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Impact of Energy Consumption on Economic Growth of Pakistan

Authors
Dr. Sabahat Subhan[1], Dr Amtul Hafeez[2], Humaira Waheed[3]
[1,2]Assistant Professor Department of Economics NUML
[3]Student, Department of Economics NUML
Ph: 03335453272
Corresponding Author
Dr. Sabahat Subhan
Email: sabahatsubhan@yahoo.com

ABSTRACT
This research paper examines the impact of energy consumption on economic growth in case of Pakistan in long run and short run by using the time series data from the period 1980-2013. To check this relationship Auto-regressive Distributed Lag Model (ARDL) for long run and Error Correction Model (ECM) for short run are used. The empirical results show that energy consumption has significant positive impact on economic growth in both long run and short run. Labor has also positive impact on economic growth and exports and capital stock have also positive impact on economic growth.
Keywords: *Energy consumption, economic growth*

INTRODUCTION

In the modern world, energy is considered as most important instrument for the economic development of a country. It is lifeline of all modern economies. In today's world all productive and supportive activities are heavily dependent on the supply of energy. Whether it is education or services, transportation and communication, industry or agriculture, health care or water supply, all these activities can only be done with the availability of adequate and reliable energy in one form or the other. Thus the economic growth of any economy is dependent on the reliable, affordable and uninterrupted supply of energy. While the growth in population and use of modern techniques in all sectors of economy like household, health, industry, education etc. increase the demand for energy. Studies done by International Energy Agency and other organization have shown that there is strong correlation between economic growth and access to the energy.

Energy is talk of town in Pakistan. From the last 10 to 12 years, Pakistan has been facing severe energy crisis both of electric power and natural gas, due to increase in demand. Natural gas and electric power are two major sources of energy for domestic, industrial and transport sector. The demand for natural gas has been increased in all the sectors of economy, while supply of natural gas is not increased. Because new reserves are not discovering, which create the difference between demand and supply so we are facing shortage of natural gas. The shortage of electric power is not due to the generation of electricity, which at the movement exceeds the peak demand by 5000MW. Shortage of electricity involve number of other factors like excessive line losses because of inefficient transmission and distribution system, low recovery of revenues from public as well as private consumers by distribution companies, high level of theft and, delayed and inadequate payments of subsidy by the government, result in a chain of defaulting companies making difficult for the Independent Power Producers (IPP,s) and

power generating companies (GENCO,s)to utilize their existing generating capacity due to financial crunch. This also causes to rise the huge circular debt. At the sectoral level, the evidence shows that energy use affects the growth of manufacturing sector of Pakistan; however, the substitution possibilities are limited among energy and non-energy inputs and between electricity and gas for the period 1972–93. While energy demand, particularly for households, responds positively and significantly to economic growth. The demand is responsive to changes in energy prices also. Own price effect is negative and the cross price elasticity estimates indicate substitution between electricity and products and between natural gas and petroleum products, especially for domestic users. But there is limited substitutability between different sources of energy. Thus, the rise in prices of energy has important implications for energy use in Pakistan.

The energy crisis badly effect the life's of people in Pakistan. Our daily life has become miserable. Thousands have lost their businesses and jobs. With the direct effect on industry and business, energy crisis also adversely affect the GDP of Pakistan, the cost of production increases, prices increases so inflation in the economy increased. To achieve the economic growth in Pakistan it is essential to solve the problem of energy. Major steps regarding the energy policy should be taken by the government. Major energy sources are electricity, natural gas and petroleum products. The detail description regarding the demand and supply of these sources is discussed below.

In Pakistan demand for electricity increased more rapidly than its supply, therefore load sheading is a common phenomenon. In cities people are facing 8-10 hours load sheading while in villages and towns it is about 12-18 hours a day. During 2012-2013 electricity consumption is about 76,789 GWH while its installed capacity is 22,812 MW while its generation is 96,497 GWH. The gap between generation and supply of electricity is due to the line losses, mismanagement of electric department and use of old machinery. These all reasons causes less supply of electricity and makes gap between demand and supply more widen. Shortage between demand and supply of electricity badly effect the commercial and household sector of Pakistan. Circular debt is also the major reason of less supply because of this independent power producers decrease their supply when their debts are not paid by the government.

Pakistan is gifted naturally with the gas resource that is being extracted from Sui (Baluchistan). Before 2006-07 there were equilibrium between demand and supply of natural gas. But after that time period Pakistan has been facing gas crisis. Supply for natural gas in Pakistan is 1,267,980 mcft during 2012-13 while its demand is 1,505,841 mcft in the same period. Reason of this gap is that by the time population is increased, demand in industrial sector for natural gas also increased while no steps are taken by government in order to increase its supply. So that gap between demand and supply of natural gas increased by the time from last decade.

Petroleum products and oil are our important input used for energy in many sectors of the economy. Pakistan import these products from oil producing countries, and some of needs are fulfilled from domestic resources. Total petroleum and oil consumption in Pakistan is about 19,393,129 tonnes while supply is about 105,281 (000 tonnes), from which petroleum product import is about 10,489 (000tonnes) and local production is 9,914 (000 tonnes) during 2012-13. These figures show that there is gap between demand and supply of petroleum products. Demand increases more rapidly than its supply. So that gap between demand and supply become more widen. Reason of this gap is that as GDP increase in the economy with time, production in the economy also increased, therefore demand for petroleum products increases but no special measures are made by the government in order to increase the supply, and gap is widen with the time.

Causal relationship between non-renewable, renewable energy consumption and economic growth is important. In order to investigate this, Tugcu et al. (2012), studied relationship between economic growth, non-renewable and renewable energy consumption by employing multivariate framework and used augmented and classical production function. This analysis includes labor force, human capital, real gross capital formation and R&D variables. Estimated results show that non-renewable and renewable energy consumption, both are matter for economic growth and this relationship is effectively explained by augmented production function.

In 2013 study is conducted for renewable electric production and development level rather than growth variable. Kazar and Kazar (2013) conducted a study to analyze the relationship between renewable sources of electricity production and development level for 154 countries, instead of economic growth variable. This study results show that in short run there is a bidirectional relationship between said variables, while in long run economic development leads renewable energy production. Furthermore, this relationship will change according to human development level of different countries. Menegaki and Ozturk (2013) analyzed relationship between energy and growth under political economy prospective. Findings of this study show that there is a bidirectional relationship between capital and political stability as well as growth and political stability. So the political aspect of an economy should not be ignored.

RESEARCH METHODOLOGY

Model specification and methodological procedure for testing the causality between energy consumption and economic growth is discussed in this section.

Theoretical Model

An econometric model is needed for testing the empirical relation between energy consumption and economic growth, where economic growth is dependent variable which is explained by energy consumption that is explanatory variable. While other independent variables are labor force, capital stock, growth rate of factor productivity, exports, and j^{th}energy source (energy sources are electricity, natural gas and petroleum products). These independent variables are explained the independent variable that is economic growth.

Over the time, an increase in the market value of goods and services produced in an economy is known as economic growth. Usually, it is measured as percentage rate of real Gross Domestic Product or real GDP. Growth rate of factor productivity is a variable which accounts for effect in total output which are not affected by traditional inputs that are labor and capital. Total factor productivity can be taken as ta measure of technological advancement in the economy in long term, if all inputs are accounted for in it. It is also known as multi factor productivity. Labor force is defined as total number of people either employed or seeking for employment who are 16 year of age or above from total population. Capital generally referred to a financial resource available for use and grows over time. Capital can be a financial or cash value of an asset or it can be machinery equipment in a firm or company. Capital stock is a total physical capital separate from land that can be grown over time by human capital. It is a term used to distinguish between human and physical capital. Export is a function of international trade where goods produced in one country are transported to another country for future sale or trade. Sale of such goods increases to the producing nation's gross output. Exports are exchanged for other products or services, if they are used for trade. Exports occur on a large scale between nations when they have fewer restrictions on trade, such as tariffs or subsidies. Power resulting from the consumption of chemical or physical resources, especially to provide heat and light or to work machines. Energy sources are those sources from which energy can be obtained

in order to provide heat, power and light. These sources of energy can be obtained from human and animal power to fossil fuels, water power, wind, sun and uranium. In our study energy sources are electricity, natural gas and petroleum products. Petroleum products and natural gas are natural sources of energy while electricity can be generated through wind and water power, coal or uranium.

ECONOMETRIC MODEL SPECIFICATION

In studies model description is important, because for findings of results in study it show the overall procedure. Model specification show which econometric model will imply and how dependent, independent variables are related with each other. Production function approach is use in this study. Basic Cobb-Douglas production function is as follows:

$Q_t=A_t\ L_t^{\beta}K_t^{\alpha}$

Q_t= Output

A_t=Factor productivity

L_t= Labor Force; and

K_t= Capital stock

Primary factor of production are labor and capital, while this study check the relation between energy consumption and economic growth. So further variables like exports and energy sources are also included in this production function. Production function assumes the following form;

$Q_t= A_t\ L_t^{\beta}K_t^{\alpha}X_t^{\eta}E_{jt}^{\gamma}$

Where :

$Q_t$is total output produced at time‘t’; $A_t$is factor productivity at time‘t’; $L_t$is labor force at time‘t’; $K_t$is capital stock at time‘t’; $X_t$is exports at time‘t’; $E_{jt}$is consumption of ‘jth’ energy at time‘t’ (where energy sources are electricity, natural gas and petroleum products).

By taking natural log on production function equation, the functional form of the model is as follows:

$\ln(Q_t)=\ln(A_t)+\alpha \ln(L_t)+\beta \ln(K_t)+\eta \ln(X_t)+\Sigma \gamma j \ln(E_{jt})$

where ‘t’ varies between 1 to 33 and j include energy sources that are electricity, natural gas and petroleum products.

For simplicity model can be written as;

$Q_t *= A_t*+\alpha L_t *+\beta K_t*+\eta X_t*+\Sigma \gamma j E_{jt}*$

Where;

Q_t *= elasticity of growth or GDP, A_t*= Intercept term, L_t *= elasticity of labor, K_t*= elasticity of capital, X_t*= elasticity of exports, and E_{jt}*= elasticity of energy sources

Independent variables are related to economic growth as: Factor productivity is an independent variable, which show positive relationship with the economic growth. While labor force is another independent variable. Labor force is efficient, it have a positive relationship with the growth. Capital stock is also positively related to the dependent variable. While exports and economic energy sources also have positive impact on the economic growth of a country

Data and Data Sources

This study is based on time series data. Data will be taken for 33 years from 1980 to 2013. And major data sources are Economic Survey of Pakistan Energy Year Book and World Bank. Details are given in Appendix 1A.

Estimation Technique

Estimation of time series requires special attention. Firstly check the stationarity of each time series. If the variables are stationary at level then OLS will be used. If variables are stationary at 1st difference than Johnson Cointegration will be used. And if variables are stationary at different levels then Autoregressive Distributed Lag Model (ARDL) will be used.

The statistical properties of variance and mean are constant over time and the value of covariance between the two time periods depends not the actual time period but only on the lag between the two time periods, so the data is said to be stationary. If the calculated value of ADF test is less than the critical value than data is said to be stationary. When data is influenced by lag or previous value so the data is said to be non-

stationary. It means that mean and variance changes with the time. If calculated value of ADF is greater than the critical value then data is non-stationary.

Augmented Dickey Fuller Test

By using the Augmented Dickey Test, check that whether variables are stationary or non-stationary with the help of Unit Root Test. There are three forms of ADF test. In the first form intercept and time trend both are not present in the second form time trend is absent and intercept is present while in the third form intercept and time trend both are present.

$\Delta Y_t = \beta_1 + \beta_2 t + \delta Yt\text{-}1 + \alpha\Sigma_i + = 1\Delta Y_{t-i} + \varepsilon_t$

Stationary hypothesis are as follow:

H_0: Data is non stationary; H_1: Data is stationary

If all the variables are stationary at level then apply the ordinary least square method. If all variables are stationary at first difference then apply the co-integration test.

Auto Regressive Distributed Lag Model (ARDL)

Long run relationship among dependent and independent variables will be analyzed through Auto Regressive Distributed Lag Model bound testing approach presented by Pesaran (2001). Log is applied on the Cobb-Douglas production function in order to make use of ARDL. Test the long run relationship between concerning variable the unrestricted error correction model is used as under;

$\Delta \ln Y_t = \beta_0 + \beta_1 \ln Y_{t-1} + \beta_2 \ln L_{t-1} + \beta_3 \ln K_{t-1} + \sum_{i=1}^{n} \beta i \Delta \ln Y_{t-i} + \sum_{k=i}^{z} \beta_k \Delta \ln L_{t-k} + \sum_{m=i}^{r} \beta_m \Delta \ln K_{t-m} + \mu_t$ …….. (1)

In equation (1) Δ is used as difference operator and μt is residual term at t time period.

Bound testing is available on F-statistic value by using Wald test. Null hypothesis states that there is no long run relationship between variables. H0= $\beta_{1=}\ \beta_{2=}\ \beta_{3=}0$. While alternative hypothesis is HA≠ $\beta_1 \neq \beta_2 \neq \beta_3 = 0$. Pair of critical values are given in the bound analysis, which are lower and upper limit values. If F value is greater than both lower and upper limit and significant than there exist long run relationship between variables.

If long run relationship is confirmed then in next step is testing short run relationship. For testing short run relationship Error Correction Mechanism Model (ECM) is applied. Equation for this is as under;

$\Delta \ln Y_t = \delta_1 + \sum_{i=1}^{n} \delta_{11} \Delta \ln Y_{t-i} + \sum_{k=1}^{z} \delta_{22} \ln L_{t-k} + \sum_{m=1}^{r} \delta_{33} \Delta \ln K_{t-m} + \eta_1 ECM_{t-1} + \mu_t$ …….. (2)

In above equation Δ is used as difference operator and μt is residual term at t time period while ECM_{t-1} is error correction term. It tells the pace of convergence from short run to long run time period as well as it also validate the long run relationship among variables.

RESULTS AND INTERPRETATION

In the year 2013 the total GDP of Pakistan is about 1.03793E+11 million rupees according to World Bank Data. While potential output is computed as 35611439228 million rupees. Data of energy sources, exports, capital and labor are used in this study. This shoe that because of less supply of energy sources then what was the capacity, the GDP of Pakistan is less than its potential. As our energy sources like electricity produced less than the installed or actual capacity, new reserves of gas are not discovered, so it becomes hurdle for economic growth. It hurts almost every sector of the economy.

Stationarity

Stationarity test is very much important for estimation, because decision regarding the estimation technique whether OLS, ARDL or Johnson cointegration is applicable, cannot be made without this. Results of stationarity are shown below:

Table 1 Test of Stationarity

Variables	t-statistics		Prob.	Stationarity	D.W Value
GDP	ADF critical value	-6.092277	0.0001	I(1)	2.037068
	1% level	-4.273277			
	5% level	-3.557759			
	10% level	-3.212361			
LF	ADF critical value	-5.136956	0.0011	I(0)	1.946163
	1% level	-4.262735			
	5% level	-3.552973			
	10% level	-3.209642			
	t-statistics	Prob.			
KT	ADF critical value	-4.355444	0.0082	I(0)	1.844585
	1% level	-4.273277			
	5% level	-3.557759			
	10% level	-3.212361			
	t-statistics	Prob.			
ES	ADF critical value	-5.228064	0.0009	I(1)	1.999341
	1% level	-4.273277			
	5% level	-3.557759			
	10% level	-3.212361			
	t-statistics	Prob.			
X	ADF critical value	-5.752619	0.0002	I(1)	1.880494
	1% level	-4.273277			
	5% level	-3.557759			
	10% level	-3.212361			
	T- statistics	Probability			

Probability value of GDP is 0.0001, which is less than critical value of 5% and GDP time series is stationary at first difference, it is integrated of order one i.e. I(1). While probability value of labor force and capital stock are 0.0011 and 0.0082 and they both are stationary at level. Energy sources and exports are not stationary but they become stationary at first difference i.e. I(1), their probability values are 0.0009 and 0.0002.

From stationarity results it is obvious, this study imply ARDL approach for estimation of data.
ARDL results are shown below in table 2.

Auto-Regressive Distributed Lag Models (ARDL) Bounds Testing

Table 2

Variables	Coefficient	Std. Error	t-statistics	Prob.
C	6.11E+09	3.58E+09	1.709730	0.1021
ES(-1)	213.6128	101.3978	2.106681	0.0473
KT(-1)	0.000778	0.000419	1.858548	0.10002
LF(-1)	154.72274	674.12998	0.229515	0.8207
X(-1)	0.011075	0.003245	3.412752	0.0026
GDP(-1)	-0.308188	0.125751	-2.450780	0.0231
R-squared		0.767994		
Adjusted R-squared		0.657514		
F-statistics		6.951473		
F-Prob.		0.000099		
Durbin-Watson stat		2.656144		

The above estimated Table 2 show the significant results of ARDL bounds testing which states there is long term relationship between the variables. The coefficient value of energy sources illustrate that if there is one unit increase in the energy sources output will increase by 213.6128 units, while coefficient value of capital shows that if there is one rupee increase in labor force the output will increase by 0.000778 rupee. If labor force is increase by one unit in production process, coefficient illustrate that the output will increase by 154.72274 units. On the other hand by increasing one rupee of exports the GDP will increase by 0.011075 rupees.

The value of R-square is significant that is 0.767994, which show that 76.80% of changes in dependent variable GDP is because of all independent variables.

Durbin Watson test value is 2.656144 that is also significant and show there is no autocorrelation in the model.

F-test probability value is 0.000099 and it is significant, so null hypothesis is rejected that is there is no long run relationship between the variables. So it is obvious from here there is long run relationship among concerning variables.

Table 3 Wald Test

Test Statistic	Value	df	Probability
F-statistic	4.420321	(5, 21)	0.0066
Chi-square	22.10160	5	0.0005

The lower and upper bounds values are 2.25 and 3.35 respectively at the 5% level of significance. F-test value of Wald test is 4.420321, which is greater than upper bound value 3.35 i.e. 4.420321>3.35 which show that there is long run relationship between the variables.

Error Correction Model (ECM)

After examining long run relationship between variables, now for estimating short run relationship between variables study employ error correction model (ECM). Results of ECM are shown below in table 4.4

Table 4

Variables	Coefficient	Std. Error	t-statistics	Prob.
C	3.79E+09	1.13E+09	3.355971	0.0026
D(ES(-1))	-82.04144	100.8803	-0.813256	0.4241
D(KT(-1))	-0.005413	0.001742	-3.106619	0.0048
D(LF(-1))	40729706	35361168	1.151820	0.2607
D(X(-1))	-0.000428	0.002250	-0.190204	0.8507
D(GDP(-1))	0.790552	0.148047	5.339886	0.0000
ECM(-1)	-0.820156	0.301319	-2.721883	0.0119
R-squared		0.647076		
Adjusted R-squared		0.558846		
Durbin-Watson stat		1.777687		

Above results in the table show there is short run relationship between the variables. ECM is speed of convergence towards the long run equilibrium relationship, value of ECM is -0.820156 and its probability value is 0.0119 which is less than 5% level of significance.

ECM model results implies that there is short run relationship between the variables.

CONCLUSION

This study investigate the association between energy consumption and economic growth of Pakistan by using Cobb-Douglas production function approach. ARDL bounds testing and ECM models are used to investigate the relationship between concerning variables. This study findings show that there is relationship between energy consumption and economic growth of Pakistan for the period 1980-2013. Firstly if talk about the electricity, there is positive association between electricity and growth of Pakistan. Pakistan's potential output is greater than actual output, this low productivity show low generation of electricity in the country. There are many reasons behind this low generation of electricity like line losses, lack of management, theft, poor distribution etc. expensive cost of production of electricity is another reason, as Pakistan produce 65% of its electricity through oil and gas. These reasons cause low generation of electricity.

Secondly, petroleum products and gas shortage is also playing a role in low growth rate of Pakistan. Pakistan is also pursuing a multi prolonged strategy in order to ensure satisfactory and uninterrupted oil and gas supply and sustain the present pattern of energy for rapid growth. Enhancing nuclear power generation capacity, greater reliance on gas and aggressive pursuit of hydro power generation are some the key elements of strategy. Pakistan is actively pursuing to meet its expanding domestic energy demand through project of regional gas pipe line. These all are prerequisites for solving the problem of energy crisis.

Minimization of gap between demand and supply is very much important not only for the current generation's economic prosperity but also for future generations. Its shortage can retorted the economic growth of Pakistan. Alternative energy sources should be developed in order to improve the availability of energy. Government should play its role and provide basic infrastructure for the searching of new and cheap sources of energy in Pakistan. Proper management of resources regarding energy should also be considered.

Policy Recommendations

- In order to increase the electricity government should take initiative for low

cost generation of electricity projects (e.g. from coal and water). And in this regard government should make Dams on priority basis.

- Circular debt of WAPDA and PEPCO must be paid by the government in order to reduce the load shedding.
- Government should emphasis on renewable sources of energy rather than non-renewable energy sources like oil and gas.

Appendix A Table 1A Summary of Data

Sr. No	Variables	Symbols	Description, Unit and Sources
1	Economic growth or Gross Domestic Product	GDP	Data is used as GDP at market price for measure of output. Data is taken from Economic Survey of Pakistan. Data series constructed on constant price of 2005.
2	Labor Force	L	Labor force data is taken from economic survey of Pakistan as labor force participation rate.
3	Capital stock	K	Secondary sources do not provide data of capital stock. Series are constructed on the basis of domestic capital formation. Capital stock series is computed on the basis of following formula: $K_t = (1-\delta) K_{t-1} + I_t$ Where: K_t = capital stock in period t; δ = rate of depreciation, assumed to be constant; K_{t-1} = capital stock in year t–1; and I_t = Gross fixed capital formation in year t.
4	Exports	X	Exports data is used in percentage form and taken from world bank.
5	Energy sources	Ejt	Energy sources are electricity, natural gas and petroleum products. The electricity consumption is measured in GWH, gas consumption is measured in MMCFT and consumption of petroleum is measured in tones. This data is taken from energy year book.

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