

ENERGY CONSUMPTION AND ECONOMIC GROWTH: Evidence from Pakistan**Najid Ahmad** (Corresponding Author)*Bahauddin Zakariya University, Multan, Sub-Campus Dera Ghazi Khan, Pakistan*
najid_2iqbal@yahoo.com**Muhammad Farhat Hayat***Bahauddin Zakariya University, Multan, Sub-Campus Dera Ghazi Khan, Pakistan***Naqvi Hamad***Govt. Post Graduate College, D.G.Khan, Pakistan***Muhammad Iqbal***Bahauddin Zakariya University, Multan, Sub-Campus Layyah, Pakistan***ABSTRACT**

This paper investigates the relationship between energy consumption and economic growth of Pakistan. A time series data has been used for the period of 1973-2006. GDP is taken as dependent variable and energy consumption as independent variable. Augmented Dicky Fuller test has been used to check the stationarity of the variables and both variables found stationary at level. The results of Granger causality test show uni-directional causality running from GDP to energy consumption. The results of ordinary least squares test show positive relation between GDP and energy consumption in Pakistan. One percent increase in energy consumption will raise GDP by 1.23%. Diagnostic tests confirm that residuals are normally distributed, coefficients are stable and there is no ARCH effect. Pakistan economy is energy dependent. Shortage of energy means lower the economic growth of Pakistan. We should utilize our own sources to meet the needs of energy like by constructing biogas plants in villages and solar energy is also alternative source. This can reduce the dependency on foreign sources.

Keywords: *Energy Consumption, GDP, OLS, Pakistan***INTRODUCTION**

This paper investigates the relationship between energy consumption and economic growth in Pakistan. Energy plays crucial role in the development of a country. It has always been critical for the development and growth of the country. Adequate energy supply is necessary to meet the needs of the country. Energy is also necessary for poverty reduction. If there is more energy it means there is an adequate access of water and electricity that is necessary for growth. There are four groups of economists who talk about the relation between energy consumption and economic growth. The first group says economic growth affect energy consumption. Second group views energy is essential for economic growth. Third group says there is bi-directional causality between them and fourth group says there is no relation between energy consumption and economic growth.

Mustafa Balat (2007) shed light on the importance of energy consumption. He views that in developing countries energy consumption has been increased. Turkish government is encouraging national and international investors to invest in energy projects. He says energy sector needs more investment for the progress of the country. He thinks wind and solar energy as an alternative sources. Olusegun (2009) thinks energy as a bone for economic growth. He finds positive relationship between energy consumption and economic growth in Nigeria. Greater energy consumption means more economic activity of the nation and as a result higher economic growth. He suggests this sector should be given attention for the development of the country. Galip Altiny (2005) analysis the relation between electricity consumption and real GDP of Turkey for the period of 1950-2000. The author finds uni-directional causality running from electricity consumption to income. He says that electric supply is necessary for economic growth.

Yemane Rufael (2010) tries to find the causal relation between real GDP and nuclear energy consumption for the period of 1971-2005. The author says it is necessary to make energy sector efficient for economic growth. Nicholas Apergis (2009) shed light on the importance of nuclear energy consumption. He investigates the relationship between nuclear energy consumption and economic growth in sixteen countries and finds bi-directional causality between nuclear energy consumption and economic growth in the short run while uni-directional causality from nuclear energy consumption to economic growth in the long run. Chiang Lee (2005) says production and consumption activities need energy as a input. He finds the relationship between energy

consumption and GDP in Taiwan. He views energy acts as a engine for economic growth in long run and energy preservation may be harmful for economic growth.

Phung (2011) examines the relationship between energy consumption and economic growth in Vietnam. He uses per capita energy consumption and per capita GDP for his analysis. He says high level of economic growth leads higher level of energy consumption and not vice versa. Nazar (2012) analysis the relationship between energy consumption and economic growth. He finds bi-directional causality between energy consumption and economic growth. Anjum Aqeel (2001) investigates the causal relation between energy consumption and economic growth. He says economic growth causes energy consumption. Monia (2011) shed light on the importance of energy saving. He finds the relationship between energy consumption and economic growth in Tunisia for the period of 1971 to 2009. He finds causality running from economic growth to energy consumption. He further adds energy saving will not effect economic growth of the country if causality runs from GDP to energy consumption.

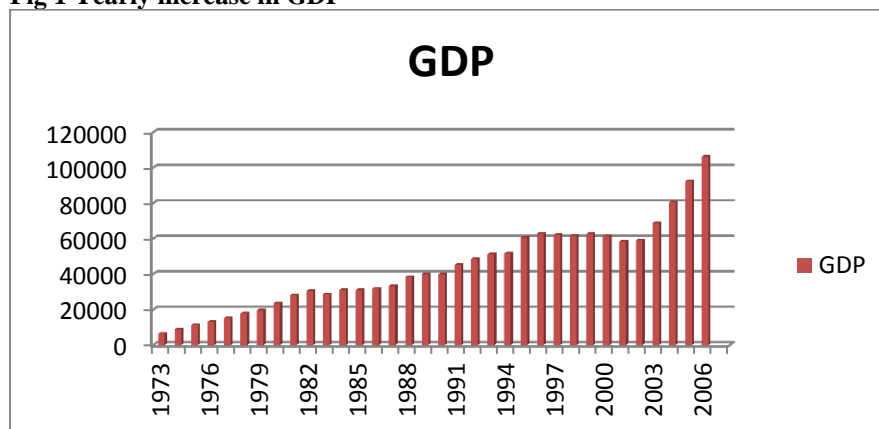
John Asafu (2000) estimates the causal relation between energy consumption and income. The author takes four countries (India, Indonesia, Philippines and Thailand) in his analysis. He uses cointegration and error correction model. He says there exists uni-directional causality running from energy consumption to income in India and Indonesia while bi-directional causality running from energy to income in Thailand and Philippines in short run. Rexford Abaidoo finds uni-directional causality running from economic growth to energy consumption in Ghana. Majid (2011) investigates the causal relation between renewable energy consumption and economic growth for 7 Asian developing countries. He uses time series data for the period of 1985 to 2007. His findings show uni-directional causality running from economic growth to renewable energy consumption in these four countries (India, Iran, Pakistan, Syrian Arab Republic).

Kamal Raj (2008) finds the relationship between energy consumption and economic growth in Nepal. He finds uni-directional causality running from GDP to electric consumption. He says energy consumption stimulates economic growth. He says increase in income will raise energy consumption as people spend more proportion of their income on goods and services that consumes energy like cars, tractors, water pumps at farms etc. Higher growth needs energy infrastructure and this growth will increase energy consumption at commercial level. The writer suggests small and microprojects as an alternative source like biogas at rural areas. Jungho Baek (2011) examines the relationship between trade, income growth and energy consumption. He views energy consumption is positively related with economic growth. Muhammad Adnan (2002) finds bi-directional causality between economic growth and energy consumption in the short run and uni-directional causality from economic growth to energy consumption in the long run. He says Pakistan should continue investing in energy sector specially in natural gas, wind, hydroelectricity and nuclear power as this investing will reduce import burden.

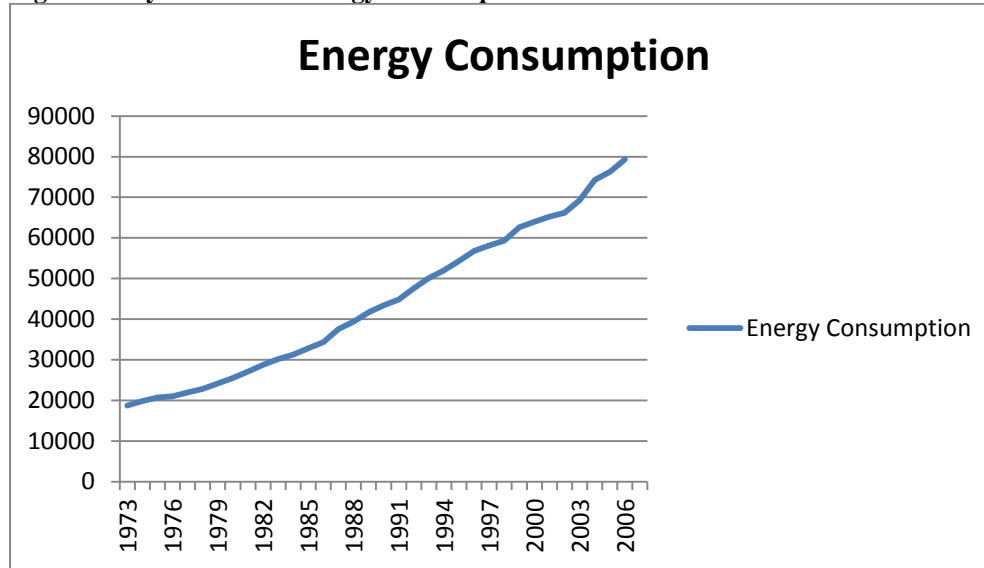
Economic Growth and Energy Consumption in Pakistan

The trend of energy consumption and economic growth in Pakistan have been poor. Mostly Pakistan faces energy shortage and It imports large share of energy from other countries. Recent condition is worse. In 1973, GDP of Pakistan was 6332.886 (mls \$) and energy consumption was 18720 (kt of oil equivalent). While there have been drastic changing in 2006. When GDP of Pakistan was 106300 (mls \$) and energy usage was 79294 (kt of oil equivalent). This trend of energy usage and economic growth in Pakistan can be seen graphically.

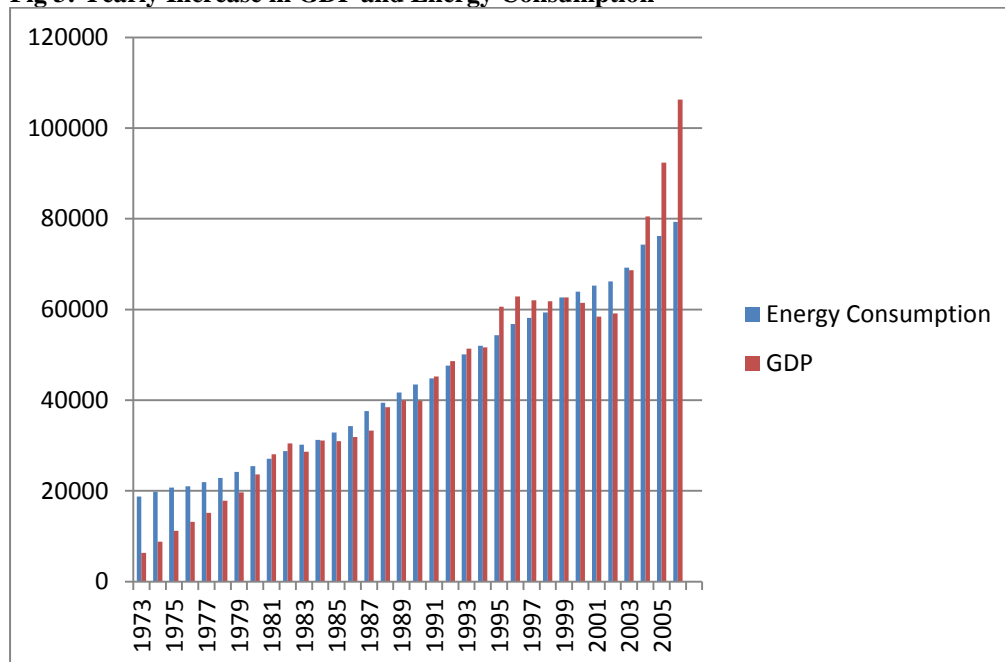
Fig 1 Yearly increase in GDP



Source: author

Fig 2: Yearly increase in Energy Consumption

Source: author

Fig 3: Yearly Increase in GDP and Energy Consumption

Source: author

Study Objectives

The basic objective of this paper is to find the relationship between energy consumption and economic growth of Pakistan.

Hypothesis

H₀: There exists no relation between energy consumption and economic growth of Pakistan.

H₁: There exists positive relation between energy consumption and economic growth of Pakistan.

Data Collection and Methodology

In order to study the impact of energy usage on Gross Domestic Product of Pakistan, a time series data has been used for the period of 1973 to 2006. Data source is World Development Indicator (WDI) and International Financial Statistic.

The Cobb-Douglas Production Function with constant returns to scale can be as:

$$GDP = \alpha EC^{\beta_1} \mu \text{-----}(1)$$

Here GDP is the Gross Domestic Product of Pakistan (mls \$), α is the total factor productivity, EC is the energy usage (kiloton of oil equivalent), β_1 is the coefficient of energy consumption and μ is the white noise error term. The multiplicative form of equation can be written in a linear form by taking log from both sides of the equation.

$$LOGGDP = LOG\alpha + \beta_1 LOGEC + LOG\mu \text{-----}(2)$$

$LOGGDP$ is the log of Gross Domestic Product, $LOG\alpha$ is the intercept that is equal to β_0 , β_1 is the coefficient of $LOGEC$ while $LOGEC$ is the log of energy consumption and $LOG\mu$ is the log of white noise error term. Expectation: $B_0 > 0$, $B_1 > 0$.

The Granger causality test can be specified as:

$$LOGGDP_t = \sum \phi_i LOGEC_{t-i} + \sum \theta_j LOGGDP_{t-j} + \mu_t \text{-----}(3)$$

$$LOGEC_t = \sum a_i LOGEC_{t-i} + \sum d_j LOGGDP_{t-j} + \mu_{t2} \text{-----}(4)$$

Initially, Augmented Dickey-Fuller test has been used to check the unit root of the variables so that it can be seen what technique is appropriate for the model. Usually, time series data show trend with the time. This trend can be removed by differencing. The results of ADF test are in table 1:

Table 1: Results of Augmented Dickey-Fuller Test at Level				
variables	ADF (t critical) Value at 1% significance level	ADF (t critical) Value at 5% significance level	T-Value	Probability
D(LOGGDP)	3.6576	2.9591	3.276574	0.0028
D(LOGEC)	3.6576	2.9591	3.366109	0.0022
Source: Author				

Both variables get stationary at level with 5% level of significance so ordinary least squares method will be appropriate technique for our model. But before applying OLS we are applying Granger Causality test to check the direction of the variables. The results of Granger Causality test are below.

Table 2: Results of Granger Causality Test			
lags 2			
Sample : 1973-2006			
Null Hypothesis	Obs	F-Statistic	Prob.
LOGEC does not Granger Cause LOGGDP	32	2.29493	0.12009
LOGGDP does not Granger Cause LOGEC	32	3.43734	0.04678
Source: Author			

The results show that Energy Consumption does not Granger Cause GDP of Pakistan. Null hypothesis is accepted at 12% (as prob is 0.12009). Here F-Statistic is 2.29493. The level of significance is taken 5-10%. The results also show that GDP does Granger Cause Energy Consumption. Here p-value is less than 5% level of significance (prob 0.04678) and in this way null hypothesis is rejected. The F-Statistic is 3.43734. So there exists uni-directional causality running from economic growth to energy consumption in Pakistan.

Table 3: Results of Ordinary Least Squares Method.

Dependent Variable: D(LOGGDP) Method: Least Squares Sample (Adjusted): 1974-2006 Included Observations: 33				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.013733	0.018672	0.735482	0.4676
D(LOGEC)	1.230979	0.918407	1.340341	0.1899
R-squared	0.054778	Mean.dependent.var	0.037119	
Adjusted R-squared	0.024287	S.D. dependent var	0.038671	
S.E. of regression	0.038199	Akaike info criterion	-3.633333	
Sum squared resid	0.045234	Schwarz criterion	-3.542635	
Log likelihood	61.94999	F-statistic	1.796515	
Durbin-Watson stat	0.901252	Prob(F-statistic)	0.189876	
Source: Author				

Here Durbin-Watson Stat is 0.901252 that is greater than R-Squared (0.054778). It shows model is non spurious. A spurious model is not acceptable. The t-statistic for the constant C is 0.735482 that is less than 2 means constant is insignificant. The t-statistic for the variable D(LOGEC) is 1.340341 that is less than 2. The coefficient of energy consumption is 1.230979 that means 1 percent increase in energy consumption will raise GDP by 1.23 percent.

Diagnostic tests are applied to check whether the series are free from heteroskedasticity and normality problems while stability test is used to check whether coefficients are stable or not. The results are given as:

Table 4: Diagnostic tests

Normality Test	
Jarque-Bera	1.453671(0.483436)
Heteroskedasticity test: ARCH	
F-Statistic	3.209078(0.055614)
Obs* R-Squared	5.780753(0.055555)
Ramsey RESET Test (Stability test)	
F-Statistic	1.246312(0.273120)
Source: Author	
Values in parentheses are p-values	

The normality test shows that residuals are normally distributed. There is no ARCH effect that is always desirable that a model should be free from ARCH effect. Ramsey RESET test is used to check the stability of the coefficients. P-value confirms that coefficients are stable. So there is no ARCH effect, residuals are normally distributed and coefficients are stable. These all are good sign for a good model.

CONCLUSION

The objective of this paper was to find the relationship between energy consumption and economic growth of Pakistan using time series data for the period of 1973-2006. Pakistan is facing the problem of energy shortage. Gap between energy usage and production is increasing constantly over the time. It is expected from this gap to retard economic growth. The results of Granger Causality test showed uni-directional causality running from GDP to energy consumption. Energy conservation policy is necessary to adopt if this causality is running from GDP to energy consumption. But policy should be designed in a way that energy conservation measures do not adversely affect on economic growth. On the other hand the results of ordinary least squares method show positive relation between GDP and energy consumption. One percent increase in energy consumption will raise GDP by 1.23 percent. It shows how Pakistan's economy is energy dependent. Shortage of energy affect negatively on economic growth that results fall in income and employment. Pakistan is facing worse energy crises these days. We cannot make progress until we fill this energy gap. As 70% population is living in rural areas. They can meet their energy requirements at home like by constructing biogas plants. Solar energy is also alternative source. These will reduce the dependency on foreign energy sources.

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