

# Dynamic Relationship between Energy Consumption and Economic Growth: Time Series Analysis from Pakistan & India

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## Abstract

*Scarcity of natural resources including energy resources motivated many researchers to extensively study the association between energy usage and country's economic growth. Therefore, this article is also an attempt to examine causal relationship between energy consumption and GDP in the long and short run of two developing countries of Asia. Empirical results driven from co-integration and vector error correction (VECM) analysis reveal that unidirectional causality in the long run is running from GDP to energy consumption in both India and Pakistan. Furthermore, researcher fails to identify any short causality (neutrality effect) between two variables in Pakistan, whereas bidirectional (feedback effect) causality in the short run for India was established. These results have significant policy implications for concerned countries. The outcomes recommend that both countries can openly initiate energy conservation methods and procedures in the long run and can go for a well-adjusted group of alternative strategies and policies for energy consumption and economic growth in the short run.*

**Keywords:** Energy Consumption, Economic Growth, Prices, Co-integration, VECM

## Introduction:

Energy is fundamental for economic processes and it always plays a very important role in the growth and development of any country as its adequacy helps in fulfillment of country's requirement and in alleviation of poverty. However, constant raise in prices of energy resources, decline in existing natural resources, search for energy alternatives and resources preservation policies and technologies have highlighted the topic of energy usage and economic growth relationship. Riaz (1984); Mahmud (2000); Anjum, A. and Butt M.S. (2001); Asafu-Adjaye (2000); Stern, D.I. (2003), Siddiqui (2004) and Saboori, Sapri and Baba (2014) concluded that higher growth is expected with the expansion in energy

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use and energy conservation can create hurdles in economic growth process. Despite the profound importance of energy for economies, there is still much that is not understood about the energy-economy relationship.

The motivating questions being: Does economic growth require increased energy consumption? If so, energy conservation measures can be expected to have adverse impacts on economic growth. If not, reductions in aggregate energy consumption could be used to address a variety of energy related issues while being growth neutral. Without an expected decline in growth, policies aimed at addressing various energy related issues such as climate change, energy security, and so on would be more readily adopted.

Apergis, N., and Payne, J., (2009) outlines several hypotheses which have emerged within the literature testing the association between economic progress and energy usage. They are called “Growth Hypothesis”, “Conservation Hypothesis”, “Neutrality Hypothesis” and “Feedback Hypothesis”. Growth hypothesis states that increase in energy consumption will ultimately enhance economic growth of a country. In an economy categorized by this hypothesis energy conservation measures would be expected to hinder growth. In contrast, the conservation hypothesis is found when economic growth leads energy consumption. This scenario occurs when increase in economic growth are predicted to lead to increase in energy consumption. Because causality does not run from energy to growth conservation efforts are not expected to adversely impact economic growth.

Furthermore, neutrality and feedback hypotheses are extensions of the growth and conservation hypotheses. When the neutrality hypothesis holds no Granger causality is found. The policy implications for the conservation and neutrality hypotheses are the same. Whether causality runs from output to energy consumption or no causality is found, conservation of energy will not hinder economic growth. In contrast, feedback relationship exists when bidirectional Granger causality present between energy consumption & economic growth. Hence, the policy implications for both feedback and growth hypothesis are same. In both scenarios energy consumption leads output indicating that conservation policies are expected to decrease economic growth.

**Emerging Issues in Economics and Finance**

Table 1: Payne’s Hypotheses of Energy Consumption and Economic Growth

Hypothesis	Causality	Expected Outcomes
Growth Hypothesis	Energy consumption leads economic growth.	Energy conservation hinders growth.
Conservation Hypothesis	Economic growth leads energy consumption.	Energy conservation does not hinder growth.
Neutrality Hypothesis	No causality between energy consumption and economic growth.	Energy conservation does not hinder growth.
Feedback Hypothesis	Bi-direction causality between energy consumption and economic growth.	Energy conservation hinders growth.

Countries are unique in their natural endowment of energy sources, the relative contribution of specific industries to gross domestic product (GDP), and their energy related policies and institutions. In recent years, many institutions like “International Institute of Energy Conservation (IIEC)” have formulated policies related to energy conservation which have attracted lots of attention from policy makers around the globe as such policies not only help in saving of energy resources but also aid in lowering emissions of greenhouses gases. However, formulation and implementation of such energy conservation policies requires an in-depth and watchful examination of the direction of causation between economic growth and energy consumption in a country as direction of causation has important implications for policy makers and for policy formulation. For example, Paul, S. (2004) in their study highlighted a unidirectional causality running from economic growth to energy use in India. They suggested that if energy conservation policies are implemented then they will have little adverse or no effects on India’s economic growth. Whereas, Asafu and Adjaye (2000) in their study on developing nations identified unidirectional causality running from energy consumption to growth in the short run for India and Indonesia and concluded that energy conservation policies will create hurdles in economic prosperity. Furthermore, Yusma and Wahilah (2010) and Sarkar et. al (2010) with many others in their studies unable to find any causal relationship between energy consumption and economic growth and suggested that energy conservation policies will have no effect on growth of the country on the contrary Omotor (2008) and Pardhan (2010) etc. have showed feedback effect or bidirectional causality between two variables indicating energy conservation policies can hinder economic growth.

**Research Problem**

This complexity of energy-growth relationship and the identification of conflicting results by previous researches highlighted the need of reexamination of relationship between energy use and economic growth in the short and long run as existence of causality between these variables can cause serious implications for the pace of economic growth and development. Therefore, this study tries to ascertain that is there any dynamic relationship between energy consumption and economic growth in Pakistan and India.

**Purpose of the Study**

The main purpose of this study is to investigate the relationship between energy consumption and economic growth in Pakistan and India as both countries have scarcity of energy resources. Moreover, if causality exists then what is the direction of causality between energy use and economic growth in both countries in the short run and long run period and what are the energy conservation policies implication on the pace of economic growth based on existing relationship between two variables in Pakistan and India.

**Research Questions**

This study tries to find the answers of following questions:

1. Is there any association among energy consumption and economic growth in Pakistan and India?
2. If relationship exists then what is the nature of association i.e. short run or long run among variables?
3. What is the direction of causality between energy use and economic growth?
4. What are energy conservation policies implication for economic growth in Pakistan and India?

**Objectives of the Research**

Fulfillment of following objectives is achieved through this research:

1. To find out current literature on the relationship between energy consumption and economic growth with a view to authenticate the current arguments and the economic theory that underpins the relationship.
2. To determine the causal direction between two variables in Pakistan and India.
3. To ascertain the effect of energy consumption on economic growth.
4. To help and facilitate policy makers to better understand the relationship among energy consumption and economic growth of Pakistan and India.

### **Limitations**

This study has its limitations as it investigates the relationship using the annual time series data because monthly or quarterly series was not available for GDP and energy consumption for both countries. Moreover, time constraints and resource limitation have also created obstructions in smooth completion of the study.

### **Literature Review**

As discussed earlier that many researchers have extensively studied the relationship between energy consumption and economic growth over the past few decades but outcomes were not conclusive about the direction of relationship between two variables as many researchers concluded unidirectional causality, bidirectional causality or no causality between energy use and economic growth of different countries across the world. The studies that are reviewed in this research also have no conclusive evidence of the direction of relationship between two variables may be due to different methodologies, different countries and different periods covered in all studies by different researchers.

### **Growth Hypothesis**

At the macroeconomic level numerous studies can be found supporting each of the Apergis, N., and Payne, J., (2009) hypotheses and focused on understanding energy-growth nexus. Khan and Qayyum (2007) study of Pakistan began the literature review. They applied ARDL and Bound test techniques and found causation running from energy usage to economic growth in Asian Countries (Pakistan, India, Bangladesh and Srilanka). Furthermore, same direction of causality was found by Rahman and Amin (2011) by applying co-integration and Granger causality techniques for Bangladesh. Abbasian et. al (2010) conducted research on Iran's data by applying VAR, Granger causality and Toda-Yamamoto's causality tests and concluded that natural gas consumption in Iran leads to economic growth in the country.

Soytas et. al (2001) also explore the association between energy consumption and economic growth for Turkey. They collected annual data for the period of 1960 to 1995 from International Energy Agency (IEA) and analyze the relationship by using multivariate co-integration technique after transforming the data with natural logarithms. They concluded in their study that unidirectional causality running from energy consumption to economic growth in Turkey.

Moreover, Masih and Masih (1997) also conducted a similar studying to check the direction of causation between economic growth and energy consumption in different Asian countries. They applied co-integration and vector error correction model (VECM) to examine the

relationship between variables. They used data for the period of 1955 to 1990 and empirical findings of their research identified a unidirectional relationship running from energy use and economic growth. Few other researchers like Asafu-Adjaye (2000), Fatai et. al (2004), Chiou Wei et. al (2008), Shahbaz, Khan and Tahir (2013) and Saboori et. al (2014) etc. also found similar results of causality running from energy consumption to economic growth in different countries by applying Granger causality test.

#### **Conservation Hypothesis**

Kraft and Kraft's (1978) study of the USA explores the link between energy consumption and GNP for a period of 1947 to 1974 and found a unidirectional causality running from GNP to energy consumption in USA. The authors assert "energy conservation programs are a feasible policy tool without impairing economic activity" (p. 403). Sim (1972) applied causality test and found unidirectional causality from economic growth to energy consumption and not vice versa. Furthermore, Yu and Jin (1992) is the first study to apply co-integration analysis to the USA. No evidence is found for a cointegrating relationship running from energy consumption and growth within the data supporting the conclusion of Kraft & Kraft (1978).

Similarly, Mehrara (2007) conducted a study by using data of Kuwait, Iran and Saudi Arabia by applying ECM and Toda Yamamoto tests and concluded that economic growth causes increase in energy consumption. Moreover, Moradi (2009) also concluded long run co-integration relationship for Iran between economic growth and oil abundance by applying co-integration and ARDL analysis and Lise and Montfort (2005) also came up with same results that causality running from GDP to energy usage in Turkey.

Phung (2011) conducted a study on Vietnam data to identify the nexus of energy consumption and economic growth. He used logarithm of per capita energy consumption and logarithm of per capita GDP for the period of 1976 to 2010. By applying co-integration and VECM analysis techniques he concluded that strong unidirectional causality is running from GDP to energy consumption and not vice versa. In addition, Anjum, A. and Butt M.S. (2001) also shed the light on similar relationship and concluded that economic growth causes increase in consumption. Monia (2011) analyze energy-growth nexus for Tunisia by applying causality tests for the period of 1971 to 2009 and identified causality from economic growth to energy usage. He further added that energy conservation will not create any impact on economic growth in Tunisia. Many other researchers like Cheng, B.S. (1997), Majid (2011), Ouedraogo (2013), Dhungel K. R. (2014), and Alshehry and Belloumi

(2015) etc. found causality running from economic growth to energy consumption in different countries.

**Neutrality Hypothesis**

Co-integration analysis has become the dominant methodology to test for the presence of energy output hypotheses. Soytas and Sari (2003) explore the G-7 countries and selected emerging economies of the world. They confirm the finding of no causality running from energy consumption to growth. Yu and Jin (1992) employed one more variable i.e. employment with energy consumption and GNP to identify the long run relationship among the variables. They collected monthly data of USA for the period of 1974 to 1990 and conclude no cointegrating relationship among variables. They further concluded that energy conservation policies have no impact on employment and economic growth in USA.

Moreover, Altinay and Karagol (2004) collected data for the period of 1950 to 2000 to determine the causality between energy consumption and GDP in Turkey and by applying unit root tests and causality tests they concluded that there is no causality running from energy consumption to GDP. On the causal relationship between energy consumption and economic growth, the studies by Erol and Yu (1987), Yu et al. (1988), Erol and Yu (1989), Yu and Jin (1992) and Yildirim, Sukruoglu and Aslan (2014) found evidence in favor of neutrality of energy consumption with respect to growth, referred to as the neutrality hypothesis by Apergis, N., and Payne, J., (2009).

**Feedback Hypothesis**

Glasure (2002) used VECM to identify the causality between energy usage and economic growth in South Korea. He used five variables such as government expenditures, money supply, oil prices with energy consumption and GDP. He collected annual data for all variables from 1961 to 1990 and concluded that bi-directional causality exist among variables in South Korea and he further highlighted that oil prices have most significant impact on energy consumption and economic growth. Following Glasure (2002), Oh and Lee (2004) also used VECM to study the causality between variables for the period of 1970 to 1990. They also used labor and capital along with energy consumption to identify the impact on economic growth of South Korea. They found evidence of bidirectional causality between energy usage and economic growth.

Hondroyannis et. al (2002) also explore the same relationship between energy consumption and GDP for Greece by incorporating one more variable in their study i.e. Consumer Price Index (CPI). Annual data from 1960 to 1996 was analyzed by applying co-integrating techniques and results indicated long run bidirectional relationship between total and industrial energy consumption and GDP. Moreover,

they fail to identify any causal relationship between residential energy usage and economic growth which means residential energy consumption is exogenous and has no impact on the level of economic growth in Greece. In 2003, Soytaş and Sari by collecting data of G7 countries and ten emerging nations analyze the relationship between energy consumption and economic growth. They found unidirectional causality in Italy and Korea running from GDP to energy usage on the contrary they found unidirectional causality in Turkey, France, Japan and Germany running from energy consumption to GDP. Only in Argentina they found bidirectional causality between energy consumption and GDP. Furthermore, Lee (2005) using per capita GSP and aggregate energy consumption also found bidirectional causality in the United States.

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 unidirectional causality from nuclear energy consumption to economic growth in the long run.

Oztürk, I. (2010) figured out that there is weak evidence about the long-run and causal relationships between electric power consumption and economic growth in Hungary for the period of 1980 to 2006. Specifically, they found that evidence of co-integration and bi-directional strong Granger causality between consumption and growth by using ARDL bounds testing approach. This study contributes not only the proof of causality, but the methodology used.

This small sample of the literature suggests that a consensus has not been emerged from the empirical tests of this issue. Therefore, research in this study tries to reexamine the consumption-growth nexus in two energy dependent Asian countries i.e. Pakistan and India. We used bivariate model like previous studies using energy consumption and economic growth.

#### **Research Methodology**

To measure the relationship between energy consumption and economic growth in Pakistan & India, the researcher used annual time series data from 1971 to 2015 due to non-availability of data. To analyze secondary data the following empirical model is specified in log-linear form. Bowers et al., (1975) propose that Ehrlich's (1975) log linear specification is sensitive to the functional form. Ehrlich (1975) and Muhammad, S. & Faridul I. (2010) argued that the log linear models produce much better empirical results:

$$Y(LGDP) = \alpha + \beta_1(LEC) + \varepsilon$$

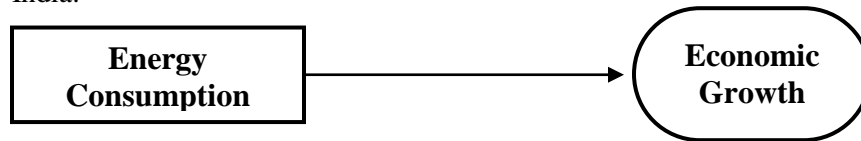
Whereas:

**GDP** = Economic Growth presented by Gross Domestic Product

**EC** = Energy Consumption measured by energy use - kg of oil equivalent per-capita

$\epsilon_t$  = Error Term

Following conceptual diagram is used to analyze the relationship between energy consumption and economic growth in Pakistan and India:



*Figure 1: Conceptual Diagram*

In this study, energy consumption is used as independent variable whereas economic growth (GDP) is used as a dependent variable. Different econometric analysis are conducted like unit root test to examine the stationarity of variables by applying ADF (Augmented Dicky Fuller) and PP (Phillips-Perron) analysis, co-integration test was used to judge any co-integrating relationships or error correction term among variables based on same order of integration and then Vector Error Correction Model (VECM) test was conducted to examine the association among all variables and for investigating the validity of Payne's hypothesis, both in long run and short run in both countries. Furthermore, Granger causality is checked between time series variables for explaining the data in order to have a comprehensive overview concerning the mechanism of the relationship between energy consumption and economic growth in both countries. After model estimation, residual diagnostic test is conducted to guarantee the strength of the results and to confirm normality, homoscedasticity and no serial correlation of the residuals assumptions are satisfied by the model.

#### **Data and Statistical Analysis**

In this study annual data starting from 1971 till 2015 is collected for Pakistan and India from different sources like State Bank of Pakistan, Reserve Bank of India, and World Bank etc. The data related to energy consumption is measured by energy use kg of oil equivalent per capita and economic growth is presented by GDP in million US\$ at year 2005 constant prices which is collected from The World Bank website. For the calculation of total energy used, total population for both countries is also gathered with energy use per capital. Hence, total energy used - kg of oil equivalent is equal to total population into energy use – kg of oil equivalent per capital.

*Total energy use = Total population × Energy use per capita*

**Unit Root Analysis:**

To check the stationary status of both countries collected data at levels and at first difference, Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests were applied.

**Table- 2: Unit Root Test Analysis**

Countries	ADF			PP		
	Test for I(0): Level			Test for I(0): Level		
	t-Stats	P-value	Decision	t-Stats	P-value	Decision
Pakistan						
GDP	-2.5217	0.1178	Non-stationary	-1.7557	0.3967	Non-stationary
Energy Consumption	-2.0692	0.2577	Non-stationary	-2.0692	0.2577	Non-stationary
India						
GDP	3.0662	1.0000	Non-stationary	5.5554	1.0000	Non-stationary
Energy Consumption	2.7518	1.0000	Non-stationary	2.7375	1.0000	Non-stationary

Countries	ADF			PP		
	Test for I(1): First Difference			Test for I(1): First Difference		
	t-Stats	P-value	Decision	t-Stats	P-value	Decision
Pakistan						
GDP	-4.8542	0.0003	Stationary	-4.9921	0.0002	Stationary
Energy Consumption	-4.7793	0.0004	Stationary	-4.7993	0.0003	Stationary
India						
GDP	-6.4414	0.0000	Stationary	-6.4324	0.0000	Stationary
Energy Consumption	-5.1655	0.0001	Stationary	-5.2548	0.0001	Stationary

Table 2 above shows ADF and PP unit root test results and the results of both tests indicate that GDP and energy consumption for both countries at level contains a unit root (i.e. non-stationary  $LGDP \sim I(1)$  and  $LEU \sim I(1)$ ). However, the unit root test at first difference for all variables in both countries shows evidence of stationarity and the acceptance of the hypothesis for the non-existence of a unit root in the series. Hence, ADF & PP tests conclude that the series does not contain unit root at first difference. So, results signify that to attain stationarity of series in Pakistan and India first differencing is needed. The order of integration for all variables is  $I(1)$  and it can be concluded that co-integration analysis can be performed on all variables in both countries.

**Co-integration Test Results – Johansen Co-integration Test:**

After conducting stationarity analysis through ADF and PP unit root tests of data, the co-integration test was applied among all variables to discover any likely long-run equilibrium relationship between them in both countries separately. To use this method lag length of the VAR is determined based on the Akaike Information Criterion (AIC). If a lag length is determined using AIC tests, the next step is to carry out an LM test for residual serial correlation with the hypothesis of no serial correlation at specific lag order. According to Johansen (1991), the VAR residuals should be uncorrelated for reliable results. If the hypothesis is rejected at any of the lag lengths chosen using the above-mentioned criteria, then there will be a need to choose a lag length where the results do not reject the hypothesis of the test Luintel and Paudyal (2006).

**Table- 3: Test of Cointegrating Relationship between Energy Use & Economic Growth**

Country	No. of CE(s)	Trace Statistics	Critical Value	Max-Eigen Value	Critical Value	Decision
Pakistan	Ho: None *	38.21	29.79	28.02	21.13	Co-integrated
	Ho: At most 1	12.05	15.49	11.48	14.26	
India	Ho: None *	38.02	29.79	26.15	21.13	Co-integrated
	Ho: At most 1	11.86	15.49	10.99	14.26	

\* denotes rejection of the hypothesis at the 0.05 or 0.1 level

Table 3 explains the Unrestricted Co-integration Rank Test (Trace & Maximum Eigenvalue) for Pakistan and India. On the basis of above results, the null hypothesis is rejected as both Trace statistics and Max Eigen statistic are more than their respective critical values at 5% significance level indicating 1 co-integrating equation. This means that the annual data collected for this research supports the research objective that there exists a long term association between energy consumption and economic growth. Hence, all variables are co-integrated indicating existence of Granger causality in at least one direction. Furthermore, above co-integration test for both countries shows that all variables are co-integrated or have long run association. Therefore, to find out the direction of causality among variable VECM is applied.

**Vector Error Correction Model (VECM)**

Empirical research shows that even when there is a positive long-run relationship, the short-run dynamics could present a different view, and the vector error correction model (VECM) helps to ascertain the nature of the relationship as well as the ability of the variables to return into equilibrium in the next period. Ely and Robinson (1997) argue that the negative relationship between stock prices and inflation has been derived from regressions over relatively short time periods, suggesting that long-term series analysis would provide a positive relationship.

**Long Run Causality**

The VECM results for long run causality of the long run equilibrium association among variables are shown in table 4 below:

**Table - 4: VECM– Long Run Causality Analysis:**

Country	Dependent Variable = LGDP	Error Correction Term (ECT)		Causality
		LEU	D(LGDP)	
Pakistan	-0.5288	-0.4971	0.2878	GDP → EU
	(-4.0522)	(-1.9799)	(0.72564)	
India	-4.5015	0.0764	-0.0014	GDP → EU
	(-4.1857)	(2.0366)	(-0.0444)	

t - values in parenthesis

For Pakistan, there exists a unidirectional causality running from GDP to energy consumption in the long run as per the significant error correction terms. Further, it can be concluded on the basis of negative coefficient of LEU and level of significance that there exist a negative relationship between energy consumption and economic growth of Pakistan as one unit increase in energy consumption will bring 0.5288 unit decrease in economic growth. This can be attributed to the fact Pakistan is net importer of oil and virtually imports most of its fuel from other countries. The heavy dependence on oil imports to keep the production afloat makes the country susceptible to damage from fluctuations in international production and pricing of energy. Thus, it can be concluded that increase in energy consumption hurts economic growth of Pakistan. The error correction term of GDP is significant and negative which explain the speed of adjustment towards long run equilibrium and its value is 0.4971 which means that about 47.7% of the deviation from the equilibrium path is corrected per annum in Pakistan in the long run.

For India, the VECM outcomes provide evidence of strong long-run relationship among variables as the coefficients of energy use is highly significant. The strong relationship can be attributed to the fact that India's main exports consist of petroleum products including natural gas. The adjustment coefficient for GDP is significantly but positive demonstrating that any exogenous shock in one variable will lead to divergence from equilibrium. An exogenous shock in the GDP use will lead to 7% movement away from the original equilibrium every year. On the other hand the error correction term for energy consumption, although negative, is insignificant indicating that all the adjustment towards the equilibrium is being done by the GDP. Thus, it can be concluded that there is unidirectional causality between the variables where causality runs from GDP to energy consumption in the long run.

The long run findings are consistent with the findings of Costantini and Martini (2010) who also found the direction of causality running from

GDP to energy use in the long run for their panel of OECD and non-OECD countries. However, our results are contradicting Asafu-Adjaye (2000) who conducted research on India and found no long run causality between energy consumption and economic growth.

**Short Run Causality**

To check the short run causality among variables VAR Granger Causality / Block Exogeneity Wald Test was applied.

**Table - 5: Short Run Causality between Energy Consumption and Economic Growth**

Country	Dependent Variable						Causality
	LGDP			LEU			
	Excluded	$\chi^2$	Prob.	Excluded	$\chi^2$	Prob.	
Pakistan	LEU	5.13	0.64	LGDP	5.22	0.63	Neutrality GDP↔ EU
India	LEU	11.6	0.04	LGDP	14.0	0.03	Feedback GDP↔ EU

From the results of granger causality test above, it is concluded that there is a bi-directional short-run causality between energy consumption and economic growth in India as the null hypothesis of non-causality is rejected at 5% level of significance. The higher rates of energy consumption create an effect on the economic development or increase in economic growth will lead to increase in energy consumption in India in the short-run. Thus, create a feedback effect between two variables in the short run. In Pakistan, however, the neutrality hypothesis could not be rejected in the short-run i.e. neither energy use nor the economic growth caused each other in the short-run in Pakistan as the null hypothesis of non-causality could not be rejected at 5% level of significance.

**Comparison**

The estimation results of this study (see table 6 below) support a “neutrality hypothesis” for Pakistan in the short-run pointing out that for the selected sample, the energy use and real GDP did not have significant implications for each other at least in the short-run. Whereas, “feedback hypothesis” which indicates that GDP is affected by the energy use and vice versa have been proven for India in the short-run. In other words, in India energy consumption does have an influence on the growth process and GDP also effect on energy use. Therefore, in India, energy conservation may not be viable as it will be damaging to economic growth in short-run.

**Table - 6: Direction of Causality in the Short Run**

Growth Hypothesis	Conservation Hypothesis	Neutrality Hypothesis	Feedback Hypothesis
-	-	Pakistan	India

In the long run, the outcomes presented in table 7 confirm that the “conservation hypothesis” is true for Pakistan and India according to the long run investigation of the correlation between energy and economic growth for the selected years. Thus, it implies that in Pakistan and India energy use does not determine pace of economic development and growth. The rationale of such result is that both countries’ main exports consist of petroleum products including natural gas. The exports of petroleum products are more as compared to other exports. Hence, indicating that growth in economic will require more energy sources. However, just increase in energy sources will increase budget expense that will hurt economic growth in both countries.

**Table - 7: Direction of Causality in the Long Run**

Growth Hypothesis	Conservation Hypothesis	Neutrality Hypothesis	Feedback Hypothesis
-	Pakistan	-	-
-	India	-	-

**Diagnostic Test**

**Table - 8: Diagnostic Test for Pakistan and India**

Country	Serial Correlation	Heteroskedasticity	Normality
Pakistan	Obs R-Squared = 9.230 P value = 0.075	Obs R-Squared = 25.588 P value = 0.374	Jarque Bera = 0.558 P value = 0.756
India	Obs R-Squared = 7.800 P value = 0.107	Obs R-Squared = 10.139 P value = 0.927	Jarque Bera = 0.357 P value = 0.836

In table 8, diagnostic test of the model reveals that the error term is normally distributed as its p value is  $0.756 > 0.05$  and  $0.836 > 0.05$  for Pakistan and India respectively so we fail to reject null hypothesis and conclude that error term of model for both countries is normally distributed. Serial correlation LM test shows that Obs-R squared value is 9.230 and 7.80 for Pakistan and India respectively and their p-values are greater than 0.05, which means that  $H_0$  must be accepted. So, we can say that in model, there is no serial correlation. Moreover, Heterosedacticity test explained model should be homosedastic not heterosedastic and from the above table it can be concluded that data is homosedastic for both countries as again p-values are greater than 0.05 suggesting acceptance of null hypothesis i.e. no heteroskedasticity in the residual terms.

**Conclusion & Recommendations**

This paper investigates the relationship between energy consumption and growth in a trivariate demand side framework. Two emerging economies

from Asia i.e. Pakistan and India were selected for this purpose. The vector error-correction mechanism (VECM) is used to examine both short-run and long-run Granger causality. The empirical results show unidirectional causality running from GDP to energy use in Pakistan and India in the long run. Similar results were found by Rafiq, S. (2009) for India. However, there is no evidence of short-run causality between the variables for Pakistan and India indicating bi-directional causality between both variables.

The policy implications for these findings are as follows. For both countries, where unidirectional causality from income to energy is found in long run, it may contribute to the fight against global warming by directly implementing energy conservation measures. In short run for India, where bi-directional causality is found, a balanced combination of alternative policies seems to be appropriate and for Pakistan, government to identify the factors that lead to economic progress and energy conservation policies in the short run will help in minimizing tradedeficit. Nevertheless, these countries may initiate environmental policies aimed at decreasing energy intensity, increasing energy efficiency, developing a market for emission trading. Moreover, these countries can invest in research and development to innovate technology that makes alternative energy sources more feasible, thus mitigating pressure in environment. They can, furthermore, increase utilization of public transportation and establish a price mechanism which may encourage the use of renewable and environmental friendly energy sources.

#### **Areas for Future Research**

This study has explored current literature and theory on consumption–growth nexus in Pakistan and India and has recommended a set of steps to be considered for analysis that can be applied to future research that seeks to determine a relationship between two time series. It would be interesting to put this set of steps in advanced economies to ascertain if they could answer the conflicting nature of the empirical relationship between energy use and economic growth.

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