. Hence, present study as a contribution to the literature characterizing the short and long run effect of renewable and non-renewable energy sources on economic growth (current US dollars) of Pakistan.

The remaining part of the paper is structured as follows; section- 2 represents the literature review, section 3 narrates data resources, theoretical framework, empirical model, methodology and estimation procedures utilized in study.

2. Literature Review

The literature on causal association between energy-growth is usually determined by four hypotheses: Growth, Conservation, Feedback and Neutrality. In the proposition of growth hypotheses; energy consumption has a major part in the process of economic growth individually or with capital and labor both. The basis of growth hypotheses ropes the existence of unidirectional causation from energy depletion to economic progression and not vice versa. Secondly, economic growth provides directions to energy utilization under the conservative supposition and this assumption supports unidirectional connectedness from economic development to energy spending and no other way around. In these circumstances, policies used to decrease the energy use will not adversely affect the growth process. Thirdly, the presence of bidirectional causality endorses the feedback assumption which is established on the inter-reliant relation between economic growth and energy consumption. This mutually dependent relationship recommends that reduction in energy consumption or variation in economic growth have counter effect on each other. Finally, the base of neutrality hypotheses reinforces that there is merely a little or no role of energy consumption on economic growth process and no causal relationship between them. In this scenario, expansion or reduction in power usage strategies will not affect the growth at all. The literature on the relationship between energy-growth can be categorized into 2 sections. The first category is condensed in Table 1; which implicates total energy-growth nexus and renewable energy consumption and economic growth.

Table 1. Summary of literature on total energy- economic growth and renewable energy consumption-economic growth

Study	Methodology	Period	Country	Hypothesis Supported
Sadorsky (2009)	Panel cointegration and fully modified ordinary least squares	1994-2003	18 emerging countries	Conservation
Apergis and Payne (2010)	Panel Error Correction Model	1992-2007	13 Eurasian countries	Feedback
Apergis and Payne (2010)	Panel Error Correction Model	1985-2005	20 OECD countries	Feedback
Odhiambo (2010)	Autoregressive distributed lag (ARDL)	1972-2006	Congo DR, Kenya, South Africa	Growth
Apergis and Payne (2010)	Panel cointegration and fully modified ordinary least squares	1992-2004	11 Common wealth of independent	Feedback
Ozturk et al. (2010)	Panel cointegration and panel causality method	1971-2005	51 countries	Feedback, Conservation
Pao and Tsai (2010)	Granger causality	1965-2009	Brazil, Russia, India, China	Growth
Balcilar et al. (2010)	Bootstrap rolling window causality	1990-2006	G-7 countries	Neutrality
Apergis and Payne (2010)	Panel cointegration and Granger causality	1980-2005	9 South American countries	Growth
Menegaki (2011)	Panel Error Correction Model	1997-2007	27 European countries	Neutrality
Apergis and Payne (2011)	Panel cointegration and panel error correction model	1980-2006	6 Central American countries	Feedback
Payne (2011)	Toda-Yamamoto causality approach	1949-2007	USA	Growth
Tiwari (2011)	Structural VAR approach	1960 -2009	India	Growth
Apergis and Payne (2011)	Panel cointegration Vector error correction model	1990-2006	88 countries	Feedback
Ozturk and Acaravci (2011)	ARDL	1971-2006	11 MENA countries	Neutrality
Belke et al. (2011)	Panel Error Correction Model	1981-2007	25 OECD countries	Feedback
Fuinhas and Marques (2012)	ARDL	1965-2009	Italy, Greece, Portugal, Spain, Turkey	Feedback
Al- Mulali and Sab (2012)	Panel cointegration and panel causality method	1980-2008	30 sub- Saharan African countries	Growth
Akkemik and Goksal (2012)	Hurlin and Venet causality approach	1980-2007	79 countries	Feedback, Neutrality, Growth
Apergis and Tang (2013)	Toda-Yamamoto, Dolado-Lütkepohl causality	1975-2007	85 countries	Growth for 46 countries
Shahbaz et al. (2013)	ARDL	1971-2011	China	Growth
Solarin and Shahbaz (2013)	ARDL	1971- 2009	Angola	Feedback
Stern and Enflo (2013)	Granger causality	1850-2010	Sweden	Conservation
Tang and Tan (2013)	ARDL	1970-2009	Malaysia	Feedback
Dergiades et al. (2013)	Parametric and non- parametric causality test	1960-2008	Greece	Growth
Ocal and Aslan (2013)	Toda-Yamamoto causality approach	1990-2010	Turkey	Conservation
Aslan et al. (2014)	Wavelet analysis and Granger causality test	1973q1-2012q1	USA	Growth
Ohler and Fetters (2014)	Panel Error Correction Model	1990-2008	20 OECD countries	Feedback
Lin and Moubarak (2014)	ARDL	1977-2011	China	Feedback
Shahbaz et al. (2015)	Rolling window causality approach	1972q1-2011q4	Pakistan	Feedback
Kyophilavong et al. (2015)	Bayer and Hanck cointegration approach	1971-2012	Thailand	Feedback
Caraiani et al. (2015)	Engle-Granger causality method	1980-2013	5 Emerging European countries	Conservation, Growth
Chang et al. (2015)	Panel heterogeneous causality approach	1990-2011	G-7 countries	Feedback

The second category of literature is in line with the objective of current study; (analyze and evaluate the effects of renewable energy consumption and non-renewable energy consumption on economic growth) therefore these studies are discussed in detail below.

Payne (2009) found no causal correlation among renewable, non- renewable energy consumptions and economic growth in US by utilizing the Toda-Yamamoto test for the period of 1949-2006; their results supported the presence of neutrality hypothesis. Similarly, Bowden and Payne (2010) also applied Toda-Yamamoto causality method to assess the same relationship for the same period in US but their findings suggested bidirectional causativeness between non-renewable energy consumption and economic growth.

Tiwari (2011) employed PVAR approach to evaluate the comparative enactment of renewable, non-renewable energy utilization on financial development. The result showed negative impact of non-renewable and positive effect of renewable energy growth rate on GDP growth rate of European and Eurasian countries.

By employing classical and augmented production function through ARDL approach of cointegration and causality test Tugcu (2012) weighed up the association relating to renewable, nonrenewable energy consumption and real GDP of G7 countries for 1980-2009. Results indicated bi-directional causality under classical and mixed results in case of augmented production function for each country.

Apergis and Payne (2012a) found unidirectional and bidirectional causality in short and long run respectively for renewable energy use to economic development. However, the effect of non-renewable energy resources and economic progress showed bidirectional causality in short as well as long run for six Central American countries.

Ruhul (2014) used panel cointegration test allowing structural breaks to analyze the energy consumptions and growth relationship in OECD countries for the period of 1980-2011. Outcomes pointed out bidirectional causality between industrial outputs and both of the energy consumption sources in short and long run. On the other hand, there exist bidirectional causativeness between non-renewable and GDP growth, and unidirectional causation between renewable energy and GDP in the short run.

Tiwari (2015) used hidden and linear cointegration technique to examine the process of renewable and non-renewable energy production on economic growth for the period of 1971 to 2011 in twelve sub-Saharan African countries. Results of their study endorsed the growth hypothesis for both renewable energy and non-renewable energy production.

Jebli and Youssef (2015) considered the link relating to renewable, non-renewable energy consumption and economic growth by using panel cointegration and panel Granger causality approach for the period 1980-2010 in 69 countries and found the bidirectional causality among renewable energy, non-renewable energy consumption and economic growth.

3. Data sources and methodology

In this study three variables were employed – economic growth (GDP), renewable energy consumptions and non-renewable energy consumptions for the period of 30 years from 1986-2015. Renewable energy sources is the combination of alternative and nuclear energy and other renewable energy, while non-renewable energy comprises of dry natural gases, kerosene oil and liquefied petroleum gases sources. Data on GDP (current US Dollars), alternative and nuclear energy and other renewable energy (% of total energy use) were obtained from World Development Indicators (2015). The sources of dry natural gases (billion cubic feet), kerosene oil and liquefied petroleum gases (thousand barrels per day) were Indexmundi (2016). Natural logarithm form of all variables was expressed in empirical investigation.

3.1 Model Specification

The study specified the Cobb-Douglas production function to examine the effects of renewable and non-renewable energy on economic growth of Pakistan.

$$lnGDP_t = \beta_0 + \beta_1 \, lnAN_t + \beta_2 \, lnRE_t + \beta_3 \, lnDNG_t + \beta_4 \, lnKO_t + \beta_5 \, lnLPG_t + U_t \qquad (1)$$

Where:

GDP_t = gross domestic product
AN_t = alternative and nuclear energy
RE_t = other renewable energy
DNG_t = dry natural gases
KO_t = kerosene oil
LPG_t = liquefied petroleum gases
U_t = error term

3.2 Estimation Procedures

3.2.1 Unit root test

It is critical to check the integration level and stationarity of data series, if incorporated variables are not stationary i.e. I(0) or I(1); it may provide spurious regression results. To provide data without variation and ensure integration of variables to get the precise results, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests were employed. Null and alternate hypothesis in both tests were the presence of unit root and variables are stationary respectively (Perron, 1990). The ADF test is specified as;

$$\Delta x = a + \beta_1 + \psi x_{t-1} + \sum_{k=0}^{n} \lambda_i \, \Delta x_{t-i} + \varepsilon_t \qquad (2)$$

Where Δ is the difference operator, x is the variable being tested, ε_t is the error term residuals and β, ψ, λ_i are the parameters. In contrast PP test is extensively different from ADF test because ADF presumes that error term is statistically independent and has constant variance. However, PP test has fewer prohibit assumptions about the distribution of errors (Asteriou, 2007).
The regression equation for the PP test;

$$\Delta y_{t-1} = \alpha_0 + \psi x_{t-1} + \varepsilon_t \quad (3)$$

3.2.2 ARDL Co integration Procedure

To analyze the co integration relationship among variables; Engle and Granger (1987), Johansen-Juselius (1990) and maximum likelihood-based Johansen (1991) techniques were most widely used. But these methods have some limitations i.e. all variables must be stationary at first difference and inconsistent results in case of small sample size. To deal with these nuisances; Autoregressive distributed lag (ARDL) approach to co integration was progressed (Pesaran, 1999). ARDL approach has several pros over other co integration tests; it is suitable whether the variables are I(0), I(1) or combination of two, give proficient results for small sample size and provide improved, rational and stout evaluations for long run coefficients even in the existence of endogenous variables (Pesaran, 1998). Considering these advantages, this study used ARDL model and following is the formulation of equation.

$$\Delta ln(GDP)_t = \propto_{10} + \sum_{i=1}^{q1} \psi_{11} \Delta\ln(GDP)_{t-i} + \sum_{i=0}^{q2} \psi_{12} \Delta\ln(AN)_{t-i} + \sum_{i=0}^{q3} \psi_{13} \Delta\ln(RE)_{t-i} + \sum_{i=0}^{q4} \psi_{14} \Delta\ln(DNG)_{t-i}$$
$$+ \sum_{i=0}^{q5} \psi_{15} \Delta\ln(KO)_{t-i} + \sum_{i=0}^{q6} \psi_{16} \Delta\ln(LPG)_{t-i} + \pi_{11}\ln(GDP)_{t-i} + \pi_{12}\ln(AN)_{t-i} + \pi_{13}\ln(RE)_{t-i}$$
$$+\pi_{14}\ln(DNG)_{t-i} + \pi_{15}\ln(KO)_{t-i} + \pi_{16}\ln(LPG)_{t-i} + U_{t1} \quad (4)$$

$$\Delta ln(AN)_t = \propto_{20} + \sum_{i=1}^{q1} \psi_{21} \Delta ln(AN)_{t-i} + \sum_{i=0}^{q2} \psi_{22} \Delta ln(GDP)_{t-i} + \sum_{i=0}^{q3} \psi_{23} \Delta ln(RE)_{t-i} + \sum_{i=0}^{q4} \psi_{24} \Delta ln(DNG)_{t-i}$$
$$+ \sum_{i=0}^{q5} \psi_{25} \Delta ln(KO)_{t-i} + \sum_{i=0}^{q6} \psi_{26} \Delta ln(LPG)_{t-i} + \pi_{21} ln(GDP)_{t-i} + \pi_{22} ln(AN)_{t-i} + \pi_{23} ln(RE)_{t-i}$$
$$+\pi_{24} ln(DNG)_{t-i} + \pi_{25} ln(KO)_{t-i} + \pi_{26} ln(LPG)_{t-i} + U_{t2} \quad (5)$$

$$\Delta ln(RE)_t = \propto_{30} + \sum_{i=1}^{q1} \psi_{31} \Delta ln(RE)_{t-i} + \sum_{i=0}^{q2} \psi_{32} \Delta ln(GDP)_{t-i} + \sum_{i=0}^{q3} \psi_{33} \Delta ln(AN)_{t-i} + \sum_{i=0}^{q4} \psi_{34} \Delta ln(DNG)_{t-i}$$
$$+ \sum_{i=0}^{q5} \psi_{35} \Delta\ln(KO)_{t-i} + \sum_{i=0}^{q6} \psi_{36} \Delta\ln(LPG)_{t-i} + \pi_{31}\ln(GDP)_{t-i} + \pi_{32}\ln(AN)_{t-i} + \pi_{33}\ln(RE)_{t-i}$$
$$+\pi_{34} ln(DNG)_{t-i} + \pi_{35} ln(KO)_{t-i} + \pi_{36} ln(LPG)_{t-i} + U_{t3} \quad (6)$$

$$\Delta ln(DNG)_t = \propto_{40} + \sum_{i=1}^{q1} \psi_{41} \Delta ln(DNG)_{t-i} + \sum_{i=0}^{q2} \psi_{42} \Delta ln(GDP)_{t-i} + \sum_{i=0}^{q3} \psi_{43} \Delta ln(AN)_{t-i} + \sum_{i=0}^{q4} \psi_{44} \Delta ln(RE)_{t-i}$$

$$+ \sum_{i=0}^{q5} \psi_{45} \Delta ln(KO)_{t-i} + \sum_{i=0}^{q6} \psi_{46} \Delta ln(LPG)_{t-i} + \pi_{41} ln(GDP)_{t-i} + \pi_{42} ln(AN)_{t-i} + \pi_{43} ln(RE)_{t-i}$$

$$+\pi_{44} ln(DNG)_{t-i} + \pi_{45} ln(KO)_{t-i} + \pi_{46} ln(LPG)_{t-i} + U_{t4} \quad (7)$$

$$\Delta ln(KO)_t = \propto_{50} + \sum_{i=1}^{q1} \psi_{51} \Delta ln(KO)_{t-i} + \sum_{i=0}^{q2} \psi_{52} \Delta ln(GDP)_{t-i} + \sum_{i=0}^{q3} \psi_{53} \Delta ln(AN)_{t-i} + \sum_{i=0}^{q4} \psi_{54} \Delta ln(RE)_{t-i}$$

$$+ \sum_{i=0}^{q5} \psi_{55} \Delta ln(DNG)_{t-i} + \sum_{i=0}^{q6} \psi_{56} \Delta ln(LPG)_{t-i} + \pi_{51} ln(GDP)_{t-i} + \pi_{52} ln(AN)_{t-i} + \pi_{53} ln(RE)_{t-i}$$

$$+\pi_{54} ln(DNG)_{t-i} + \pi_{55} ln(KO)_{t-i} + \pi_{56} ln(LPG)_{t-i} + U_{t5} \quad (8)$$

$$\Delta ln(LPG)_t = \propto_{60} + \sum_{i=1}^{q1} \psi_{61} \Delta ln(LPG)_{t-i} + \sum_{i=0}^{q2} \psi_{62} \Delta ln(GDP)_{t-i} + \sum_{i=0}^{q3} \psi_{63} \Delta ln(AN)_{t-i} + \sum_{i=0}^{q4} \psi_{64} \Delta ln(RE)_{t-i}$$

$$+ \sum_{i=0}^{q5} \psi_{65} \Delta ln(DNG)_{t-i} + \sum_{i=0}^{q6} \psi_{66} \Delta ln(KO)_{t-i} + \pi_{61} ln(GDP)_{t-i} + \pi_{62} ln(AN)_{t-i} + \pi_{63} ln(RE)_{t-i}$$

$$+\pi_{64} ln(DNG)_{t-i} + \pi_{65} ln(KO)_{t-i} + \pi_{66} ln(LPG)_{t-i} + U_{t6} \quad (9)$$

Where difference operator signifies by Δ sign, $\propto_{10} \ldots \propto_{60}$ represents constant terms, $\psi_{11} \ldots \psi_{66}$ denote short-run coefficients, while long-run coefficients are symbolized by $\pi_{11} \ldots \pi_{66}$ and $U_{t1} \ldots U_{t6}$ are the error terms. The selection of optimal lag length of variables assimilated in ARDL model was characterized through Schwarz Bayesian Criterion (SBC).

3.2.3 F-Statistics for Testing the Existence of Long-Run Relationship

Long run relationship between variables was observed through bound test using F-statistics with 2 borders (lower and upper). The null hypothesis in this test is no long-run relation among variables. If F-statistics value is lesser than lower boundary, the null hypothesis is accepted, otherwise it is rejected and test will be inconclusive if it falls between these bounds.

3.2.4 Error correction model

Error Correction Model (ECM) specified the short-run behavior of dependent variable and speed of adjustment at steady rate in stochastic equation. ECM assists to observe that; at what level of volatility in long-run connection will be alleviated in current time and in a given structure is there any intrinsic mechanism to retrieve the steadiness after a surprise (Pesaran, 1996). ECM is applicable when all variables integrated at same level and variables used here are stationary at first difference form I (1); hence we advanced to establish the relationship between them.

The ECM equation specified in a multivariate context is given as under:

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$$\Delta ln(GDP)_t = \beta_0 + \sum_{i=0}^{q1} \beta_{1i} \Delta \ln(GDP)_{t-1} + \sum_{i=0}^{q2} \beta_{2i} \Delta \ln(AN)_{t-i} + \sum_{i=0}^{q3} \beta_{3i} \Delta ln(RE)_{t-i} + \sum_{i=0}^{q4} \beta_{4i} \Delta \ln(DNG)_{t-i} + \sum_{i=0}^{q5} \beta_{5i} \Delta \ln(KO)_{t-i} + \sum_{i=0}^{q6} \beta_{6i} \Delta \ln(LPG)_{t-i} + \lambda EC_{t-i} + \varepsilon_t \quad (10)$$

Where $q_1 - q_6$ represents optimal lag length, λ is speed of adjustment parameter and EC symbolizes error correction term.

3.2.5 Diagnostic tests

Some diagnostic tests were also performed to validate the strength of cointegration estimation. Ramsey's RESET, Lagrange multiplier (LM) and normality test were executed for model specification, serial correlation and heteroscedasticity correspondingly.

4. Results

The empirical results start with the attributes and descriptions of economic growth, renewable, and non-renewable energy consumptions illustrated through descriptive statistics analysis. **Table 2** shows the results of summary statistics which express that the differences in the values of minimum and maximum were substantially large enough for each data series and mean values were also adequately flexible. Possibly, methods of standard valuation will provide legitimate outcomes as values of standard deviation are within moderate span. **Table 3** presents the analysis of stationary property of the data and ensures integration level of variables. For this purpose, several unit root tests comprising ADF and PP were used to check the test statistic results at level and at first difference. According to the results, all incorporated variables were stationary at first difference form in both tests at one percent significance level. ARDL approach and ECM can be appropriate to apply in this condition.

Table 2. Descriptive statistics

Variables	Mean	Std. Dev.	Min	Max
$lnGDP_t$	25.187	0.532	24.412	26.137
$lnAN_t$	1.325	0.117	1.039	1.496
$lnRE_t$	3.910	0.081	3.783	4.062
$lnDNG_t$	6.767	0.356	6.178	7.284
$lnKO_t$	7.955	0.5988	7.063	9.158
$lnLPG_t$	7.804	0.688	6.688	8.844

ln denotes log natural form.

Table 3. Unit Root Test Results

Variables	ADF (At Level)	ADF (1st Difference)	PP (At Level)	PP (1st Difference)
$lnGDP_t$	0.492	-4.882*	0.539	-4.887*
$lnAN_t$	-1.835	-5.377*	-1.881	-5.404*
$lnRE_t$	-1.932	-4.703*	-2.003	-4.703*
$lnDNG_t$	-1.207	-4.490*	-1.198	-4.490*
$lnKO_t$	-0.129	-7.374*	-0.100	-7.995*
$lnLPG_t$	-1.092	-4.775*	-1.627	-11.308*

* show the significance level at 1percent.

Estimated F-statistic value of long-run relation is sympathetic in ideal lag length selection of model (Bahmani-Oskooee et al. 2000). Values of lower and upper bound with order of lag one are 2.62 and 3.79 respectively. Hence calculated value of F-statistic[1] (4.40) support the rejection of null hypothesis therefore long run relationship exists. Critical bound values (at 95 percent significance level) for F-statistics were attained from Table CI (*iii)* Case III: unhampered intercept and no tendency specified in (Pesaran et al. 2001).

[1] Table of F-Statistics for Testing the Existence of Long-Run Relationship was not pasted here to save place but will be provided on request.

Table 4. Estimated Long-Run Coefficients using ARDL (1, 1, 0, 1, 1, 0) selected based on Schwarz Bayesian Criterion

Variables	Coefficient	Standard Error	T-Ratio
$lnAN_t$	0.710	0.164	4.324[0.000]*
$lnRE_t$	2.295	0.736	3.120[0.008]*
$lnDNG_t$	2.020	0.152	13.283[0.000]*
$lnKO_t$	0.026	0.096	0.276[0.787]
$lnLPG_t$	-0.030	0.032	-0.933[0.368]

* show the significance level at 1 percent.

Table 5. Error Correction Representation for the Selected ARDL (1, 1, 0, 1, 1) selected based on Schwarz Bayesian Criterion

Variables	Coefficient	Standard Error	T-Ratio
$lnAN_t$	0.004	0.128	0.028[0.979]
$lnRE_t$	1.658	0.725	2.286[0.039]**
$lnDNG_t$	0.795	0.180	4.406[0.000]*
$lnKO_t$	-0.071	0.047	-1.506[0.156]
$lnLPG_t$	-0.022	0.024	-0.894[0.388]
ecm(-1)	-0.722	0.155	-4.666[0.000]*

* and ** show the significance level at 1and 5 percent respectively.

Outcomes of the long-run coefficients from ARDL estimation are postulated in **Table 4.** The estimation shows that *lnAN, lnRE* and *lnDNG* have highly significant long-run relationship (at 1% significance level) with GDP. One percent increase in AN, RE and DNG will produce 0.71, 2.29 and 2.02 percent rise in economic development of Pakistan in the long-run, respectively. The results found no significant long-run cointegration relationship between *lnKO, lnLPG* and GDP.

The results of error correction representation are demonstrated in **Table 5**. Results confirm the presence of long run relationship among variables because the term of error correction is highly significant at one percent significance level with anticipated negative sign. Coefficient value of ecm_t (-0.722) signifies the speed of adjustment which suggests that conjunction speed from previous year's disequilibrium in economic growth to current year's stability is 72.20 percent. Moreover, results show that *ln(RE)* and *ln(DNG)* significantly affect the economic growth of Pakistan in short run.

Table 6. Diagnostic test results

Test	Statistic	Test	Statistic
R square	0.9972	Adjusted R Square	0.9953
Serial correlation	0.925[0.43]	Heterosecedasticity	1.146[0.40]
Ramsey RESET	3.698[0.08]		

Finally, **Table 6** displays the results of diagnostic test established from ARDL evaluations. Values of R square and adjusted R square indicates best fit of the model. In addition, LM test point out no serial correlation, Ramsey's RESET specifies that model is efficiently instructed and there is no heteroscedasticity found under normality test. In addition, cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ) tests were also employed to inspect the steadiness of selected ARDL model (Brown et al. 1975). Figure (2 and 3) shows that the expected coefficients stay within the critical restraints (solid dotted lines in figures) at 5 percent significance level; hence it is concluded that the model is structurally stable. The straight line is critically bounds at 5% level of significance.

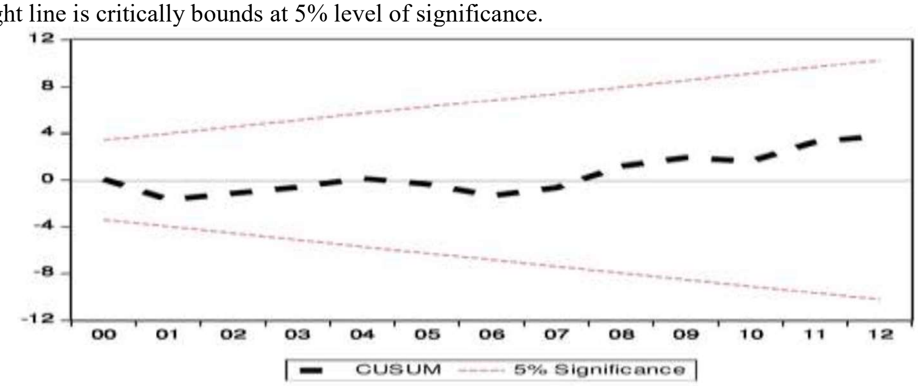

Figure 2. Cumulative Sum of Recursive Residuals

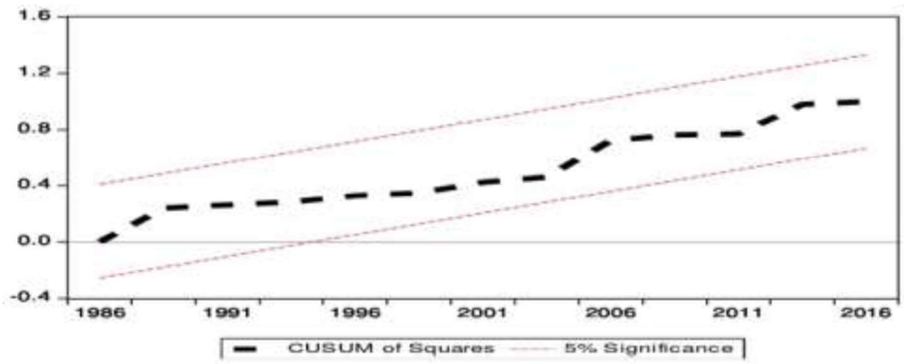

Figure 3. Cumulative Sum of Squares of Recursive Residuals

5. Discussion

Findings of short-run and long-run valuations of renewable, nonrenewable consumptions and economic growth suggest that the policy should be adopted to promote renewable energy usage as it will increase the economic growth of Pakistan and alleviate the unfavorable effects of nonrenewable energy usage. Presently, 11 percent of total energy use is provided by the renewable sources and energy imports have risen from 18.30 to 24.12 % during the period of 1986-2014; most of them are non-renewable energy (World Bank, 2016). Therefore, dependence on imported energy sources should be reduced and more attention be paid on the utilization of domestic renewables as a replacement for non-renewable resources. Furthermore, it also indicates that to establish non-renewable energy as safe and established mean of liveliness is too difficult because it cause damage to the environment as well.

6. Conclusion

Pakistan is an emerging country in the utilization of renewable energy sources. More than 75 percent of their energy needs are fulfilled through non-renewable resources. In that context, this study tries to assess the liaison among consumption patterns of both energy sources and check which have more effect on economic growth of Pakistan. The analysis of study is based on ARDL to co integration approach and error correction model (due to several advantages discussed above). Results of ARDL indicate that renewable sources along with dry natural gases will significantly affect the economic growth of Pakistan in the long run. Moreover, error correction representation also confirms the long-run relationship among variables and only renewable energy consumption and dry natural gases have significant effect on economic development. Kerosene oil and liquefied petroleum gases have insignificant effect on GDP for both periods.

Findings of the study imply that there is no harmful impact of using energy restorative polices on economic growth. At present, Pakistan is energy deficient especially in the electricity sector but they should not panic to develop more non-renewable sources to make sure the supply of desired energy demands. To cope up with these deficiencies, Pakistan should raise their pace shifting towards green energy consumptions and formulations of some new power projects based on renewables [Neelum–Jhelum Hydropower Plant and Quaid-e-Azam Solar Park] will definitely help to enhance the development of this sector which can assist to achieve the sustainable economic growth. Gracious environment should be provided to the investors (local and abroad) to capitalize renewable energy sector in the country.

In addition, it is crucial to square the rising demand of energy without adversely affect the atmosphere, because at present smog[1] cause extravagantly nuisance in routine life matters and creates health concerns. Hence, it is essential to increase the usage of renewables and lessen the role of non-renewables (Kerosene oil and liquefied petroleum gases in our case) to minimal level and also exploit the substantial potential of renewable sources available in Pakistan.

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[1] Smog is a mixture of solid and liquid fog and smoke particles formed when humidity is high in the air.

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