ISSN 1684-8403
Journal of Statistics
Volume 21, 2014. pp. 15-40

Relationship among Electricity Consumption, Economic Growth, Consumer Price Index and Foreign Direct Investment in Pakistan: A Time Series Modeling Approach

Zahid Ahmad[1], Samia Kanwal[2] and Jaffer Hussian[3]

Abstract

This research paper investigates a relationship among electric power consumption, economic growth, Consumer Price Index (CPI) and Foreign Direct Investment (FDI) in Pakistan, by applying Granger Causality Test for the period 1971-2010. Vector Error Correction Model has been applied to determine the short run and long run Causality. The empirical results have confirmed the presence of short run and long run Causality among variables. The results have shown the Bi-directional Granger Causality between Consumer Price Index and electric power consumption in Pakistan. Furthermore, the results reveal that there is evidence of bidirectional Causality between electric power consumption and Foreign Direct Investment. This implies that electric power consumption may increase in-flow of Foreign Direct Investment into Pakistan and thus reduce deficit and help in improving balance of payment. There is also evidence of Uni-directional Causality running from electric power consumption to economic growth. Findings of the study dictate that policy makers should be proficient enough to boost the economic fabric of the country.

Keywords

Electric power consumption, Economic growth, Consumer Price Index (CPI), Foreign Direct Investment (FDI)

[1] Associate Professor, Faculty of Commerce, University of Central Punjab, Lahore, Pakistan.
Email: zahid_69@hotmail.com
[2] M.Phil. (Scholar), University of Central Punjab, Lahore, Pakistan.
Email: samiakanwal26@hotmail.com
[3] Chairperson, Department of Statistics, GC University, Lahore, Pakistan.
Email: jafferfarooq@hotmail.com

1. Introduction

Electricity is a typical form of energy and its uses are rapidly increasing day by day. Also it is a glaring fact that human civilization is sprawling with the flexible use of electricity. To meet this challenging task, demand for electricity is associated with all aspects of development. Electrification is connected with increased savings and higher income, higher industrial and agricultural productivity, improved educational opportunities, less poverty, and so on. A realistic and credible demand forecast of electrical energy resources is essential to coin efficient policies in order to sustain economic growth (Wolde-Rufale, 2006).

Empirical studies have investigated the relationship between electric power consumption and a number of macroeconomic variables like economic growth, employment, imports, exports and FDI. In this study, the relationship is investigated among electricity consumption, economic growth, Consumer Price Index (CPI) and Foreign Direct Investment (FDI). This study is conducted in order to analyze short run and long run relationship. Relationship among these variables is important for two main reasons. Firstly, electricity plays key role in economic growth. Electricity consumption stimulates economic growth by expanding business activities, increasing employment opportunities and encourages FDI in the country. Secondly, it is important to know about kind of policies to be adopted by the government regarding electricity consumption to ensure sustainable economic growth.

Energy is a fundamental factor for the social and economic development of nations and, consequently, the consumption levels of electricity is a sign of economic prosperity. GDP growth rate is also the key driver of demand for energy (International Energy Agency (IEA), 2006).

According to IEA (2006), global electricity demand is expected to double in the next twenty five years, from 14376 TeraWatt-hours (TWh) in the year 2004 to 28,093 TWh in 2030, growing at 2.6% per year on average. IEA (2006) forecast electricity demand in developing countries, which is growing three times faster as in the OECD countries, in Asian developing countries, especially growth rates of India and China are 5.4% and 4.9% per year, respectively.

1.1 Overview of Electricity Sector of Pakistan: Pakistan is facing energy crisis for the last several years and, particularly in summer, the problem becomes severe. Large number of users remain without electricity supply for variable periods of time. The periods of power outages last from 8 to 10 hours per day for urban areas while in rural areas it goes up to 20 hours a day.

Electricity generation sector in Pakistan consists of both public and private sectors. Water and Power Development Authority (WAPDA) and Karachi Electric Supply Company (KESC) are two main producers in the public sector. The overall authority and responsibility for formulation and implementation of power related policies rests with the Federal Ministry of Water and Power. KESC and WAPDA are public owned enterprises. KESC is public limited company, which was established in 1931 under the Indian Companies Act 188. KESC is primarily engaged in generation, distribution and transmission of electricity. It supplies electricity to more than 10 million users. It has 9.91% share in total installed electricity generation capacity (Saleem, 2007).

WAPDA plays a highly important role in the electricity sector of Pakistan. WAPDA was established in 1958 for the purpose of undertaking development of water and power resources. It supplies electricity to entire country, excluding Karachi and its surroundings. WAPDA produces 54.7% of electricity and controls 100% distribution. It supplies electricity to 13 million consumers, out of 22 million estimated households. It is projected that about 55% of the total population has access to electricity. Only 40% of rural areas are electrified. About 45% of the population in entire country and 60% of population in rural areas do not have access to electricity. Alternative sources of power like oil, bio-digesters are used by these people (Saleem, 2007).

Pakistan had power generation capacity of 60MW, when population was 31.5 million in 1947. The government of Pakistan took charge of the KESC by acquiring major shareholding in 1952. Karachi Electric Supply Company generates, transmits and distributes electric power to the agricultural, commercial, industrial and residential consumers of Karachi.

WAPDA was created in 1958, for coordination and giving a unified direction for water and power sectors improvement schemes, which were previously handled by the respective irrigation and electricity departments of the provinces. The total electricity generation capacity reached 119 MW in 1959, and that time country was going through a period of significant and rapid development, when a solid and dependable infrastructure of electricity was required to support the economic activity and development. WAPDA took the control of power development to initiate a number of thermal and hydel generation projects, transmission and a distribution system to meet the rapidly increasing demand of electricity. In 1965, the generation capacity of electricity increased to 636 MW from 119 MW in 1959. Only 609 villages had access to electricity when WAPDA was established, while in 1965 number of villages with electricity rose to 1882. The rapid progress in electricity witnessed economic growth in the country. Power development picked up speed and, the electricity generation capacity rose to 1331 MW in 1970 from 636 MW, mainly due to increase in the installation of hydel and thermal power units. Electricity generation capacity was 3,000 MW in the year 1980, which rapidly rose to over 7,000 MW in 1990-91 (Consulate General of Switzerland in Karachi, 2011).

However, growth of electricity consumption in Pakistan has been much higher than economic growth due to the increase in rural electrification, urbanization and industrialization. From the year 1970 to the early 1990s, demand of electricity was higher than the electricity supply that was growing at 9 to10% per annum consistently. In the early 1990s, electricity demand exceeded electricity supply by about 15 to 25%, resulting in supply gap of 1,500 - 2,000 MW which further lead to power outages to fill up the gap. There was a weak relationship between the demand and electricity price on demand side, which failed to manage the demand. On the supply side, the main reason of power shortage was less investment by the government in power sector. Economic growth rate of Pakistan declined to 4 to 5% per annum during the 1990s compared with 6 % in the years of 1980s (Consulate General of Switzerland in Karachi, 2011).

In order to eliminate the problem of power outages in minimum time period, the government of Pakistan established an Energy Task Force (ETF) in the year 1993 to formulate a consolidated and comprehensive policy for renewal of energy sector. In March 1994, on the advice of the ETF, the government announced a “Policy Framework and Package of Incentives for Private Sector Power Generation Projects” to attract private investors in power development sector. In this policy, fixed level tariff of US$ 5.57/kWh was offered to the prospective investors along with many other incentives to attract foreign investment in the power development sector. The power policy 1994 not only overcame the problem of power outages, but also resulted in surplus power generation in the country (Consulate General of Switzerland in Karachi, 2011).

WAPDA was broken down vertically into fourteen separate units in the year 2000: four units were of the thermal power generation companies, nine were of the distribution companies and one unit was of the transmission company. The government of Pakistan privatized KESC in November 2005 by transfer of 74.35% shares. Presently, WAPDA and KESC manage their own networks and are interrelated via 220 KV double circuit transmission lines, thus both can supply power to each other. By June 2010, the total combined power generation capacity of WAPDA, KESC and Independent Power Procedures (IPPs) was 20,922 MW (Consulate General of Switzerland in Karachi, 2011).

1.2 Research Objectives: The purpose of this research is to investigate a relationship among the electricity consumption, economic growth, price level and FDI in Pakistan. Specific objectives of this research are:

- To analyze the long run relationship among different macroeconomic variables.
- To analyze the short run relationship among concerned variables of the study.
- To find the possible existence of Causality running from electricity consumption to economic growth, price level and foreign direct investment or vice versa.

2. Literature Review

Literature review provides additional information on electricity consumption, economic growth, price level, consumer expenditure and FDI. Previous studies used secondary data and applied multiple techniques in order to measure the long and short run relationship between electricity use and economic growth. This study is conducted in a sequence to examine the relationship among variables in Pakistan.

It is important to determine the causal relationship between economic growth and electricity consumption, particularly to find out whether economic growth is significant determinant of energy consumption or vice versa? Answer of this question will help government to formulate energy related policies. If there is Causality from energy consumption to economic growth then decrease in energy consumption may lead to budget deficit, unemployment and low income etc. However, if results show that there is no Causality from energy consumption to economic growth then energy conservation policy may be adopted with no adverse impact on economy. It has been sown in SAARC countries that economic growth causes electricity consumption (Imran and Siddique, 2010)

Emeka (2010) analyzed the Causality relationship between real GDP and electricity consumption by using Granger Causality Test in Nigeria based on annual data for the period 1978 to 2008. Using Co-integration and Error Correction Model, author found that electricity consumption and real GDP are Co-integrated in Nigeria, and also found Uni-directional Causality running from real GDP to electricity consumption but no Causality was found from electricity consumption to real GDP. This implies that energy policies may not affect the economic growth of Nigeria.

Sami and Makun (2011) found Uni-directional Causality running from GDP per capita to electricity consumption in long and short run in Japan, which hold the conservation hypothesis. The authors concluded that government should ensure sustainability of electricity supply by investing in energy infrastructure to avoid adverse effects of electricity crises on real income per capita.

Hossain and Saeki (2011) studied the relationship between electricity consumption and economic growth for the period 1971 to 2007 using time series data for the panel of south Asian countries. Authors asserted that conservation policies regarding electricity would be harmful for economic development only for Bangladesh in South Asia but the economies of other countries like Pakistan, Iran, Nepal, India and Sri-Lanka would not suffer by any energy conservation policy.

Bekhet and Salwati (2011) found Uni-directional Causality from electricity consumption to GDP growth, FDI and inflation. Causality from electricity consumption to FDI shows that electricity consumption may increase in-flow of FDI in Malaysia, which improves the balance of payment and reduces deficit. Causality running from electricity consumption to CPI implies that increase in electricity consumption leads to inflation, and consequently reduces consumer purchasing power. They suggest in this study that electricity consumption is a key factor for economic growth in Malaysia and policy makers should ensure continuous supply of electricity for sustainable economic growth.

Kiran and Guris (2009) investigated the relationship between electricity consumption and GDP by applying Lagrange Multiplier (LM) Unit Root Test and Granger Causality Test. Authors found Bi-directional Causality between electricity consumption and economic growth in Turkey. It implies that rise in electricity consumption brings an increase in economic growth and vice versa.

Noor and Siddiqi (2010) tested Causality between electricity consumption and GDP in five South Asian countries. In this study, short run Uni-directional Causality was found from GDP to electricity consumption per capita, while Uni-directional Causality was found from electricity consumption to GDP in the long run. Findings of the study suggest that energy conservation policies should be adopted in these countries in order to avoid shortage of electricity.

In case of Pakistan, Adnan and Riaz (2008) found short run Bi-directional Causality, but in long run they found Uni-directional Causality running from economic growth to electricity consumption. The important implication of their study is that Pakistan should continue to make investment, particularly in hydroelectricity, coal, wind, gas and nuclear power in order to reduce import burden.

Aqeel and Butt (2001) conducted a study to determine Causality between energy consumption, economic growth and employment in Pakistan, by using Hsiao's Version of Granger Causality Test. They found Uni-directional Causality running from economic growth to total energy consumption and petroleum consumption, from electricity consumption to economic growth, but in case of gas no Causality was found there.

Shahbaz and Feridum (2012) examined the relationship between electricity consumption and economic growth by using ARDL testing procedure in order to identify the long run equilibrium relationship in Pakistan over the period 1971-2008. The results of their study indicate that variables are in long run equilibrium relationship and they found Uni-directional Causality running from economic growth to electricity consumption.

3. Theoretical Framework

Little attention is paid to the role of energy in economic development by the mainstream theory of economic growth. However, to understand the role of energy in economic development, it is essential to take with the importance of energy in the production.

3.1 Endogenous Growth Theory: The Endogenous Growth Theory was developed as a result of the flaws in Neo-classical (Exogenous) Growth Theory. In Endogenous Growth Theory, which was first presented in 1986, Romar takes

knowledge as an input in the production function. The theory explains the long run growth by endogenizing technical progress or productivity growth.
The major assumptions of the theory are:

- Increasing returns to scale because of positive externalities
- Human capital (knowledge, training and skills of individuals) and technological progress are essential for long run growth.
- Private investment in Research and Development is the most important source of technological progress
- Knowledge or technical advances are non-rival good.

Neo-classical Growth Theory explains that technological progress is the sole cause of continuing economic growth. As the level of technological knowledge increases, the functional relationship between productive output and inputs changes. Better qualities or greater quantities of output can be created from the same quantity of inputs.

Technology is taken as an endogenous factor which could be linked with energy. Most of the technologies are dependent on useful energy to power it. Here technology refers to plants, machinery and the likes. These technologies are practically useless in the absence of energy supply (electricity or petroleum). The law of thermodynamics explains this concept to justify by stating that “production process can’t be driven without energy conversion”. Energy is not the sole determinant of technology but is an essential factor to ensure that technology is being utilized. Conversion of energy from its raw form to useful form is highly technology oriented.

Taking signal from the technology oriented nature of energy production, it is also well known that energy production is capital intensive, so huge machineries are needed to produce useable energy. It means a significant amount of capital will be needed to produce energy. Huge investments are required not only to produce energy but also to attain energy efficiency. Justifying the Endogenous Growth Model, labor and capital will be used along with various energy sources in model specification.

4. Data and Econometric Methodology

Time series data on electricity consumption, economic growth (GDP), CPI and FDI is used to explore the Causal relationship between electricity consumption and respective microeconomic variables in Pakistan over the period 1980-2004. The necessary data were collected from world development indicators and Statistical Bureau of Pakistan. In this study, electricity consumption is expressed in terms of MegaWatts per hour. CPI is used as a proxy of prices to measure the reaction of electricity to change in price level. FDI include both in-flow and out-flow, but in this study, only net value of in-flow is considered. FDI and GDP are expressed in US million Dollars.

4.1 Econometric Methodology: To examine the Granger Causality between electricity consumption and macroeconomic variables i.e. economic growth, CPI and FDI, the following methodology has been applied. The time series econometric procedures are used in order to determine the relationship among EPC, CPI, FDI and GDP i.e. whether EPC affect CPI, FDI and GDP or is it CPI, FDI and GDP that drive the demand for more electricity in economy. Three steps are involved in estimating the relationship among EPC, CPI, FDI and GDP. The first step is to test whether the variables are stationary or not i.e. electric power consumption, consumer price index, FDI and GDP. In this study, the Augmented Dickey Fuller (ADF) Test is used to check the stationary.

ADF Test is an augmented form of the Dickey Fuller (DF) Test. In case of DF Test there may be a problem of autocorrelation. To tackle this problem of autocorrelation, Dickey Fuller (1979) developed a test which is known as Augmented Dickey Fuller Test. In statistics and econometrics, ADF Test is used to check Unit Root in a time series data. The testing procedure for the ADF Test is same as for the DF test but it is applied to the model as:

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \delta_1 \Delta Y_{t-1} + \ldots + \delta_{P-1} \Delta Y_{t-P} + \varepsilon_t$$

The second step is to investigate the existence of a long run association among electric power consumption, CPI, FDI and GDP i.e. whether a linear combination of the series is stationary. This stationary linear combination is known as the Co-integrating equation. In this study, the Johansen Co-integration Test is used to examine the existence of long-run relationship among the variables. The Co-integration Technique is used to Test the equilibrium relationship among non-stationary series while abstracting short run deviations from equilibrium. This estimator also gives efficient estimates of the adjustment parameter(s) and of the Co-integrating vector(s). Let us start with the AR(k) Model, which under the assumption of Co-integration of order ‘k’ can be written as:

$$\Delta Y_t = \mu + T_1 \Delta Y_{t-1} + \ldots + T_{K-1} \Delta Y_{t-K+1} + \Pi\, Y_{t-K} + \varepsilon_t$$
$$\Delta Y_t = \mu + T_1 \Delta Y_{t-1} + \ldots + T_{K-1} \Delta Y_{t-K+1} + \alpha\beta' Y_{t-K} + \varepsilon_t$$

Once the Co-integration is found in the Model, the residuals from the equilibrium regression are used to estimate the Vector Error Correction Model (VECM) in the third step. VECM can help in better understanding of the nature of non-stationarity among the different component series and can also improve long run forecasting over an Unconstrained Model. The VECM can distinguish between a short run and a long run relationship among the variables and can recognize sources of causation that cannot be detected by the Granger Causality Test. VECM can be written as:

$$\Delta Y_t = \alpha_2 + \beta_2 ECT_{t-1} + \alpha_{21}(i)\, \Delta Y_{t-1} + \alpha_{22}(i)\, \Delta X_{t-1} + \varepsilon_{2t}$$
$$\Delta X_t = \alpha_1 + \beta_1 ECT_{t-1} + \alpha_{11}(i)\, \Delta Y_{t-1} + \alpha_{12}(i)\, \Delta X_{t-1} + \varepsilon_1$$

5. Findings and Discussion

The results of the Unit Root Tests are summarized in Tables 2 to 9. The null hypothesis which reveals that variable is not stationary cannot be rejected because p-value is more than 5% (level of significance). But the null hypothesis is rejected at 5% level of significance at second difference. Therefore, it is concluded that all the series are stationary and integrated of order one, i.e I(1) over the sample under consideration.

After stationary of variables, next step is to determine whether the long run equilibrium relationship exists among concerned variables or not. The Johansen Co-integration Test is deployed to determine the long run association. The estimated results of the Co-integration for the relevant variables are reported in Table 10. p-values of Johansen Trace Statistics and Maximum Eigen Value Statistics found long-run relationship among EPC, CPI, FDI and GDP. The result of Johansen Co-integration Test shows that p-value (0.0002) of Trace Statistics and Maximum Eigen Value is less than 5%, so null hypothesis can be rejected that there is no Co-integration among variables, and accept alternative hypothesis which is that Co-integration or long run relationship exists among variables.

Since all the variables are I(1) and having found that there is a Co-integration among variables, it implies that Granger Causality exists in at least one direction. But Co-integration does not identify the direction of Causality. VECM is deployed to determine the direction of Causality. The significance of VECM not only determines the direction of Causality but also distinguishes between short run and long run Causality. Long run Causality is examined through the significance of coefficient of the lagged error correction term. Results of long term Causality are reported in Table 11. Since the p-value (0.000) of error correction term is less than 5%, so the null hypothesis is rejected which is that there is no long run Causal relationship from CPI, FDI and GDP to EPC.

To determine the short run Causality under VECM Model, Wald Test is applied. Results of Wald Test are shown in Table 12. Coefficient of variables are c(4), c(5), c(6), c(7), c(8) and c(9). If these coefficients jointly influence the EPC then it can be said that there is short run Causality from independent variables i.e. CPI, FDI and GDP to dependent variable EPC. If p-value is less than 5%, the null hypothesis is rejected, which is that there is no short run Causality among variables. So it can be observed that p-value (0.0013) of Chi-square is less than 5%, so the null hypothesis is rejected. Results indicate that there is short run Causality among variables.

Pairwise Granger Causality Test is used to determine the Causality between the series of variables. Results are shown in Table 13. Results indicate that there is Bi-directional Causality between CPI and EPC. Same results are found for FDI and EPC. Uni-directional Causality is found from EPC to GDP.

6. Conclusion

This study investigates a Causal relationship between electric power consumption and other concerned macroeconomic variables such as CPI, FDI and economic growth by applying Granger Causality Test in Pakistan over the period 1971-2008. Understanding the nexus between electricity consumption and concerned independent variables is very important in the effective design and execution of energy and environmental policies.

The empirical results confirmed the presence of short run and long run Causality among variables. The results have shown the Bi-directional Granger Causality between CPI and electric power consumption in Pakistan. Result implies that increase in electric power consumption will lead to increase in inflation and as a result it will decrease the consumer purchasing power and vice versa. Furthermore, the results reveal that there is evidence of Bi-directional Causality between electric power consumption and FDI. It implies that electric power consumption may increase the FDI in-flow in Pakistan and thus reduce deficit and improve the balance of payment, and FDI may increase the electricity consumption and consequently improve the economic growth.

The results also reveal that there is Uni-directional Causality running from electric power consumption to economic growth. Findings of this study imply that energy conservation policies would have adverse impact on economic growth of Pakistan. So, the policy makers should adopt policies in a way that may not harm the economic growth of the country.

7. Recommendations

Government of Pakistan should ensure sustainable and continuous supply of electricity in order to attract FDI in-flow and to foster the economic growth of the country. Policy makers should adopt policies in such a way that decreasing in demand of electricity may not harm economic growth of the country. Furthermore, government should ensure sustainability of electricity supply by investing in energy infrastructure to avoid adverse effects of electricity crises on economic growth and FDI in-flow. Government should also provide opportunities to attract private investment to promote competition in electricity industry in order to decrease cost of electricity and cost of production. There are some more recommendations as follows:

- Transmission and distribution losses should be controlled by policy makers, which are very high in the country.
- Policy makers should adopt alternative sources to generate electricity such as coal, wind and solar energy in order to reduce oil import burden.
- Pakistan is 5th largest in terms of coal reserves in the world, so these coal reserves should be utilized for generation of electricity in the country.

Table 1: Descriptive Statistics

	EPC	CPI	FDI	GDP
Mean	3.49E+10	51.69996	782.3207	56535.27
Median	3.14E+10	34.16604	258.4145	42811.49
Maximum	7.71E+10	180.7763	5590.000	176870.0
Minimum	5.58E+09	5.474557	1.000000	6324.884
Std. Dev.	2.42E+10	44.44828	1382.583	45385.42
Skewness	0.380679	1.148270	2.507888	1.234529
Kurtosis	1.819485	3.664367	8.423121	3.712635
Jarque-Bera	3.288803	9.525798	90.94709	11.00683
Probability	0.193128	0.008541	0.000000	0.004073
Sum	1.39E+12	2067.998	31292.83	2261411.
Sum Sq. Dev.	2.28E+22	77050.34	74549899	8.03E+10
Observations	40	40	40	40

Table 2: Stationary of CPI (Level)

Null Hypothesis: LCPI has a Unit Root
Exogenous: Constant
Lag Length: 5 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.059918	0.9577
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LCPI)
Method: Least Squares
Sample (adjusted): 1977 2010
Included observations: 34 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
LCPI(-1)	0.000480	0.008004	0.059918	0.9527
D(LCPI(-1))	0.549164	0.175501	3.129123	0.0042

D(LCPI(-2))	0.100484	0.188815	0.532183	0.5990
D(LCPI(-3))	0.061380	0.228078	0.269117	0.7899
D(LCPI(-4))	-0.045222	0.221590	-0.204078	0.8398
D(LCPI(-5))	-0.136105	0.151396	-0.899001	0.3766
C	0.016478	0.016593	0.993095	0.3295

R-squared	0.409016	Mean dependent var	0.035046
Adjusted R-squared	0.277687	S.D. dependent var	0.015068
S.E. of regression	0.012806	Akaike info criterion	-5.696543
Sum squared resid	0.004428	Schwarz criterion	-5.382292
Log likelihood	103.8412	Hannan-Quinn criterion	-5.589374
F-statistic	3.114423	Durbin-Watson stat	1.906213
Prob(F-statistic)	0.018881		

Table 3: Stationary of EPC (Level)

Null Hypothesis: LEPC has a Unit Root

Exogenous: Constant

Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.460414	0.1327
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LEPC)

Method: Least Squares

Sample (adjusted): 1972 2010

Included observations: 39 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
LEPC(-1)	-0.022314	0.009069	-2.460414	0.0187
C	0.260879	0.094328	2.765643	0.0088

R-squared	0.140607	Mean dependent var	0.028939
Adjusted R-squared	0.117380	S.D. dependent var	0.022342

S.E. of regression	0.020990	Akaike info criterion	-4.839657
Sum squared resid	0.016301	Schwarz criterion	-4.754346
Log likelihood	96.37330	Hannan-Quinn criterion	-4.809048
F-statistic	6.053638	Durbin-Watson stat	1.655031
Prob(F-statistic)	0.018669		

Table 4: Stationary of FDI (Level)

Null Hypothesis: LFDI has a Unit Root

Exogenous: Constant

Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.443577	0.1369
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LFDI)

Method: Least Squares

Sample (adjusted): 1972 2010

Included observations: 39 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
LFDI(-1)	-0.136572	0.055890	-2.443577	0.0194
C	1.209182	0.462741	2.613089	0.0129

R-squared	0.138956	Mean dependent var	0.084731
Adjusted R-squared	0.115684	S.D. dependent var	0.323698
S.E. of regression	0.304400	Akaike info criterion	0.508970
Sum squared resid	3.428387	Schwarz criterion	0.594280
Log likelihood	-7.924906	Hannan-Quinn criterion	0.539578
F-statistic	5.971068	Durbin-Watson stat	2.184056
Prob(F-statistic)	0.019432		

Table 5: Stationary of GDP (Level)

Null Hypothesis: LGDP has a Unit Root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.145995	0.9370
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP)
Method: Least Squares
Sample (adjusted): 1972 2010
Included observations: 39 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
LGDP(-1)	-0.003347	0.022927	-0.145995	0.8847
C	0.066802	0.243039	0.274861	0.7850

R-squared	0.000576	Mean dependent var	0.031340
Adjusted R-squared	-0.026436	S.D. dependent var	0.050861
S.E. of regression	0.051528	Akaike info criterion	-3.043446
Sum squared resid	0.098242	Schwarz criterion	-2.958135
Log likelihood	61.34720	Hannan-Quinn criterion	-3.012837
F-statistic	0.021314	Durbin-Watson stat	1.650430
Prob(F-statistic)	0.884718		

Table 6: Stationary of CPI (First difference)

Null Hypothesis: D(LCPI) has a Unit Root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.074295	0.0371
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LCPI,2)
Method: Least Squares
Sample (adjusted): 1973 2010
Included observations: 38 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
D(LCPI(-1))	-0.416430	0.135456	-3.074295	0.0040
C	0.016933	0.005933	2.853932	0.0071

R-squared	0.207943	Mean dependent var	0.000908
Adjusted R-squared	0.185942	S.D. dependent var	0.019364
S.E. of regression	0.017471	Akaike info criterion	-5.205355
Sum squared resid	0.010988	Schwarz criterion	-5.119167
Log likelihood	100.9018	Hannan-Quinn criterion	-5.174690
F-statistic	9.451287	Durbin-Watson stat	1.320248
Prob(F-statistic)	0.004011		

Table 7: Stationary of EPC (First difference)

Null Hypothesis: D(LEPC) has a Unit Root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.664196	0.0006
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Dependent Variable: D(LEPC,2)
Method: Least Squares
Sample (adjusted): 1973 2010
Included observations: 38 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
D(LEPC(-1))	-0.769950	0.165077	-4.664196	0.0000
C	0.022815	0.006080	3.752354	0.0006

R-squared	0.376674	Mean dependent var	-0.000229
Adjusted R-squared	0.359360	S.D. dependent var	0.027294
S.E. of regression	0.021846	Akaike info criterion	-4.758369
Sum squared resid	0.017181	Schwarz criterion	-4.672180
Log likelihood	92.40901	Hannan-Quinn criterion	-4.727703
F-statistic	21.75472	Durbin-Watson stat	1.774365
Prob(F-statistic)	0.000042		

Table 8: Stationary of FDI (First difference)

Null Hypothesis: D(LFDI) has a Unit Root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.967537	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LFDI,2)
Method: Least Squares
Sample (adjusted): 1973 2010
Included observations: 38 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
D(LFDI(-1))	-1.275535	0.127969	-9.967537	0.0000
C	0.079007	0.042834	1.844491	0.0734

R-squared	0.734026	Mean dependent var	-0.034074
Adjusted R-squared	0.726638	S.D. dependent var	0.486990
S.E. of regression	0.254618	Akaike info criterion	0.153091
Sum squared resid	2.333892	Schwarz criterion	0.239280
Log likelihood	-0.908736	Hannan-Quinn criterion	0.183757
F-statistic	99.35180	Durbin-Watson stat	1.803831
Prob(F-statistic)	0.000000		

Table 9: Stationary of GDP (First difference)

Null Hypothesis: D(LGDP) has a Unit Root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.475245	0.0001
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Dependent Variable: D(LGDP,2)
Method: Least Squares
Sample (adjusted): 1973 2010
Included observations: 38 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP(-1))	-0.866787	0.158310	-5.475245	0.0000
C	0.029502	0.009440	3.125247	0.0035

R-squared	0.454366	Mean dependent var	0.002503
Adjusted R-squared	0.439210	S.D. dependent var	0.066261
S.E. of regression	0.049621	Akaike info criterion	-3.117628
Sum squared resid	0.088639	Schwarz criterion	-3.031439
Log likelihood	61.23493	Hannan-Quinn criterion	-3.086963
F-statistic	29.97831	Durbin-Watson stat	1.918459
Prob(F-statistic)	0.000003		

Table 10: Johansen Co-integration Test

Sample (adjusted): 1973 2010
Included observations: 38 after adjustments
Trend assumption: Linear deterministic trend
Series: LCPI LEPC LFDI LGDP
Lags interval (in first differences): 1 to 1
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigen Value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.660486	68.48349	47.85613	0.0002
At most 1	0.403336	27.43433	29.79707	0.0914
At most 2	0.140894	7.811081	15.49471	0.4858
At most 3	0.052276	2.040308	3.841466	0.1532

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigen Value	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.660486	41.04916	27.58434	0.0005
At most 1	0.403336	19.62325	21.13162	0.0802
At most 2	0.140894	5.770774	14.26460	0.6428
At most 3	0.052276	2.040308	3.841466	0.1532

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LCPI	LEPC	LFDI	LGDP
-16.56518	9.026276	-5.140576	18.96462
5.122762	5.587600	-5.140236	1.777221
-11.59400	6.013831	-0.465962	9.996214
7.157013	-13.13087	-2.844309	13.19542

Unrestricted Adjustment Coefficients (alpha):				
D(LCPI)	0.003771	-0.004054	0.001260	-0.002901
D(LEPC)	0.010750	-0.002140	-0.005583	0.000826
D(LFDI)	0.067780	0.098680	-0.022566	-0.026569
D(LGDP)	-0.018060	0.005297	-0.008830	-0.003814

1 Cointegrating Equation(s):		Log likelihood	298.9051
Normalized cointegrating coefficients (standard error in parentheses)			
LCPI	LEPC	LFDI	LGDP
1.000000	-0.544895	0.310324	-1.144848
	(0.09517)	(0.05786)	(0.15636)
Adjustment coefficients (standard error in parentheses)			
D(LCPI)	-0.062467		
	(0.04346)		
D(LEPC)	-0.178076		
	(0.05114)		
D(LFDI)	-1.122795		
	(0.61161)		
D(LGDP)	0.299159		
	(0.09574)		

2 Cointegrating Equation(s):		Log likelihood	308.7167
Normalized cointegrating coefficients (standard error in parentheses)			
LCPI	LEPC	LFDI	LGDP
1.000000	0.000000	-0.127333	-0.647879
		(0.11115)	(0.26611)
0.000000	1.000000	-0.803196	0.912047
		(0.19478)	(0.46634)
Adjustment coefficients (standard error in parentheses)			
D(LCPI)	-0.083234	0.011387	
	(0.04376)	(0.02679)	
D(LEPC)	-0.189038	0.085075	
	(0.05313)	(0.03253)	
D(LFDI)	-0.617281	1.163189	
	(0.56423)	(0.34544)	
D(LGDP)	0.326295	-0.133412	

	(0.09889)	(0.06054)		
3 Cointegrating Equation(s):		Log likelihood	311.6021	
Normalized cointegrating coefficients (standard error in parentheses)				
LCPI	LEPC	LFDI	LGDP	
1.000000	0.000000	0.000000	-0.780157	
			(0.08441)	
0.000000	1.000000	0.000000	0.077656	
			(0.41562)	
0.000000	0.000000	1.000000	-1.038838	
			(0.50818)	
Adjustment coefficients (standard error in parentheses)				
D(LCPI)	-0.097840	0.018963	0.000865	
	(0.05244)	(0.03067)	(0.01831)	
D(LEPC)	-0.124314	0.051502	-0.041660	
	(0.06050)	(0.03539)	(0.02113)	
D(LFDI)	-0.355656	1.027484	-0.845154	
	(0.67362)	(0.39403)	(0.23525)	
D(LGDP)	0.428673	-0.186515	0.069722	
	(0.11442)	(0.06693)	(0.03996)	

Table 11: Error Correction Model

Method: Least Squares
Sample (adjusted): 1974 2010
Included observations: 37 after adjustments
D(LEPC) = C(1)*(LEPC(-1) - 2.49447401645*LCPI(-1) - 0.752895684373
*LFDI(-1) + 2.85032385384*LGDP(-1) - 30.5491771542) + C(2)
*D(LEPC(-1)) + C(3)*D(LEPC(-2)) + C(4)*D(LCPI(-1)) + C(5)*D(LCPI(
-2)) + C(6)*D(LFDI(-1)) + C(7)*D(LFDI(-2)) + C(8)*D(LGDP(-1)) + C(9)
*D(LGDP(-2)) + C(10)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.101686	0.017499	5.810984	0.0000
C(2)	-0.415330	0.170510	-2.435814	0.0217
C(3)	-0.477530	0.158701	-3.008991	0.0056
C(4)	-0.042199	0.164693	-0.256226	0.7997
C(5)	-0.350833	0.173053	-2.027318	0.0526
C(6)	0.052128	0.015989	3.260230	0.0030
C(7)	0.017103	0.010672	1.602594	0.1207

C(8)	-0.002219	0.071258	-0.031144	0.9754
C(9)	-0.120880	0.064439	-1.875886	0.0715
C(10)	0.070256	0.010651	6.596320	0.0000

R-squared	0.647871	Mean dependent var	0.028923
Adjusted R-squared	0.530494	S.D. dependent var	0.021895
S.E. of regression	0.015002	Akaike info criterion	-5.335776
Sum squared resid	0.006077	Schwarz criterion	-4.900393
Log likelihood	108.7119	Hannan-Quinn criterion	-5.182283
F-statistic	5.519596	Durbin-Watson stat	2.353896
Prob(F-statistic)	0.000252		

Table 12: Wald Test

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	3.625836	(6, 27)	0.0091
Chi-square	21.75502	6	0.0013

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	-0.042199	0.164693
C(5)	-0.350833	0.173053
C(6)	0.052128	0.015989
C(7)	0.017103	0.010672
C(8)	-0.002219	0.071258
C(9)	-0.120880	0.064439

Restrictions are linear in coefficients.

Table 13: Granger Causality Test

Pairwise Granger Causality Tests
Sample: 1971 2010
Lags: 6

Null Hypothesis:	Obs	F-Statistic	Prob.
CPI does not Granger Cause EPC	34	7.54344	0.0002
EPC does not Granger Cause CPI		4.70901	0.0035
FDI does not Granger Cause EPC	34	3.21248	0.0213
EPC does not Granger Cause FDI		4.40385	0.0049
GDP does not Granger Cause EPC	34	2.41129	0.0625
EPC does not Granger Cause GDP		5.30499	0.0018

References

1. Adnan, Q. M. and Riaz, S. (2008). Causality between energy consumption and economic growth: The case of Pakistan. *The Labor Journal of Economics*, **13(2)**, 45-48.
2. Aqeel, A. and Butt, M. S. (2001). The relationship between energy consumption and economic growth in Pakistan. *Asia-Pacific Development Journal*, **8(2)**, 101-110.
3. Bekhet, H. A. and Salwati, N. (2011). Causality analysis among electricity consumption, consumer expenditure, GDP and FDI: A case study of Malaysia. *Journal of Economics and International Finance*, **3(4)**, 228-235.
4. Consulate General of Switzerland in Karachi. (2011). *Pakistan Power Sector.*
5. Dickey, D. A. and Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive time series with a Unit Root. *Journal of the American Statistical Association*, **74**, 427–431.
6. Emeka, E. E. (2010). Causality analysis of Nigerian electricity consumption and economic growth. *Journal of Economics and Engineering*, **4**, 80-85
7. Hossain, M. S. and Saeki, C. (2011). Does electricity consumption panel Granger cause economic growth in South Asia? Evidence from Bangladesh, India, Iran, Nepal, Pakistan and Sri-Lanka. *European Journal of Social Sciences*, **25(3)**, 316-328.
8. Imran, K. and Siddique, M. M. (2010). Energy consumption and economic growth: A case study of three SAARC countries. *European Journal of Social Sciences*, **16(2)**, 206-213.

9. International Energy Agency. (2006). *World Energy Outlook*. Paris.
10. Kiran, B. and Guris, B. (2009). Relationship between electricity consumption and GDP in Turkey. *Problems and Perspectives in Management*, **7(1)**, 166-171.
11. MacKinnon, J. G. (1996). Numerical Distribution Functions for Unit Root and Cointegration Tests. *Journal of Applied Econometrics*, **11**, 601-618.
12. MacKinnon, J. G., Haug, A. A. and Michelis, L. (1999). Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration. *Journal of Applied Econometrics*, **14**, 563-577.
13. Noor, S. and Siddiqi, M. W. (2010). Energy consumption and economic growth in South Asian countries: A Co-integrated Panel Analysis. *International Journal of Human and Social Sciences*, **43**, 196-201.
14. Romer, Paul M. (1986) Increasing returns and long-run growth. *Journal of Political Economy*, **94(5)**, 1002–1037.
15. Saleem, M. (2007). Bench-marking and regulation for the electricity distribution sector in Pakistan: Lessons for Dveloping Countries. *South Asia Economic Journal*, **8**, 117-138.
16. Sami, J. and Makun, K. K. (2011). The relationship between exports, electricity consumption and economic growth. *World Review of Business Research*, **1**, 28-37.
17. Shahbaz, M. and Feridum, M. (2012). Electricity consumption and economic growth: Empirical evidence from economic growth. *Quality and Quantity*, **46**, 1583-1599.
18. Wolde-Rufale, Y. (2006). Electricity consumption and economic growth: A time series experience for 17 African countries. *Energy Policy*, **34**, 1106-1114.