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ANALYSING THE CAUSAL RELATIONSHIP AMONG CO_2 EMISSION, ENERGY CONSUMPTION AND ECONOMICS GROWTH

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Abstract:

The study analysis the relationship among CO_2 emission, Energy consumption, and economic growth in Pakistan. The annual time series data from 1973 to 2017 used. Both formal and informal method are used to determine the stationary level. For regression analysis, Vector Auto regression (VAR) model is used. The results confirm that theCO_2 emission and energy consumption has positive but insignificant effect onper capita GDP or Economic growth. Granger Causality VAR confirms unidirectional causality between Energy consumption and CO_2 emission. While no causality found between CO_2emission on economic growth and energy consumption on economic growth.

1. Introduction

Industrialisation and developed infrastructure are the main determinants economic growth of any country. But due to increased economic activity creates environmental hazard in the form of CO_2emission. CO_2emissionopens a debate on the environment protection issues. The main object of this study is to determine the relation among energy consumption, CO_2 emission and GDP growth in Pakistan. The time series data from 1973 to 2017 collected from various sources. Different time series estimation techniques like VAR, Co-integration and Granger Causality applied to confirm the short as well as long run relationship among the variables.

Energy is considered as a significant element for human life. For economic and social development of a nation, no one can ignore the importance and inevitability of energy. The evidence reveals various types of energy ranging from wood as the oldest to nuclear the modern sources of energy (Mirza, Ahmad, & Majeed, 2008). Literally, two broad categories of energy are found in the earth namely, renewable and non-renewable. However, the spectrum of energy sources is lengthy such as, renewable energy including the hydro, geothermal, solar, biomass, wind and so on. These sources are automatically generated from

natural resources and can be unlimited, therefore, called renewable. Contrarily, non-renewable energy comprises nuclear, gas, oil, coal and so on which is limited in nature and difficult to replenish naturally (Luecke, 2011). There is close link among the foreign direct investment, energy consumption and economic growth. As a study conducted by Abdouli and Hammami (2017), claims the existence of bidirectional causal relationship among economic growth, foreign direct investment inflow, and energy consumption. This entails, if the energy consumption upsurges it will result in a greater FDI flows to these countries (Abdouli & Hammami, 2017).

It has been persistently a challenge for developing as well as developed nations to achieve a reasonable balance concerning economic development and global environment protection. Several studies determine that CO_2emissions are amongst core issues for growing the environmental degradation, and greenhouse gas contributes to the global warming phenomenon (Danish et al.,2017a). Nonetheless, the ecological footprint can be also considered as a responsible element for the environmental deterioration.

After 1980, Pakistan pursued a liberalization policy as a developing country, so a phrasal transition from agriculture to industrialization took place from 1980. But due to dysfunctional politics, law and order the pace of this transactional state prolongs or lengthens.So, this study is important as it discussed the causality among the energy consumption, CO_2 emission and economic growth in context of Pakistan.

2. Literature review:

There is an immense studies found using CO_2 emission to describe the economic growth or describe the relation among these two variables. Some studies found in literature describe the validity of the environment Kuznet curve i.e. studies of Ang(2007) Sabooriet al (2012) Grossman and Krueger(1991) Friedl and Getzner(2003).

Haunky (2010) investigated the environment Kuznet curve for thirty six higher income countries over a period of 1980 to 2005. Unidirectional causality result obtained i.e. GDP per capita (economic growth) to CO2 emision per capita had been found in long run and short run.Sabooriet al (2012)studied Malaysia data set for the period 1980to 2009 found unidirection causuality from CO2 to Economic growth in long run.

Studies that found no result or result contrary to the environment Kunzet Curve are; Holtz Eakin and Selden(1995) studied one hundred and thirty countries for the period 1951to 1986 determine Enviroment Kuznet curve and found upward rising curve. Friedl and Getzner (2003) found ‘ n’ shape curve. Richmmond and Kaufman (2006) studied thirty six different countries and found no significant relationship between economic growth and CO2 emission.

Now review turn on to the second variable of energy consumption.Initially work done by Kraft and Kraft (1978) that suggest higher economic growth required higher energy consumption. Granger causality test is used to establish the relationshipbetween economic growth and energy consumption. Similar studies with different countries data set are Stem (1993). Belloumi (2009) Pao(2009) and Ghosh (2010).

Stem (1993) studied united state energy consumption impact on GDP over a period of 1947 to 1990. This study use multivariate vector auto-corelation model and found unidirectional relationship from energy consumption to economic growth.

Yuan et al. (2007) studied China energy consumption relation with economic growth over a period of 1963 to 2005 use Johsansen co-integration and vector error correction model

found bilateral relation in long run between energy consumption and economic growth while unidirectional relation from energy consumption to economic growth in short run.Belloumi (2009) studied Tunisia economic growth with energy consumption used vector error correction model to establish relationship over a period of 1971 to 2004 found bilateral relationship in long run. Ghosh (2010) studied India energy consumption relation with economic growth use ARDL approach for the period 1971 to 2006 found bilateral relationship. Altinay and Karagol (2004) investigated the causal relationship between energy consumption and per capita income of Turkey over a period of 1950to 2000 found strong relation of energy consumption to income. They use electricity consumption as a proxy of energy consumption and conclude that electricity supply is vital for the economic growth of turkey.

Finally reviewing turn on those studies that use both emission of CO_2 and energy consumption as a determinant of economic growth. It was initiated by Ang (2007) and Soytas et al. (2007). Similarly also found in Halicioglu (2009) and Zhang Cheng (2009) etc. Some are discussed here that have common proposition with ours.Ang(2007) use France data for year 1960 to 2000 determine energy consumption cause economic growth no relation found among CO_2 emission on economic growth. Soytas et al. (2007) studied United States data over a period of 1960 to 2000 found unidirectional causality of energy consumption to CO_2 emission Apergis and Payne (2009) studied six central American countries 1971 to 2004 found bilateral causality between CO_2 emission and economic growth while unidirectional causality between energy consumption to CO2 emission and economic growth to CO_2 emission.Halicioglu (2009) studied Turkey over a period 1960 to 2005 bilateral relation between CO_2 emission and economic growth and unidirectional of CO2 to energy consumption. Zhang and Cheng (2009) studied china data set over a period of 1960 to 2007 found unidirectional economic growth to energy consumption and energy consumption to emission of CO2.Soytas and Sari(2009) studied turkey data set for a period of 1960 to 2000 use granger causality test and found bilateral relation between CO2emision and energy consumption in the long run.Arouri et al (2012) studied energy consumption, CO2 emission and GDP growth for twelve middle east and African countries over a period 1981 to 2005 found quadratic relationship between GDP and CO2 emission.the study related to Pakistan was conducted by M. Hussain et el (2012) and found that there is a long term relationship between these economic growth, energy consumption and CO_2 emission, with bidirectional causality between per capita CO2 emission and per capita energy consumption. And found that per capita GDP growth were explained by per capita CO_2 emission.

3. Data and Methodology:

The present study is to determine the association among CO2 emission, energy consumption and economic growth. The time series data from 1973 to 2017 of Pakistan collected from world development indicator and applies Cobb Douglas production function. The summary statistics is presented in table 1.

Table 1: Summary Statistics

	y	**CO**	**E**	**k**
Mean	6.197602	-0.451785	6.013971	5.007418
Median	6.142200	-0.344806	6.077352	5.036081
Maximum	7.344624	-0.009011	6.261040	5.255326
Minimum	4.608169	-1.146523	5.674317	4.582915
Std. Dev.	0.658159	0.361561	0.186933	0.169563
Skewness	-0.057355	-0.560409	-0.481220	-0.938360

Kurtosis	2.613570	1.995081	1.767377	3.083982
Jarque-Bera	0.304662	4.248929	4.585593	6.617120
Probability	0.858704	0.119497	0.100984	0.036569
Sum	278.8921	-20.33033	270.6287	225.3338
Sum Sq. Dev.	19.05962	5.751947	1.537533	1.265073
Observations	45	45	45	45

The Cobb Douglas production function is

$Y = A\,K^{\alpha}L^{1-\alpha}$ ……1

The Cobb Douglas production function in generalized and linearize forms are presented in equation (2) and equation (3) respectively:

$y = A\,E^{a_1}C^{a_2}k^{a_3}$…….2

To linearize the above model using logarithmic transformation of the above functional

$$\ln(Y) = \ln(A) + a_1 \ln(E) + a_2 \ln(C) + a_3 \ln(k) \ldots.3$$

$$\boldsymbol{ln(y_t) = a_0 + a_1 ln(E_t) + a_2 ln(C_t) + a_3 ln(k_t) + u_t \ldots\ldots\ldots 4}$$

In equation (4), ln(A-Technology) = a_o, 'y_t' is real GDP per capita; E_t isenergy consumption, C_t is per capita CO2 emission and k_t is per capita capital. a_o,a_1,a_2,and $a_3$are parameters and associated with returnto scale with energy consumption, CO2 emission per capita..

4. Result and Discussion:

Initially the stationarity is checked through informal and formal. To do so the variable of economic growth(GDP per capita), CO_2 emission, energy consumption and capital per labour ratio are not stationary at level both informal and formal test conclude that all these variables are stationary at first level and result is presented in table number 2.

TABLE2:SUMMARY FOR STATIONARITY

Time series	**Stationary level**
Economic growth (y_t)	I(1)
CO_2 emission (CO_t)	I(1)
Energy Consumption (E_t)	I(1)
CapitalLabour ratio (k_t)	I(1)

The lag length criteria checked and result is presented in table number 3. The results It support the informal test result obtained from correlogram test. All variables are stationary at first difference so unrestricted VAR model is used.

Table 3: Lag Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	51.42767	NA	0.000374	-2.215984	-1.965217	-2.124668
1	120.8997	3.540499	1.54e-05	-5.409743	-4.991799	-5.257551
2	123.0345	121.9997*	1.69e-05*	-5.318754*	-4.733632*	-5.105685*

3	126.0691	4.737084	1.79e-05	-5.271666	-4.519366	-4.997720
4	129.4489	4.945965	1.86e-05	-5.241409	-4.321932	-4.906586

We obtained estimated result through unrestricted VAR model. To achieve our main objective that CO_2emission and energy consumption are determinate of economic growth. Result are presented in the equation. with 2 lags while executing the model with intercept (trend) CO_2emission(CO) and energy consumption (E) are used as exogenous variables. The estimated VAR equation is shown under

$$Y = 1.033 * Y(-1) - 0.080 * Y(-2) - 0.437 * K(-1) + 0.053 * K(-2) + 0.207 + 0.018 * CO + 0.342 * E$$

The sign of CO_2 emission is positive and sign of Energy consumption is also positive.The t statistic values of CO_2 emission and energy consumption was 0.04483 and 0.5275 respectively. On basis of statistical evidence available we conclude that at 5% significance level the critical value is 1.684 that is greater than the t-statistic computed so both these variables are insignificant in explaining the economic growth of Pakistan.

To prediction the direction of causality, we applied VAR granger causality test and result is presented in table number 4.

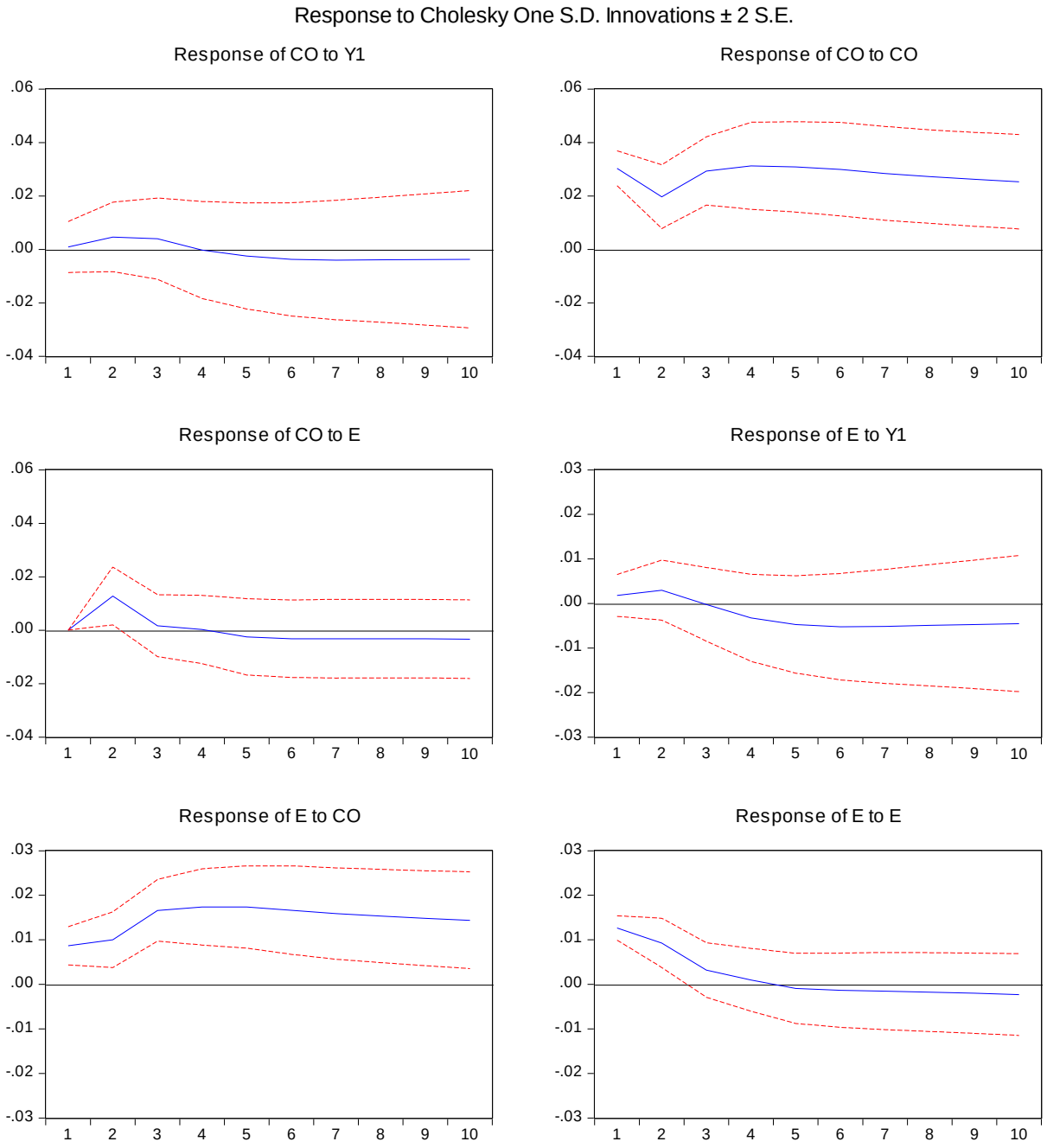
TABLE4: SUMMARY OF RESULT FOR VAR GRANGER CAUSALITY

Null Hypothesis(Ho)	**Direction of causality**	**No. of lags**	**f-statistics**	**Probability**	**Result**	**Conclusion**
CO_2 does not Granger Cause Y	CO_2→y	2	0.34694	0.7091	Do not Reject Ho	CO_2 does not Granger cause y
Y does not Granger Cause CO_2	y → CO_2	2	0.47533	0.6253	Do not Reject Ho	y does not Granger cause CO_2
E does not Granger Cause Y	E→y	2	0.82789	0.4447	Do not Reject Ho	E does not Granger cause y
Y does not Granger Cause E	y → E	2	0.08163	0.9218	Do not Reject Ho	y does not Granger cause E
E does not Granger Cause CO_2	E→CO_2	2	4.91783	0.0126	Reject Ho	E Granger cause CO_2
CO_2 does not Granger Cause E	CO_2→E	2	2.20744	0.1239	Do not Reject Ho	CO_2 does not Granger Cause E

From table number 4, we conclude that there are no causality between CO_2emission and economic growth and also no causality between energy consumption and economic growth. However there is unidirectional causality between energy consumption to

CO_2emission at two lagsinother words there is no reverse causality while including two lags.Further to support the empirical result of Granger causality test impulse response with different dependent variable is shown in the figure1.

Figure 1.



5. Conclusion and Policy Implication:

Current study investigates the causalityamong CO_2 emission, energy consumption and economic growth of Pakistan on annual data for the period 1973 to 2017 and for empirical analysis Granger Causality test is used. F-statistics were used to predict the direction. The conclusion obtained from empirical investigation is that there is unidirectional causality

among energy consumption and CO_2emission of Pakistan. The result obtained are contrary to the result obtained byM. Hussain(2012).

The answer to the first research question 'Is CO_2 emission and energy consumption act as exogenous variable in production function of Pakistan?'is that both these variablesdonot show their influence on the economic growth nor they use as the exogenous determinants in explaining production function of Pakistan. Second question of our research 'Is CO_2 emission caused economic growth in Pakistan?' the answer to that question is also 'No' because CO_2 emission does not cause economic growth in case of Pakistan. Third question of our research 'Is energy consumption caused economic growth in Pakistan?' answer to that question is also 'No'because energy consumption does not cause economic growth in case of Pakistan.The final question of our study 'Is CO_2 emission caused energy consumption in Pakistan?' The answer to that question is 'Yes' that is energy consumption cause CO_2 emission in case of Pakistan. From the above answer to the research question set in the current studied we can conclude that energy consumption cause the increase in the production of CO_2 but this energy consumption (or resource) is not use to increase the economic growth(i.e. production or GDP per capita) . In other word we can say that we are not using our resource for productive activities. The other reasoning that can also be obtained from the study is that Pakistan economy is still based on the production primary commodity (i.e. agricultural product).

References:

Ang, J., 2007. CO2 emissions, energy consumption, and output in France. Energy Policy 35, 4772-4778.

Ang, J., 2008. Economic development, pollutant emissions and energy consumption in Malaysia. Journal of Policy Modelling 30, 271-278.

Apergis, N. and Payne, J.E. (2009), "CO2 emission, energy usage and output in Central America",Energy Policy, Vol. 37, pp. 3282-6.

Dinda S., 2004. Environmental Kuznets curve hypothesis: a survey. Ecological Economics 49, 431-455

Dinda, S., Coondoo, D., 2006. Income and emission: a panel data-based cointegration analysis. Ecological Economics 57, 167-181.

Engle, R., Granger, C., 1987. Cointegration and error correction representation: estimation and testing. Econometrica 55, 251-276.

Friedl, B. and Getzner, M. (2003), "Determinants of CO2 emission in a small open economy",Ecological Economics, Vol. 45, pp. 133-48.

Friedl, B., Getzner, M., 2003. Determinants of CO2 emissions in a small open economy. Ecological Economics 45, 133-148.

Ghosh, S. (2010), "Examining carbon emissions economic growth nexus for India: a multivariatecointegration approach", Energy Policy, Vol. 38, pp. 3008-14.

Granger, C.W.J. (1969), "Investigating causal relations by econometric models and cross spectralmethods", Econometrica, Vol. 7, pp. 424-38.

Grossman, G., Krueger, A., 1991. Environmental impacts of a north American free trade agreement. National Bureau of Economics Research Working Paper, No.3194, NBER, Cambridge.

Grossman, G., Krueger, A., 1995. Economic environment and the economic growth. Quarterly Journal of Economics 110, 353-377.

International Trade and Environment. Discussion Papers, No. 159, World Bank, Washington, D.C.

Kraft, J., Kraft,A., 1978. On the relationship between energy and GNP. Journal of Energy Development 3, 401-403.

Kuznets, S., 1955. Economic growth and income inequality. American Economic Review 45, 1-28.

Managi, S., Jena, P. R., 2008. Environmental productivity and Kuznets curve in India. Ecological Economics 65, 432-440.

Masih, A. M. M., Masih, R., 1996. Energy consumption, real income and temporal causality results from a multi-country study based on cointegration and error correction modelling techniques. Energy Economics 18, 165-183.

Matloub Hussain, Muhammad Irfan Javaid, Paul R. Drake, (2012),"An econometric study of carbon dioxide emissions, energy consumption, and economic growth of Pakistan", international Journal of Energy Sector Management, Vol. 6 Iss: 4 pp. 518 - 533

Soytas, U., Sari, R., Ewing, T., 2007. Energy consumption, income, and carbon emissions in the United States. Ecological Economics 62, 482-489.

Soytas,U., Sari, R., in press. Energy consumption, economic growth, and energy emissions: challenges faced by an EU candidate member. Ecological economics, doi:10.1016 /j.ecolecon.2007 .06 .014.

Stern, D. I.,2004. The rise and fall of the environmental Kuznets curve. World Development 32, 1419-1439.

Yang, H. Y., 2000. A note on the causal relationship between energy and GDP in Taiwan. Energy Economics 22, 309-317.

Zhang, X.P. and Cheng, X.M. (2009), "Energy consumption, carbon emission and economicgrowth", Ecological Economics, Vol. 68, pp. 2706-12.

Appendix:

VAR Granger Causality/Block Exogeneity Wald Tests
Sample: 1973 2017
Included observations: 43

Dependent variable: Y

Excluded	Chi-sq	df	Prob.

K	8.684691	2	0.0130
All	8.684691	2	0.0130

Dependent variable: K

Excluded	Chi-sq	df	Prob.
Y	1.778603	2	0.4109
All	1.778603	2	0.4109

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 10/29/18 Time: 20:36
Sample: 1973 2017
Included observations: 43

Component	Skewness	Chi-sq	df	Prob.
1	-0.035125	0.008842	1	0.9251
2	-0.106838	0.081803	1	0.7749
Joint		0.090645	2	0.9557

Component	Kurtosis	Chi-sq	df	Prob.
1	2.375504	0.698742	1	0.4032
2	2.999456	5.31E-07	1	0.9994
Joint		0.698743	2	0.7051

Component	Jarque-Bera	df	Prob.
1	0.707584	2	0.7020
2	0.081803	2	0.9599
Joint	0.789387	4	0.9399