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Energy Consumption and Economic Growth: Time Series Evidence from Pakistan

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Abstract
This study is an attempt to signify the role of energy consumption in the economic growth of Pakistan. For this purpose 33 years data for the period 1981 to 2013 has taken to determine the long run relation between energy consumption and economic growth level in Pakistan. By applying ARDL approach it has confirmed that energy consumption plays vital role in the enhancement of economic growth level as all independent variable has positive and significant impact over dependent variable that confirms that energy is a key factor to increase the economic growth level in Pakistan.
Keywords: Energy consumption, Economic Growth, ARDL

1. Introduction

In 1973 after the Arab oil crisis and rapid increase in oil prices, the oil importing countries faced the severe supply shock which in most of the cases led towards the lower economic growth and the corresponding increase in inflation rates. This energy situation became a serious issue and the relationship between economic growth and energy consumption came under a sudden focus [(*Adnan & Riaz,2008)*].

Production efficiency is closely related to the direct or indirect use of energy as energy is a vital input for the production process. It is considered as one of the basic input for economic growth. For the growth and development of an economy the energy consumption is a key indicator [(Khan & Qayoom, 2005)].

It is necessary for developing economies to keep balance between their growing needs and the supply of energy along with large and high population growth rate, it is necessary for them. If the right and accurate measures are not taken, it will become difficult for developing economies to stand developed world.

Pakistan like other developing countries is also an energy concentrating economy and requires more energy to meet the needs of the economy because non oil producing countries are fulfilling their needs of energy by importing oil [(Shahbaz and Feridun,2011)].

In 1995-96 imported oil was contributing 92% of the net consumption of the economy and contributing 44% of the total energy consumption. Thus to fulfill the growing energy needs of the country, the country is facing the restrictions from the both demand management policies and also from the supply side.

1.2 Energy sector situation In Pakistan

The energy sector is continued to be the dominant constraint in economic growth. In 1980, the two third part of the energy needs was fulfilled by the domestic sources. In 1990s the country was still involved in different activities to fill the huge gap between the limited energy supply and increasing demand. In early 2000, the energy sector specially the electricity sector had received the great attention due to the growth rate in its demand. For a great number of industries gas and electricity shortage is considered to be the root cause of limited production activities. The energy intensive industries (steel, iron, petroleum, electrical and engineering industries) faced the fall of 0.20 percent in real GDP growth. The economy is facing almost Rs.380 billion that is 2 percent of the GDP as a cost of power crisis while in the last four years 2008, the subsidy to the power sector is almost the 2.5 percent of the GDP (Rs.11billion). Thus this crisis in power sector caused the underutilization of the power sources having the installed capacity of 4000 MW. Investment sector has also affected by this crisis in the power sector [*(Safdar et.al, 2007)*].

1.3 Significance of the study

Energy plays a vital role in the growth of an economy. In case of Pakistan due to energy crisis there is huge short fall in industrial sector as well as agriculture sector also affected. As Pakistan is an agriculture economy and agriculture sector has a vital role in real economic growth, due to better performance of energy sector not only income level of the major portion of the population of Pakistan increases this will also increases the exports of country by producing more and it is essential to know that how much energy role is important in the economic growth of Pakistan *(Chaudhary et al. 2012).*

1.4 Objective of the study

1. Main objective of the study is to analyze the causlity between energy consumption on economic growth of Pakistan over the period of 1983 to 2013.

2. To estimate short run and long run impacts of energy consumption on Pakistan' economy.
3. To provide a road map and set parameters to overcome energy crisis in Pakistan.

2. Literature Review

The main purpose of this chapter is to build theoretical relationship between dependent and independent variables. Several studies had been conducted that describe the significant causality between energy consumption on economic growth, with the help of studies conducted before and included in this chapter it can be easily examined the significance of energy consumption to enhance the economic growth in the world.

Organization of this chapter is as follows first section indicates the impact of energy consumption in developed countries, second section indicates the similar impact in developing countries and studies conducted in Pakistan to examine this relationship are in section number three.

2.1 Developed country studies

Hong, To et al. (2011) examined the energy consumption effects on economic growth of Australia by taking four decades of data from 1970 to 2011. Granger causality test and bound testing co-integration method to investigate possible statistical associations between the variables. Results suggest that energy consumption and economic growth of Australia are positively related to each other but being positive relation there is no statistically significant between dependent and independent variables either in the short run or in long run. Further more study finds weak association between the two variables by the multivariate Granger causality test results.

Belke *et a1*. (2010) Studied to examine the long run association between energy consumption and real GDP of Germany by including energy prices from 1981 to 2007. Study finds that energy consumption is the major instrument for real economic growth at both international and national level. Furthermore a bidirectional affiliation between energy consumption and economic growth found by Granger Causality test and energy utilization is price inelastic according to result estimated.

Arouri *et al*. (2014) study contribute to literature by examining the affiliation among energy utilization and economic growth using output per capita as proxy of economic growth in France. Time series data has been used for the period of 1960 to 2011 to examining the relation through causality test. Results suggest that there exist positive relation between energy consumption and economic growth in case of France. Further more study explained that energy consumption in some last decades in France enhanced the output level as well as per capita income.

Ghazi and Sakka (2004) Used aggregate production sector technology where labor, capital and energy are used as individual inputs of production. This study investigates the causality between energy use and output growth in Canada through a vector error-correction model. After that by Johansen cointegration technique empirical findings point out that the long run engagement of energy use, capital, labor and output in Canada. Granger-causality results show the short run dynamics of the variables is running in both directions between and energy use output growth. Policy implication of this study examine is that the energy is a restrictive reason to output growth of Canada.

2.2 Developing Country studies

Masuduzzaman (2013) investigate the association between investment, economic growth and electricity consumption for Bangladesh by using co-integration and causality analysis for the year 1981 to 2011. The Johansen co-integration tests specify that all three variables are cointegrated. Granger test results illustrate the from electricity consumption to economic growth unidirectional causality running and error correction terms also found for electricity consumption and economic growth. Results suggest that over time high electricity utilization and investment in Bangladesh give mount to more economic growth.

Adhikari and Chen (2012) take the 80 developing countries data for the period of 1990 to 2009 to examine the long run relationship between energy consumption and economic growth. To check the relationship between dependent and independent variables panel unit root test, panel co-integration and panel dynamic OLS technique are applied. Three income group lower, middle and higher income group are made for all 80 countries. The empirically results shows long run cointegration between energy consumption and economic growth for the whole 80 countries and as well as for each income group of countries. Study finds the huge relation. The findings clearly suggest that energy consumption has a statistically significant and positive impact on economic growth in the long run for these all 80 developing countries.

Qing and Yujie (2012) introduced the energy as a new factor of production into Cobb Douglas production function as a factor of economic growth. Study used two stages of different levels for economic development for the years 1985 to 2000 and 2001 to 2009. Time series data for each year has been taken to check the causality between variables through Granger Causality test. Results indicates that energy consumption plays different role at different stages for the economy of China however this is important factor which put positive to economic growth but energy consumption is not a key variable that uplift the economic growth.

Chiang and Chang (2005) estimate the both linear effect and non-linear effect of energy consumption on economic growth by using the data of Taiwan for the period of 1955 to 2003. Study finds evidence ofa level-dependent effect between the two variables. Results provide evidence that the connection between economic growth and energy consumption in Taiwan is inverse and U-shape. However the empirical result suggests that such a relationship exists only where there is a low level of energy utilization in Taiwan. Study also finds that threshold regression model provides better empirical results than standard linear model for the policy maker.

Adjaye (2000) has taken four south Asian developing countries such as Indonesia, Philppines, India and Thailand to estimate the casual relationship between energy consumption and economic growth using cointegration and error correction modeling techniques. The estimates indicate that unidirectional Granger causality runs from energy consumption to income for India and Indonesia in short um and bidirectional Granger causality runs from energy consumption to income for Philippines and Thailand.

Mallick (2006) examines whether economic growth is enhanced if energy fuels in the context of India. By using Granger causality test this study indicates that more oil, more electricity and more coal consumption is needed to increase the economic growth in the country. But estimated results with the help of VAR model indicate the bi-directional influence among economic growth and electricity consumption and unidirectional influence from gross domestic product growth to consumption of natural gas. As the study has different result on by using two econometric models have policy implication to natural gas and reducing oil consumption for higher level of economic growth in India.

2.3 Studies in Case of Pakistan

Azeem and Ramzan (2013) analyzed the impact of energy consumption on economic growth of Pakistan with the help of secondary data. This study finds that short fall of energy resources supply has significant effect on the economic growth of Pakistan. The findings discovered that Pakistan has small manufacturing sector then its neighbor economies like Malaysia, Indonesia, India, China, Bangladesh and Philippines and due to increase of energy prices manufacturing sector of Pakistan worst affected. Large economies like China and India takes benefit with this situation and smaller countries like Pakistan will experience badly. Pakistan should focal point on the employment of hydroelectric resources such as building of dams like Bhasha Dam, Kala Bagh Dam to produce economical electricity. Thar coal project should also address with the help of China to meet energy crises.

Chaudhary, Safdar and Farooq (2012) examined the relationship between economic growth and energy consumption in case of Pakistan by taking annual data for the period of 1972 to 2012, Study argued that demand for energy is growing quickly in the world and most of the economies are facing energy shortfall and as a result it is harshly affecting the economic growth of the countries. In case of Pakistan investment in the energy sector is insufficient and majority of commercial energy infrastructure is still underdeveloped and there are lots of flaws in the demand and supply side especially relating to payments of energy sector. The result indicates that the utilization of electricity is significantly enhancing economic growth among other sources of energy and because of high volume of imports oil consumption is also adversely affecting economic growth. This study has policy point there should be shift from expensive resources of energy like oil to cheap resources of energy like coal and Gas and government should make short run as well as long term plans to produce low price energy domestically.

Shahbaz and Feridun (2011) investigate the long run relationship between economic growth and electricity consumption by using Autoregressive distributed Lag (ARDL) bond test approach. Firstly integration order of the variables have identified by unit root test and after that Casual relationship have identified between these two variables through Wald-test for the economy of Pakistan over the period of 1971 to 2008. A long run equilibrium point has indicated by the result between economic growth and electricity used and vice versa.

Ahamd (2010) empirically proved that energy consumption plays key role to enhance the level of economic growth of any country with the help of existing literature it is statistically proved that in case of Pakistan level of growth is higher when there was efficient use of energy consumption and vise versa.

Kakar and Khilji (2010) explore the relationship between total energy consumption and economic growth for the period 1980 to 2009 in Pakistan by using Cointegration and Error Correction Model. Result indicates a unidirectional causality between economic growth and energy consumption according to Granger causality test. Furthermore result confirms that any shock in energy consumption affect the economic growth of Pakistan in long run because it is essential for economic growth in case of Pakistan.

Summary

Conclusion of the all literature examined is this, there exist a positive causility between energy consumption and economic growth and energy consumption boosts the economic growth in almost all countries whether it is developing or developed. More energy consumption leads to more productivity level and increases the level of economic growth in term of Gross domestic products. This study also analyze there is positive relation of energy consumption with economic growth of Pakistan.

Tabulated Form of Literature review
(With Name, Dependent, Independent Variables and Results)

Name and Year	Dependent Variable	Independent Variables	Model	Findings/Results
Hong To, Wijiweera and Charles (2011)	Economic growth	Oil, Electricity, Coal and Gas consumption	Granger causality test and bound testing cointegration	Energy consumption and economic growth are positively but statistically insignificant
Arouri et al, (2014)	output per capita	Oil, Electricity, Coal and Gas consumption	causality test	Energy consumption in France enhanced the output level as well as per capita income.
Ghali and Sakka (2004)	Output growth	labor, capital, energy used	causality test	Results show the short run dynamics of the variables is running in both directions between and energy use output growth
Belke et a1. (2010)	GDP growth	Energy used	Cointegration	There is a long run positive relation between the variables.
Adhikari and Chen (2012)	Per capita income	Electricity used, Oil consumption, Coal consumption	Panel cointegration and panel dynamic OLS techniques are applied	Shows long run cointegration between energy consumption and economic growth for the whole 80 countries as well as for each income group of countries.
Adjaye (2000)	Per capita income	Energy consumption	Cointegration, Granger causality, Error correction, modeling techniques	Granger causality runs from energy consumption to income for India and Indonesia in short run and bidirectional Granger causality runs from energy consumption to income for Philippines and Thailand.
Masuduzzaman (2013)	Output Growth	Electricity consumed	Cointegration, Granger Causality test	There is unidirectional causality running from electricity to output growth and a long run affiliation between dependent and independent variable.
Qing and Yujie (2012)	GDP	Energy consumed	Granger causality	Result indicates that energy is important factor for economic growth but it is not only essential factor.
Chiang and Chang (2005)	Economic Growth	Energy consumed	Cointegration	There is a inverse U-shaped relationship between economic growth and energy used.
Mallick (2006)	GDP	oil, electricity and coal consumption	Granger causality test, VAR	Bi-directional influence among economic growth and electricity consumption and unidirectional influence from gross domestic product growth to consumption of natural gas.
Azeem and Ramzan (2013)	GDP growth rate	Electricity, Coal, Gas and Oil consumption	Cointegration	Increase of energy prices manufacturing sector of Pakistan consumption worst affected.
Chaudhary, Safdar and Farooq (2012)	GDP growth rate	oil, electricity and coal consumption	OLS cointegration	Utilization of electricity is significantly enhancing economic growth among other sources of energy and because of high volume of imports oil consumption is also adversely affecting economic growth.
Shahbaz and Feridun (2011)	GDP growth rate	Electricity used	ARDL	A long run equilibrium point has indicated by the result between economic growth and electricity used and Vice versa.
Kakar and Khilji (2010)	Economic growth	Energy consumed	Granger causality, Cointegration	Result indicates the bidirectional causilty between variables and long run relation exist between variables further more results suggest that energy consumption is essential for economic growth in case of Pakistan.

3. Data and Variable Description

3.1 Data Description

This study is an attempt to examine the impact of energy consumption on the economic growth of Pakistan. Time series data for the period of 1981 to 2013 has been analyzed for this purpose. Data for this purpose has been collected from various sources. Data for gross domestic products (GDP) is collected from the economic survey of Pakistan and data of energy consumption has collected from United States Energy information administration.

Table Description of Variables

Serial No	Variables	Source
1	GDP Growth rate	Economic Survey of Pakistan.
2	Oil Consumption	United States Energy Information Administration.
3	Gas Consumption	United States Energy Information Administration.
4	Electricity Consumption	United States Energy Information Administration.
5	Coal Consumption	United States Energy Information Administration.
6	Per capita Energy Consumption	World Development Index

3.2 Description of Variables

3.2.1 Real Economic Growth

Real economic growth refers to the value of finally produced goods and services within the boundary of a country by using one year time period and it includes total investment, total consumption, net exports (exports - imports). In 2013 the GDP growth rate of Pakistan Bureau of Statistics.

3.2.2 Oil Consumption

Crude oil is refined from of oil use to produce other petroleum products such as diesel, heating oil, jet fuels, asphalt, lubricants, butane and propane. Current consumption of crude oil in Pakistan is 385 thousand barrels per day. Crude oil is considered to be a key variable to generate economic activities.

3.2.3 Gas Consumption

Data for dry natural gas or consumer-grade natural gas consumption has been taken for estimation. Current consumption of natural Gas of Pakistan is 1542 billion cubic feet in 2013. Natural gas is used in different sectors of the economy where as the major use of Gas is in industrial sector in Pakistan.

3.2.4 Coal Consumption

Coal is another major source of energy in Pakistan and all over the world. Current coal consumption in Pakistan is 69000 thousand short tons in year 2013. Pakistan has over 175 billion tons coal reserve according to The United State Geological Survey. Coal can be converted into Gas or in liquid petrol or can be use directly for coal fired power generation plants in industrial sector for production process.

3.2.5 Electricity Consumption

Data for hydroelectric power consumption is used for the estimation. Hydroelectric is from of electricity generated by the use of flowing water and in Pakistan its consumption for year 2013 is 31.55 Billion KWH. Electricity is considered to be a major factor of economic activities and have prominent role in economic growth of Pakistan.

3.3 Construction of Variables

3.3.1Total Energy Consumption

Total energy consumption refers to sum of all type of energy such as oil consumption, coal consumption, Gas consumption and Electricity consumption.

$$TEC = TOC+TCC+TGC+TEC$$

Where
TEC = Total Energy consumption
TOC = Total Oil Consumption
TCC = Total Coal Consumption
TGC = Total Gas Consumption
TEC = Total Electricity Consumption

3.3.2 Total Per Capita energy Consumption

Total per capita energy consumption refers to sum of total amount of energy consumed by all individuals of the country.

$$TPEC = TEC/ Total\ Population$$

4. Methodology Framework

This chapter is an attempt to examine the causality between energy consumption and economic growth of

Pakistan. Stationery data series for dependent and independent variables are taken for the analysis because non-stationery date leads towards misleading results. Augmented dickey Fuller test has been used to check the stationarity of the data, further more Autoregressive Distributed Lagged (ARDL) is applied for long run relation between energy consumption and economic growth and Error correction model (ECM) has applied for short run analysis.

4.1 Testable Hypothesis

Hypothesis No.1

$\mathbf{H}_0$: There is no causality between energy consumption and economic growth in long run.

$\mathbf{H}_1$: There is a causality relation between energy consumption and economic growth in long run.

Hypothesis No.2

$\mathbf{H}_0$: There is a no short run relation between energy consumption and economic growth.

$\mathbf{H}_1$: There is a short run relation between energy consumption and economic growth.

4.2 Variables Specification

$$Y_{RGDP} = \alpha+\beta_1 TEC+\beta_2 TPEC+\mu$$

Where

Y_{RGDP} = Real Gross domestic products growth rate

TEC = Total Energy Consumption Growth Rate

TPEC = Total Per capita Energy Consumption Growth Rate

μ = Error term

Data of all variables has taken in annual growth rate.

4.3 Time Series

Time series refers to an ordered sequence of numerical data. Simply one can say that a time series is a series of numeric data which is collected at different time periods and time period can be weekly, monthly, semi annually or annually. Time series is helpful to analyze the behavior of economic variable or any variable over time which is taken like monthly or yearly. Non-stationarity of data is problem of time series. A time series considered to be stationary when mean and variance of data series is constant over time.

4.4 Non-Stationary and Stationary

4.4.1 Non-Stationary

Major problem of time series data is non-stationary. Non-stationary means Mean and Variance of the data series is not constant over time. Non-stationary data gives misleading forecasting and results. If Xt and Yt are taken as variable and both series are not stationary at level it means Xt and Yt are non-stationary. Random walk with drift and Random walk without drift are the example of non-stationary data.

$$Y_t = \alpha+Y_{t-1}+\epsilon_t \ldots\ldots\ldots\ldots \text{ Random Walk with Drift}$$
$$Y_t = \alpha+Y_{t-1}+\beta_t+\epsilon_t \ldots\ldots. \text{ Random Walk without Drift}$$

4.4.2 Stationary

Non-stationary data converted into Stationary in order to take accurate results from time series. Mean and Variance of time series becomes constant over time after making time series stationary. Two data series Xt and Yt are stationary if they are stationary at level.

$$Xt\ldots\ldots\ldots\ldots I(0)$$
$$Y_t\ldots\ldots\ldots\ldots I(0)$$

After taking differences of Random walk with drift and Random walk witout drift can be converted into stationary process. Equatins for Stationary Random walk with and without drift are given below.

$$Y_t-y_{t-1} = \alpha+ \epsilon_t \ldots\ldots\ldots\ldots \text{ Random Walk with Drift}$$
$$Y_t-Y_{t-1} = \alpha+\beta_t+\epsilon_t \ldots\ldots. \text{ Random Walk without Drift}$$

4.5 Unit Root Test

As this study is dealing with time series data analysis and problem of non-stationarity is common in time series data so data should be stationary for the analysis. Data becomes stationary when Mean and Variance of the time series data becomes constant over time. As it is important to make data stationary before regression to avoid spurious results Unit Root Test is applied for this purpose.

If the regression equation is given as

$$Y_t = \alpha Y_{t-1}+\mu_t \ldots\ldots\ldots (1)$$

OLS and cointegration cannot be applied because it is non-stationary. So to make stationary the above equation Yt-1 is subtracted from both sides.

$$Y_t- Y_{t-1} = \alpha Y_{t-1}- Y_{t-1}+\mu_t \ldots\ldots\ldots (2)$$

And equation (2) becomes

$$\Delta Y_t = Y_{t-1}(\alpha-1)+\mu_t \ldots\ldots. (3)$$

There are three forms to regress Unit root test

- Without constant and Trend
  $\Delta Y_t = \delta Y_{t-1}+\mu_t$
- Without constant but with Trend
  $\Delta Y_t = \alpha+ \delta Y_{t-1} + \mu_t$
- With constant and Trend
  $\Delta Y_t = \alpha+\delta T+\delta Y_{t-1}+ \mu_t$

Hypothesis

If

$\mathbf{H}_0$: **δ**=0 then Series is non-stationary and there exist unit root.

$\mathbf{H}_1$: **δ**< 0 then series is stationary

For stationary series the value of δ should be less than zero and null hypothesis is rejected.

4.6 Auto Regressive Distributed Lag (ARDL) Model

Study applied ARDL model to determine the long run relationship between energy consumption and economic growth in case of Pakistan. This model can be used for both cases whether the data is stationary or not.

Equation for long run relation between energy consumption and economic growth has given follow.

$$\Delta\ell_n(GDP) = \alpha_\circ + \alpha \sum_{i=1}^{n} \theta_t \Delta\ell_n(TEC)_{t-i} + \alpha_2 \sum_{i=1}^{n} \theta_t \Delta\ell_n(TPEC)_{t-i} + \lambda_1 \ell_n(TEC)_{t-i} + \lambda_2 \ell_n(TPEC)_{t-i}$$

$$\Delta\ell_n(GDP) = \beta_\circ + \sum_{i=1}^{n} \beta_t \Delta\ell_n(TEC)_{t-i} + \alpha_2 \sum_{i=1}^{n} \beta_2 \Delta\ell_n(TPEC)_{t-i}$$

4.7 Error Correction Model

Error correction model is used when variables are in disequilibrium this model. If two variables X and Y are taken and cointegrated with each other their short run association can be explain through Error correction Model.

Equation for short run relationship between dependent and independent variables can be written as

$$\boldsymbol{\Delta GDP = \alpha_0 + \alpha_1 \Delta TEC + \alpha_2 \Delta TPEC + \beta \mu_{t-1} + e_t}$$

Where

α = Short Run coefficient

β = Adjustment coefficient

GDP = Gross Domestic Products

TEC = Total Energy Consumption

TPEC = Total per Capita Energy Consumption

5. Empirical Results and Discussion

5.1 Unit Root Results

Variables	Result		Probability	Integration Order
RGDP	**ADF Critical values**	**-8.347813**	0.0000	**I(1)**
	1% level	-2.647120		
	5% level	-1.952910		
	10% level	-1.610011		
TEC	**ADF Critical values**	**-7.256268**	0.0000	**I(1)**
	1% level	-2.647120		
	5% level	-1.952910		
	10% level	-1.610011		
PCEC	**ADF Critical values**	**-2.825001**	0.0086	**I(1)**
	1% level	-2.647120		
	5% level	-1.952910		
	10% level	-1.610011		

Source: Author's Own Calculations

Hypothesis

$\mathbf{H}_o$ = Data Series is Non-Stationary

$\mathbf{H}_1$ = Data Series is Stationary

It is confirmed by applying unit root test that all three variables are stationary at first difference. Critical values

for all variables are greater than ADF calculated values at 1%, 5% and 10% level of significance that leads to reject the null hypothesis that data series are non-stationary. As all the Variables are Stationary at first difference and at same integration level it strongly suggest applying Cointegration test to confirm the long run relationship between energy consumption and economic growth.

5.2 Granger Causality Test

Firstly, to estimate the causal relationship the causality test has employed which was proposed by Granger (1969) and in Econometrics literature the Granger's test is considered an appropriate methodology for detecting the existence of a causal association between two different variables. Hence, now apply the Granger Causality test to check the causal association between real gross domestic product growth and energy consumption.
The equations are given as follow.

$$RGDP_t = \alpha + \beta TEC_{t-i} + \gamma RGDP_{t-j} + \mu \quad \text{..... (Eq-5.1)}$$

$$TEC_t = \alpha + \delta RGDP_{t-i} + \theta TEC_{t-j} + \varepsilon \quad \text{..... (Eq-5.2)}$$

TEC = Total energy consumption
RGDP = Real Growth in gross domestic product
α, β, γ, θ, and δ parameters in equation 1, and 2
μ = Error term in the equation 1
ε = error term in the equation 2
And t is time period, i and j shows the lag length

Table 5.2

Pairwise Granger Causality Tests		
Null Hypothesis	**F-statistics**	**Prob.**
TEC does not Granger Cause GRGDP	4.09903	0.0294
GRGDP does not Granger Cause TEC	0.32326	0.7269

Source: Author's Calculation based on SBP data set

Table 5.2 indicates the result of pairwise Granger causilty test between energy consumption and economic growth of Pakistan. According to results gross domestic products growth rate rate does not granger cause the total energy consumption as the probability value for this is 0.7 that's why null hypothesis will accepted but probability value for null hypothesis that total energy consumption does not granger cause gross domestic products growth rate has rejected because probability value is 0.02. it confirms that there is a uni-directional causual relationship between total energy consumption and real gross domestic products growth rate and this relation runs from total energy consumption to gross domestic products growth rate in case of Pakistan economy.

5.3 Wald Test for the Existence of Long Run Relationship

Wald Test:			
Equation: Untitled			
Test Statistic	**Value**	**df**	**Probability**
F-statistic	**3.514901**	(4, 21)	0.0240
Chi-square	14.05960	4	0.0071

Note: The critical values are taken from Pesaran et al (2001

Results of Wald test indicates clear existence of long run relationship between energy consumption and economic growth in Pakistan. On the basis of F-statistics Null hypothesis is rejected that there is no long run relationship between energy consumption and economic growth of Pakistan.

5.4 Auto Regressive Distributed Lag (ARDL) Model

Following table showing the results of ARDL model.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.138348	0.931727	0.148486	0.8834
PCEC(-1)	0.176213	0.089879	1.960558	0.0426
TEC(-1)	0.25456	0.046848	5.433743	0.0055
R-squared	**0.808966**	Mean dependent var	-0.135714	
Adjusted R-squared	0.778671	S.D. dependent var	2.426431	
S.E. of regression	2.060795	Akaike info criterion	4.496378	
Sum squared resid	89.18437	Schwarz criterion	4.829429	
Log likelihood	-55.9493	Hannan-Quinn criter.	4.598195	
F-statistic	7.738481	Durbin-Watson stat	2.294927	
Prob(F-statistic)	0.009902			

Significance of the both independent variables can be observed from t-statistics value or from probability value of independent variables. Probability value less than 0.05 indicating the significance of the variables so bothe independent variables have significant impact over dependent variable in the long run.

$$GDP = c + \beta_1 PCEC + \beta_2 TEC$$

$$GDP = 0.13 + 0.17PCEC + 0.25TEC$$

First of all intercept showing all other variable which are not included in the model it is statically insignificant means other variables have no impact on GDP growth rate in long run.

First independent variable is Per capita energy consumption (PCEC). Result indicates PCEC is significantly and positively related to GDP growth rate in the long run. 1% increase in Per capita energy consumption increases the GDP growth rate by 0.17% in long run and vise versa by keeping other variables constant. If value of Per capita energy consumption increases it means more energy resources in form of Oil, Gas, and Electricity are available to people to fulfill their demands and to contribute in economic growth of the country.

Similarly next independent variable which is Total energy consumption is also significant and has positive impact over the Gross domestic products growth rate in case of Pakistan. If Total energy consumption increases by 1% it will leads to increase GDP growth rate by 0.25% and vise versa in long run by keeping others factors constant. . It is observed that energy consumption is used as major input factor in production process of many industries in Pakistan. Pakistan is non-oil producing country it import oil at high prices that retort the economic growth of country, if alternative energy sources like Coal, Gas or electricity used in production process of industrial sector than producer face less input cost and have huge production potential that will helpful to generate more output, more export, more foreign exchange and in long run leads to increase the economic growth in Pakistan. Study of Azeem and Ramzan (2013) gives the same results

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5.5 Error Correction Model (ECM)

Error Correction Model has applied is to determine the short run relationship between energy consumption and economic growth in Pakistan.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.145412	0.393497	-0.369539	0.7153
D(PCEC(-1))	0.10018	0.031244	3.206375624	0.0185
D(TEC(-1))	0.26541	0.048251	5.500611386	0.0098
ECT(-1)	**-0.37188**	0.11559	-3.217233325	0.0047
R-squared	0.712802	**Mean dependent var**		-0.13571
Adjusted R-squared	0.679348	**S.D. dependent var**		2.426431
S.E. of regression	2.059827	**Akaike info criterion**		4.47053
Sum squared resid	93.34351	**Schwarz criterion**		4.756003
Log likelihood	-56.58742	**Hannan-Quinn criter.**		4.557802
F-statistic	8.093214	**Durbin-Watson stat**		2.50707
Prob(F-statistic)	0.009045			

Coefficient value of ECT(-1) which is -0.37188 showing the average annual convergence in short run to achieve equilibrium in long run.

Short run model illustrates both independent variables are highly significant and have positive impact

on economic growth of Pakistan. 1% increase in Per Capita energy consumption increases the GDP growth rate by 0.10% in short run, similarly 1% increase in Total energy consumption will leads to increase GDP growth rate by 0.26% in short run by keeping all other variables constant.

On the basis of above results it can be observed that there exist positive causality between energy consumption and economic growth and energy consumption positively contributes to economic growth of Pakistan in short run as well as in long run both cases.

6. Conclusion and Suggestions

6.1 Conclusion

This study is based to estimate the relationship between energy consumption and economic growth of Pakistan containing time series data ranging from 1981 to 2013. On the basis of results study is able to reject the null hypothesis of the study that there is no long run relation between energy consumption and economic growth in case of Pakistan and conclude that there exist a significant and positive relation between energy consumption and economic growth of Pakistan as results indicated by ARDL approach. Increasing energy consumption through proper policies enhances the economic growth of country in long run and vise versa. Furthermore short run impact of energy consumption over economic growth is illustrated by Error correction model that is also showing significant impact and also model convergence towards equilibrium.

6.2 Suggestions

Following are some suggestions for policy purpose based on the relation of energy consumption and economic growth.

1. Government should ensure such policies that diversify the energy imports specially oil and to increase the domestic energy supply resources like Coal, Gas and Electricity, it will save huge amount of foreign reserve in Pakistan.
2. Government should continue to invest in energy sector in Pakistan where there is a potential like in Sindh and Blochistan there is huge potential to produce Solar and wind energy that will helpful to solve supply side problems.
3. On consumer side government should also launch some awareness programs for the efficient use of energy that will leads to reduce down the energy short fall in Pakistan.
4. Government should adopt the loss (by any means i.e. line loss, wastage, theft etc) minimization polices.
5. The low cost electricity generation projects should be started (like coal and water)
6. Government should adopt those polices which emphasis on increasing the role of private sector in the electricity generation.
7. Government should emphasis on the renewable sources of electricity generation instead of non-renewable like oil and gas.

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