Impact of Energy Consumption and Environment on Economic Growth in Pakistan

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Abstract
The study determines the impact of climate change and energy consumption on economic growth in Pakistan over the period from 1981 to 2014. With advanced energy appliances energy uses are increasing day by day and the use of this highly consumption rate taking implications on macroeconomic policies and structure. The study estimated ARDL approach of cointegration and UECM technique used to establish the long run and short run relationship among economic growth, CO2 emissions, energy consumption and the employment ratio. The results show that there are long run and short run relationships among the variables in the model. There is positive and significant impact of CO2 emissions, energy consumption, and employment ratio on per capita GDP in the long run. The results for direction of causality indicate that there is unidirectional relationship of carbon emissions per capita and energy consumption per capita on GDP per capita, but employment ratio causes GDP per capita in the short run. On the basis of our empirical findings, it can be concluded that energy conservation policies and controlling carbon dioxide emissions, are likely to have no adverse effect on economic growth in Pakistan in the short run..

Key Words: Energy Consumption, CO2, Employment, Economic Growth

Introduction
Energy plays the key role in the economic growth of a country. The efficiency and productive of the country can improve by the use of energy. The role of energy in economic development is well established in the energy economics literature.

Climate changes and global warming is main issue of the world for last two decades. $CO_2$is major source of green houses which contributes 58.8% of green house gases emissions (world bank 2007). Thus the impact of global warming and climate changes has been assessed by academics. The united nation also take active part and try to reduce the effects of global warming and force the world to reduce the emission of CO_2 by binding agreements such as Kyoto protocol. The Kyoto protocol is a protocol aiming to reduce global warming. The protocol was formed on 11 December, 1997 in Kyoto, Japan and come into force on 16 Febourary, 2005. Pakistan signed the Kyoto protocol in 2005.

The choice of studying Pakistan is motivated because Pakistan is 6th most populated country in the world and its exports are mostly manufactured goods which cause high CO_2 emission. Secondly in Pakistan the mostly energy producing plants are also on fuel due to which the Pakistan has produced one of the largest volume of CO_2 in the world. Many development theories also predict that in developing nations there is high pressure on environment.

Pakistan national assembly has passed the "Pakistan environment protection act" in 1997 to protect the natural resources and environment of the country. The study empirically examine the long run and short run relationship of energy consumption, CO_2emission an employment ratio and economic growth in a multivariate frame work for Pakistan during 1981 to 2013 periods. At present, Pakistan is facing a worse energy crisis in the history. It is expected that

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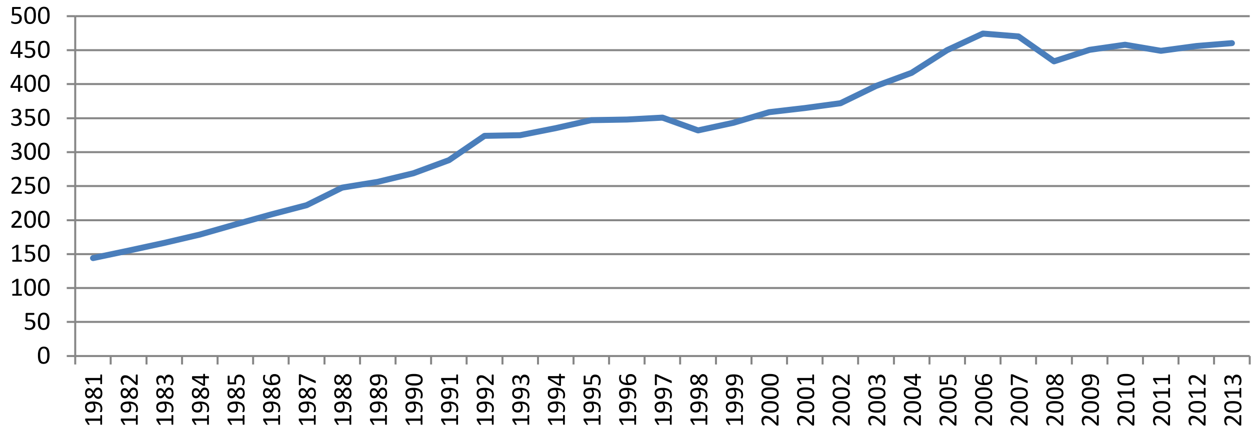
if the country is growing at the rate of 6% then the energy consumption must grows in double digit. Pakistan's energy requirements are expected to double in the next few years.

Figure No:1 Energy Consomtion Per Capita



Source: World Bank

The importance of energy lies in all aspect of development -when energy products are exported it increased the foreign earning by increasing foreign investment, transfer of technology in the process of exploration, production and marketing; the employment in energy sector is increased; the worker welfare improved by increasing the salaries and wages, it improved the infrastructure and socio-economic activities in the country. Thus in the quest for optimal development and efficient management of available energy resources, equitably allocation and efficient utilization can put the economy on the part of sustainable growth and development. Arising from this argument, adequate supply of energy thus becomes central to the radical transformation of the nation's economy.

The main purpose of the study to see effects of economic growth on CO2, energy consumption and employment ratio. If energy consumption effects positively on economic growth then these energy conversation laws will affect the economic growth adversely. The study used an auto regreesive distributed lag (ARDL) model and vector error correction model (VECM) to establish the long run and short run relationships among the variables. One of the interesting features of the study is that it differentiates short run and the long run effect because it has been observed that impact of energy consumption varies from short to long run for the same country. For this purpose, we have employed ARDL modeling to co-integration to find out long run and short run effect. Unit root problem of the data is handled by ADF test. In coming sections there is debate on literature review, Methodology and data descriptions, and results and conclusion at the end.

Literature Review

Since the initial study by Kraft and Kraft (1978) the causal relationship between energy consumption and economic growth has under taken. This energy consumption and growth relations also provide for environment policies.

Ilhan et al (2010) shows that for existence of granger causality neither CO_2 emissionn per capital nor energy consumption per capita cause real GDP per capita buth employment ratio cause GDP raito per capita in short term Turkey case. Ugur et al (2007) found that income does not granger caus carbon emission in long run however energy use have granger cause.

Pao and Tsai (2010) found that in BRIC countries there is bi-directional strong causality between energy consumption and CO_2 emission. They also found that energy consumption and output have bi-directional long run causality. However uni-directionnal causality between energy consumption and CO_2 emission with output respectively.

In a study on economic growth and energy consumption in six central American economies, Apergis & Payne (2009) found that there is short run and long run causality between energy and consumption and economic growth. Hye and Riaz (2010) found bidirectional causality between economic growth and energy consumption in the short run and unidirectional causality in the long run.

In the study of economic growth and energy consumption in 19 African countries, Nondo & Kahsai (2009) found that long run and short run causality is unidirectional between economic growth and energy consumption. Alam et al (2012) in his study on Bangladesh found unidirectional causality between economic growth and energy consumption both in short run and long run. While bidirectional causality between electricity consumption and economic growth.

Population is strongly connected with energy consumption (Barliwala & Reddy, 1993). Limited and exhausted resources of engergy cause all countries to struggle for the great economic growth. Every year, the world population increase and the energy resources are increasingly needed in numerous human's activities. However, the limited resources of energy can limit the economic activities and thus hindering the economic development. People consume energy for various activities such as transportation, agriculture, and industries. We are unable to imagine that if exhausted energy occurs in the world; it can certainly cripple all countries economy. Lower population can probably reduce the demand in energy but a reduction in energy consumption can affect the economic growth. Shaari, et.al (2013), Ighodaro (2010) Lise & Monfort, (2006) stated that if a decrease in energy consumption can affect economic growth. Therefore energy consumption is a strong determinant of economic growth. This study is to examine the relationship among population, energy consumption and economic growth.

In the case of Pakistan, Riaz (1984) investigated the relationship between EC and EG using log linear regression analysis. The regression analysis of the energy-growth relationship has shown independence between socioeconomic variables and EC. Masih and Masih (1996) found a co-integrated relationship between EC and GDP in India, Pakistan, and Indonesia, but no such evidence in the case of Malaysia, Singapore, and the Philippines. Yang (2000) investigated the causal relationship between GDP and EC—including that of coal, natural gas, and electricity—analyzing the aggregate as well several disaggregated categories and found a bidirectional causality between total EC and GDP in India; in the case of Pakistan and Indonesia, GDP was found to cause EC. Anjum and Butt (2001) found that EG caused total EC, but further investigation indicated that EG did not lead to growth in petroleum consumption, while in the case of the gas sector, neither EG nor gas consumption affected each other. In the power sector, however, electricity consumption was found to lead to EG without feedback. Finally, EC was found to directly cause employment. Alam and Butt (2002) concluded that EC, EG, capital, and labor were co-integrated and that causality ran from EC to EG in the short and long run.

Model and Econometric Methodology:

In this study the relationships among economic growth, CO2 emissions, energy consumption and the employment ratio in Pakistan is examine by applying multivariate model analysis techniques. The country has the 6th largest population with growing economy and is expected to have high levels of energy consumption and CO2 emissions. The study is based on the assumption that economic growth is driven by high energy consumption that is likely to produce CO2 driven economic growth in the country (Ozturk and Acaavci, 2010). The basic form of the relationship between the variables can be expressed as:

$$Y_t = f(COP_t, ENP_t LAP_t)$$

where, (Y) represents GDP, (COP) represents CO2 emissions, (ENP) represents energy consumption and (LAP) represents the employment ratio or the total labor force ratio to total population. The relationship can be expressed in an equation as follows:

$Y_t = \alpha + \beta COP_t + \delta ENP_{t,} + \theta LAP_T + \varepsilon_t$……………(i)

The study employed a log-linear model specification, and is thus likely to give more definitive results. The equation (i) can be modified in a logarithmic form:

$lY_t = \alpha + \beta lCOP_t + \delta lENP_{t,} + \theta lLAP_t + \varepsilon_t$………(ii)

The coefficient β, δ and θ represents their respective elasticities, and ε is the disturbance term in the model.

Where, Yt= GDP Per capita (GDPt/Nt)

COPt= Carbon Dioxide per capita (COPt/Nt)

ENPt= Energy consumption per capita (ENPt/Nt)

LAPt= Total labor force ratio to total population

Empirical Results

Table 1 presented the result of Dicky fuller (1979) and Augmented Dicky fuller (1981) test. The results reveal that some variable integrated at level and some are not.

Table 1 Unit root test of ADF

Augmented Dickey-Fuller Test Results					
Variable	**At level**		**At first difference**		
	Intercept	**Trend and intercept**	**Intercept**	**Trend and Intercept**	**Decision**
PCI	-1.264[1] (0.6334)	-2.214[1] (0.4660)	-3.580[0] (0.0120)**	-3.674[0] (0.0390)**	I(1)
EPC	-1.890[0] (0.3326)	-1.251[0] (0.8823)	-4.386[0] (0.0015)***	-4.449[0] (0.0040)***	I(1)
LFP	-2.241[0] (0.999)	-1.254[0] (0.881)	-4.290[0] (0.002)***	-5.427[0] (0.000)***	I(1)
CO2	-1.890[0] (0.2848)	-2.1047[0] (0.523)	-7.230[0] (0.000)***	-7.919[0] (0.000)***	I(1)

ARDL approach for co-integration

Table No. 2 VAR Lag Order Selection Criteria

Endogenous variables: PCI EPC LFP CO2						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	291.0105	NA	5.76e-14	-19.13404	-18.94721	-19.07427
1	430.4720	232.4358	1.55e-17	-27.36480	-26.43067*	-27.06596
2	442.4489	16.76765	2.16e-17	-27.09659	-25.41516	-26.55869
3	474.0469	35.81102*	9.06e-18*	-28.13646*	-25.70772	-27.35948*

* indicates lag order selected by the criterion

The results of VAR model suggested that lag selection criterion of AIC indicated three lags as optimal lags to incorporate in the ARDL model. In the second step in ARDL the study applied the following model for bond testing to check co-integration among the variables.

$$DPCI_t = \beta_1 + \beta_{2i}\sum_{i=1}^{3} DEPC_{t-i} + \beta_{3i}\sum_{i=0}^{3} DCO2_{t-i} + \beta_{4i}\sum_{i=0}^{3} DLFP_{t-i} + \beta_5 PCI_{t-1} + \beta_6 EPC_{t-1} + \beta_7 LFP_{t-1} + \beta_8 C02_{t-1} + \varepsilon_t \ldots\ldots(II)$$

In model 5.1 there are two kinds of coefficients in the equation which includes short run as well long run coefficients. For testing the existence of co-integration the study applied Wald test on following hypothesis.

$\boldsymbol{H_0}: \beta_7 = \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0$

(No co-integration exists between variables)

$\boldsymbol{H_1}: \beta_7 \neq \beta_8 \neq \beta_9 \neq \beta_{10} \neq \beta_{11} \neq 0$

(There is Co-integration)

The results of Wald test determined that Ho is rejected in favor of existence of co-integration among the variables. F-statistics is 4.123 and probability value is 0.0175 which is significant at 1% level of significance (Table A.1 in Annexes). The F-statistics is compared with F-critical from Pesaran et al. (2001). Bond test results are given in table.

Table 3 Bond test results

Test Statistics	**Value**	**K**
F-statistics	4.123	4
	Critical Bond values	
Significance	**I0 Bond**	**I1 Bond**
10%	1.99	2.94
50%	2.77	3.28
2.5%	2.55	3.61
1%	2.88	3.99

Table indicates that the value of F-statistics is greater than 1% level upper bond value which indicated that there is co-integration exists among the variables used in the model.

Table 4: Long run results

Dependent Variable: PCI				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	113.525	133.046	0.853	0.4003
EPC	1.652***	0.424	3.893	0.0005
CO2	898.168***	307.370	2.922	0.0065
LFP	2443.490***	696.892	3.506	0.0015
		Diagnostics		
R-squared	0.989179	F-statistic		914.1629
Adjusted R-squared	0.988097	Prob(F-statistic)		0.0000

Table 5: Short run ECM Model

Dependent Variable: DPCI				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.171	8.267	0.625	0.5399
DPCI(-1)	0.300*	0.146	2.047	0.0564
DPCI(-2)	0.142	0.134	1.065	0.3015
DPCI(-3)	0.236**	0.105	2.236	0.0390

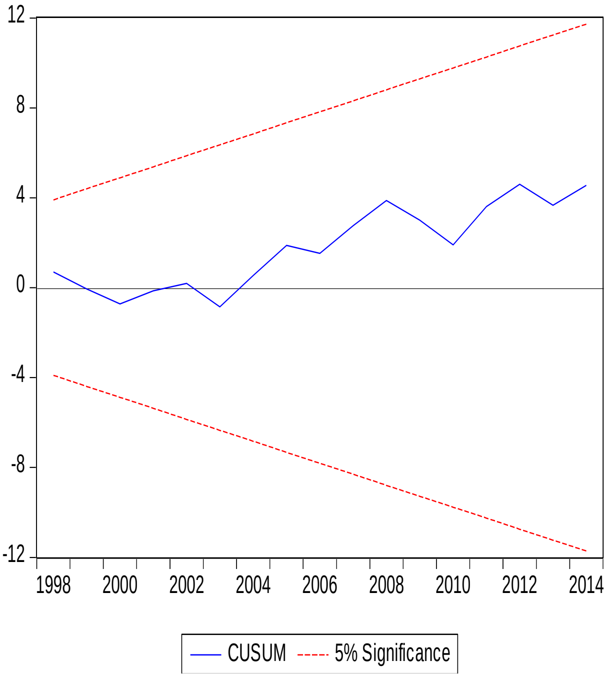
DEPC	1.915***	0.286	6.691	0.0000
DEPC(-1)	-0.699	0.475	-1.470	0.1596
DEPC(-2)	-0.875**	0.357	-2.450	0.0254
DCO2	602.201***	175.563	3.430	0.0032
DLFP	-783.602	955.613	-0.820	0.4236
DLFP(-1)	-597.726	1092.826	-0.546	0.5915
DLFP(-2)	1638.964	1155.981	1.417	0.1743
DLFP(-3)	-2733.154**	1171.627	-2.332	0.0322
ECM(-1)	-0.357***	0.099	-3.586	0.0023
Diagnostics				
R-squared	0.887563	F-statistic		11.18298
Adjusted R-squared	0.808196	Prob(F-statistic)		0.0000

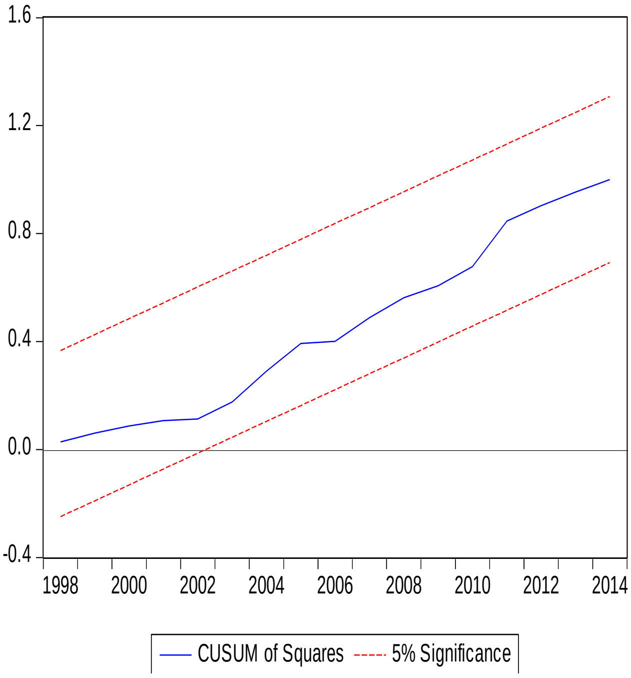
Diagnostics tests which are applied on the short run ECM model one are, Breusch-Godfrey Serial Correlation LM Test, Heteroskedasticity Test of Breusch-Pagan-Godfrey, Jarque-Bera Test of Normality, and Ramsey RESET Test. The results of the diagnostics tests are given in the following Table 5.7.

Table 6 Diagnostic tests for ECM Model One

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	0.3890	Prob.	0.5416
Obs*R-squared	0.7121	Prob. Chi-Square	0.3984
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.1225	Prob.	0.4034
Obs*R-squared	13.2624	Prob. Chi-Square	0.3503
Jarque-Bera Test of Normality			
Jarque-Bera	1.0347	Prob.	0.5960
Ramsey RESET Test			
t-statistic	0.9210	Prob.	0.3716
F-statistic	0.8482	Prob.	0.3716

CUSUM and CUSUM squared





Conclusions and Suggestions

This paper used the ARDL test and VECM based test techniques to establish the short run and long run relationships between the variables in the model. It is very difficult for the policy makers to control the CO2 emmision in the growing economy so the environmental protection is an important challenge. This paper examines the relationships among economic growth, CO2 emissions, energy consumption and the employment ratio in Pakistan during the period of 1980-2011. The estimated long run coefficients of CO2 emissions per capita, energy consumption per capita and employment ratio are positive and significant. In long run there is positive and significant relationship between energy consumption and GDP. It is due that the development of Pakistan economy is based on energy intensive industry and our energy intensive lifestyles in buildings and transport sectors. The energy consumption also increases due to rapid increase in GDP in last decade of the data. High energy consumption is encouraged due to expansion in middle class in the country. The elasticity of CO2 emissions per capita intensity in Pakistan is lower than the elasticity of energy consumption per capita intensity. This implies that CO2 intensity is at a slower pace than energy consumption intensity

The application of the ECM-based Granger Causality test is found to be consistent with the outcomes of the ARDL test. The results indicate that GDP does not Granger Cause CO2 emissions and demonstrate that in a logarithmic model, the EKC hypothesis does not hold in the case of Pakistan. In the Short run, the Granger causality results support the neutrality hypothesis that there is no causal relationship between economic growth and energy consumption in Pakistan. However, the long run income elasticity of carbon emissions is greater than the short run income elasticity of carbon emissions, which implies that income leads to greater carbon dioxide emissions in the country. The significant and positive impact of energy consumption on economic growth suggests that energy consumption is crucial for growth, but the rapid pace of CO2 emissions requires the adoption of alternative sources of energy and approaches to development to protect the environment in Pakistan

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