Journal of Economics and Sustainable Development www.iiste.org
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.4, No.5, 2013

Energy Input, Price and Industrial Output in Pakistan: A Cointegration Approach

Ahmar Qasim Qazi[1*] Zhao Yulin[2]

[12]School of Economics, Wuhan University of Technology 122 Luoshi Road, Wuhan, 430070 P. R. China

* E-mail of the corresponding author: ahmer_qazi@yahoo.com

Abstract

The study has utilized the Johansen Method of Cointegration in order to examine the relationship between the disaggregate energy consumption and the industrial output. The oil, gas, coal and electricity consumption variables have been selected for the disaggregate energy consumption. The result confirms the positive effect of disaggregate energy consumption on the industrial output. Furthermore, bidirectional causality has been identified in case of oil consumption, whereas, unidirectional causality running from electricity consumption to the industrial output is also seen. Moreover, unidirectional causality has been observed from the industrial output to the coal consumption, though there is no such causality occurs between the gas consumption and output. The adamant adherence to the conservative energy policies could prove harmful to the industrial production. Therefore, the government has to develop the innovative energy policies in order to cope with the immediate and future energy demands. Additionally, the government must seriously explore the possibilities of using the alternative energy sources such as solar and wind in order to boost up the clean industrial growth as well as meet the required energy demand of this sector.

Keywords: Energy Consumption, Output, Johansen Cointegration Test

1. Introduction

The level of industrial output is determined by the availability and efficient utilization of energy resources along with the labor and capital inputs. It has been observed that the industrial demand for energy has moderately been different across the states, depending upon scale and combination of economic activity and the technological advancement, besides the other factors. Furthermore, energy is required for the industrial sector so as to carry out different types of activities, such as lighting, processing and assembling etcetera. Consequently, the industrial sector is profoundly dependent on energy in the form of oil, natural gas, coal and the secondary source, electricity. Realizing the significant role which the energy consumption play in the production process, the researchers undertook upon themselves the necessity to indentify the causal relationship between the energy consumption at the aggregate as well as at disaggregate levels and the output growth.

The energy use in Pakistan, a developing economy, is distributed mainly among four different sectors namely, industry, transportation, households and commercial. From these consumers, the industrial sector is the largest energy user, consuming around 40% of the total energy consumption (Pakistan Energy Year Book 2009). At the disaggregate consumption level, the sector has been fulfilling its energy requirements mainly from gas and oil sources. The energy consumption in the industrial sector has gradually been declining for the last several years. Figure-1 exhibits the annual growth rate in percentage of disaggregate energy sources consumed by the industrial sector. The energy consumption growth rate is consistently dropping from around 20% in 2005 to -2.64% in 2008 for the gas consumption, which is the largest energy source to the industries. The second highest source of energy for industries has been the oil consumption that too has sharply gone down from 10% in 2005 to -33% in 2007. During that period the industries substituted coal for oil which fact is incorporated in Figure-1. Moreover, the least demanded energy source for industry i.e. electricity, has also been showing downward turn from positive to negative growth.

Consequently, inadequate energy supply has been a stern restriction for the industrial growth in Pakistan. The adverse after effects of energy shortage could easily be seen in the subsequent years. The large-scale manufacturing annual growth rate dropped from 18.8% in 2004-05 to -8.2% in 2008-09 (Economic Survey of Pakistan 2009-10). An almost similar trend is witnessed in most of the small-scale manufacturing industries.

The industrial sector is contributing significantly towards the growth of economy and Pakistan. This sector alone contributes around 26% to GDP (CIA World Fatbook-2010) and employs almost 20% of the total labor force of the country (CIA World Factbook-2010). The current energy crisis has greatly deteriorated the industrial sector as a result thereof thousands of the industrial units have come to a standstill and hundred thousands of workers are rendered jobless. The industrial sector has still an enormous capacity and potential to contribute to the economy at a higher level and to absorb more labor force, provided it gets through the socio-economic problems, such as energy shortages and political instability.

Keeping in mind the above mentioned facts, it is essential to conduct a study, particularly for the relationship between industrial growths and disaggregate energy sources for Pakistan, so that reliable implications could be drawn in order to formulate rationale endurable energy policies aiming at favorable and clean industrial growth. The previous studies on this relationship have failed to appreciate the individual energy consuming sector dependency on the use of different energy sources. The energy conservative policies for the country would not deliver the same effect in the growth of each sector of economy, as each sector has its own disaggregated energy requirements. The study is the first (to best of my knowledge) to analyze the linkage between the industrial growth and disaggregate energy use in the case of Pakistan. Previous studies on this subject were made at the aggregate level of the economy (see Aqeel and Butt, 2001; Zahid 2008; Jamil and Ahmed 2010; and Shahbaz and Lean 2012). The use of aggregate data would hardly be useful for effectively distinguishing between the particular energy impacts on the output as well as the dependency of different energy resources of a particular country (Ramazan et al. 2008 and Yang 2000).

The remainder of the paper is organized as follows: Section 2 provides a short review of the literature, Section 3 introduces the methodology and data, Section 4 discusses and analyzes the results and the last Section 5 concludes the study with recommendations.

2. Brief Literature Review

The direction of relationship between the energy consumption and income has been the topic of enquiry after the pioneer works of Kraft and Kraft (1978) who conducted the study by utilizing data from 1947 to 1974 for the US economy and found causality from income to energy use. Since then, plenty of researches have been carried out by adopting different methods and techniques on the topic and obtained mix results. The reasons for mix results could be found in the differences in the availability of energy resources, infrastructure and the structure of the economies in the countries studied.

In subsequent years, Sims and Granger causality tests were extensively used to examine the energy consumption and income relationship. Among them Akarca and Long (1980) who suggested that the US is uncertain with respect to the causal relationship, later on Yu and Hwang (1984) cleared the uncertainty with the non existence of causal relationship between energy consumption and GNP in the US economy by using updated data from 1947-1979. Yu and Choi (1985) extended the previous research of Yu and Hwang (1984) by international assessment and comparison about five countries that were in numerous phases of development and utilizing disaggregate energy categories (i.e. solid fuels, liquid fuels, natural gas) and they found that the relationship between energy and GNP differs among countries and the causality was very sensitive to the sample choice. They didn’t find causality for the US, UK and Poland but obtained unidirectional causality from GNP to energy use for South Korea and contrary for the Philippines. Afterwards Erol and Yu (1987) examined the similar relationship for the industrialized nations and found causality from real income to energy for Japan and Italy and from energy consumption to real income for West Germany. The unidirectional causality from GNP to energy consumption was observed for the US at the fourth year lag by Abosedra and Baghestani (1989).

The previous researches faced criticism over the problem of unit root in the time series data and the tests didn’t permit a straight test for the relative descriptive strength of the neoclassical models. As a result, the succeeding studies employed bivariate, trivariate and multivariate cointegrating vectors and Granger causality tests based on dynamic error correction model (VECM). Stern (1993) investigated the relationship under the Vector Autoregression (VAR) environment but he couldn't find any evidence that the energy consumption Granger causes GDP by using USA data from 1947-1990 and later Stern (2000), reconfirmed his previous research by taking the USA post-war period and found similar results for energy and output relationship. The following studies are based on VECM. Masih and Masih (1996) used data 1955-1990 and obtained unidirectional causality running from energy to income for India and exactly opposed for Indonesia and bidirectional causality for Pakistan. Glasure and Lee (1997) obtained bidirectional causality for Singapore and South Korea by using data 1961–1990. Masih and Masih (1998) utilized data 1955–1991and found causality running from energy to income for Srilanka and Thailand. Asafu-Adjaye (2000) employed data 1973–1995 and found bidirectional causality for Thailand and Philippines and one way causality from energy to income for India and Indonesia. Hondroyiannis et al. (2002) obtained bidirectional causality for Greece by using data 1960-1996. Soytas and Sari (2003) used data 1950–1992 and found bidirectional causality for Argentina and unidirectional causality from energy to income for Turkey and contrary for South Korea. Ghali and El-Sakka (2004) discovered bidirectional causality for Canada by using data 1961-1997, and Oh and Lee (2004) used data 1970–1999 and identified bidirectional causality for South Korea.

Keeping in mind the heterogeneous characteristics of countries, Lee (2005) and Al-Iriani (2006) used panel based cointegration and vector error correction model in order to investigate relationship. The former study conducted for 18 developing countries for the period 1975 to 2001 and observed unidirectional causality running from energy to GDP and in latter study just opposite result was obtained for Gulf Cooperation countries by using 1971–2002 data.

As regards Pakistan, countable empirical researches were conducted at aggregate and disaggregate level. At the aggregate level, Alam and Butt (2002) and Qazi and Riaz (2008) found bidirectional causality between the energy consumption and income. At the time, when a study was conducted for South Asian economies, unidirectional causality running from energy consumption to growth was evidenced by Khan and Qayyum (2007) for Pakistan. Aqeel and Butt (2001) conducted a study at the disaggregate energy consumption level to identify the causality between economic growth and disaggregate energy consumption and found unidirectional causality from electricity to growth and economic growth to petroleum consumption. Furthermore, they did not find any causality between gas consumption and economic growth. Zahid (2002) studied the relationship in South Asian countries and found causality running from coal consumption to economic growth and from economic growth to electricity consumption which is quite opposite to the findings of Aqeel and Butt (2001) for Pakistan. Jamil and Ahmed (2010) found the causality running from economic growth to electricity consumption whereas bidirectional causality was obtained in electricity and economic growth by the Shahbaz & Lean (2012) with some specification changes.

3. Data and Methodology

The annual data has been collected for the period 1972–2010 from different reliable sources. The industrial output is represented by the value added (INTVA) at the constant 2002 US $ obtained from the World Bank data indicators. The price variable is selected to be included in the model specification due to the two considerably significant reasons. Firstly, prices perform significant function in the level of effective performance of the economy and secondly, the energy consumption and demand level is determined through prices. The data on energy prices is not easily available therefore Consumer Price index (CPI) is used as a proxy to energy prices. It is reasonable to use CPI on account of energy prices in Pakistan because energy items are significant part of the consumer basket so the rise in the energy prices could be instinct indication in the rise in the CPI. Furthermore, the problem of proportionality in energy prices and CPI would not be significant in context of Pakistan as the country has active price regulatory authorities which play their role for check and balance on proportionality. The employment rate (EMP) is used to represent employed labor force that is obtained from the World Bank data indicators. Oil in tons (OIL), gas in mm cft (GAS), electricity in Gwh (ELE) and coal in 000 metric tons (COL) are used as disaggregate energy consumption variables and are collected from the different published economic surveys of Pakistan. All data are converted into logarithm forms and adjusted by season.

The study employs the Johansen Maximum Likelihood approach (Johansen 1988; Johansen and Juselius 1990, 1992) to establish the statistical relationship between the variables. The technique has numerous advantages such as, the Johansen (ML) procedure allows us to obtain the multiple cointegrating relationships, whereas all the tests are based on the maximum eigenvalue test and trace statistics test. Besides identifying the long-run association between the variables, the test also provides the long-run coefficients of the variables. Moreover, the test is based on the VAR (Vector Autoregressive) approach to cointegration in which all variables are considered to be endogenous that prevents the unfair selection of dependent variable. The outcome of the Johansen cointegration test is sensitive to the selection of the optimal lags used in the model, therefore Akaike Information Criterion (AIC) is adopted in the model selection.

Once the long-run association has been established through the Johansen (ML) approach, it is equally important to measure the short-run coefficients as well as the direction of causality between the variables. This requires the application of Vector Error Correction Models (VECMs) which are also known as restricted VAR models. In VECM all variables in the system are considered to be endogenous variables, same as in the unrestricted VAR environment, so the number of equations becomes equal to the number of variables. In our study VECMs could be written as follows:

$$\Delta LINTVA_t = \alpha_1 + \sum_{i=1}^{p} \gamma_{1i} \, \Delta LINTVA_{t-i} + \sum_{i=1}^{h} \gamma_{1i} \, \Delta LEMP_{t-i} + \sum_{i=1}^{z} \gamma_{1i} \, \Delta LCPI_{t-i} + \sum_{i=1}^{r} \gamma_{1i} \, \Delta LEN_{t-i} + \lambda_1 ECT_{t-1} + u_{1t} \quad \ldots\ldots (1)$$

$$\Delta LEN_t = \alpha_2 + \sum_{i=1}^{p} \gamma_{2i} \, \Delta LEN_{t-i} + \sum_{i=1}^{h} \gamma_{2i} \, \Delta LEMP_{t-i} + \sum_{i=1}^{z} \gamma_{2i} \, \Delta LCPI_{t-i} + \sum_{i=1}^{r} \gamma_{2i} \, \Delta LINTVA_{t-i} + \lambda_2 ECT_{t-1} + u_{2t} \quad \ldots. (2)$$

$$\Delta EMP_t = \alpha_3 + \sum_{i=1}^{p} \gamma_{3i} \, \Delta LINTVA_{t-i} + \sum_{i=1}^{h} \gamma_{3i} \, \Delta LEMP_{t-i} + \sum_{i=1}^{z} \gamma_{3i} \, \Delta LCPI_{t-i} + \sum_{i=1}^{r} \gamma_{3i} \, \Delta LEN_{t-i} + \lambda_3 ECT_{t-1} + u_{3t} \quad \ldots\ldots (3)$$

$$\Delta CPI_t = \alpha_4 + \sum_{i=1}^{p} \gamma_{4i} \, \Delta LINTVA_{t-i} + \sum_{i=1}^{h} \gamma_{4i} \, \Delta LEMP_{t-i} + \sum_{i=1}^{z} \gamma_{4i} \, \Delta LCPI_{t-i} + \sum_{i=1}^{r} \gamma_{4i} \, \Delta LEN_{t-i} + \lambda_4 ECT_{t-1} + u_{4t} \quad \ldots\ldots (4)$$

Where, EN represents the particular disaggregate energy variable under consideration and u_{it} are the normally distributed error terms. ECT_{t-1} in the equations represent the Error Correction term and its coefficient measures move away from the long-run equilibrium. The statistically significance of the ECT_{t-1} suggests the existence of long-run relationship among the variables.
At last, the direction of causality has been indentified for the cointegrating variables under the VECM. The VECM allows us to observe the causality by implying the joint significance of the lagged terms for each of the variables in the equations. Furthermore, joint short and long run causality measured through the joint significance of the ECT_{t-1} and lagged terms of each of the variables.

4. Empirical Results and Discussion

The first and foremost thing to do is to determine whether the series of variables are stationary or not. The regression is said to be spurious or meaningless in the presence of the unit root in the series. The cointegration test applies only when the variables have the same order of integration. Therefore, the study follows the Augmented Dickey Fuller (ADF, 1979) and Philips-Perron (PP, 1988) tests in order to determine the level of integration among the variables. Table-1 shows the results of unit root in the series. The said tests have confirmed that all the series of variables become stationary after the first difference. It also means that all the variables have same order of integration that is I(1).

The next step that follows after the ascertainment of the order of integration, is an application of Johansen

Cointegration test. The study follows two tests statistics developed by the Johansen (1988) and Johansen & Juselius (1990). The one is Trace Test and the other is Maximal Eigenvalue Test. Both these tests are conducted to find out the cointegrating vectors in an equation. The Trace Test is applied on the null hypothesis that is the number of cointegrating vectors are less than or equal to r, against the alternative hypothesis that there are more than r cointegrated vectors. Whereas, the Maximal Eigenvalue test is conducted under the null hypothesis of r cointegrating vectors present against the alternative hypothesis that there are r+1 cointegrating vectors present. The result obtained through the Johansen Cointegration Test would be very delicate as to the selection of lags in the model. Therefore, we employ the Akaike Information Criterion (AIC) under the VAR environment system to select the optimal lag length used in the model. The AIC confirmed the optimal lag length that is two. Table-2 exhibits the results of Trace Statistics and Maximal Eigenvalue which confirm that the variables have the unique long run association.

Once the long run relationship is established, we could subsequently make analysis of the result of estimated coefficients of the long run. Table-3 shows the long run coefficients which we could interpret as elasticities because the estimated model is in log linear form. The result shows that the disaggregate energy variables and employment level significantly affects the industrial value added in the long run. The coefficients of LOIL and LCOL are the same that is 0.21 which suggests that 1% rise in the consumption of Oil and Coal in an industrial sector would lead to 0.21% rise in the value added output. The contribution made by the consumption of gas is the highest among the other energy sources, the coefficient of LGAS is 0.57, it means 1% rise in the gas consumption causes 0.57% rise in the output level. At the end, 1% rise in electricity consumption leads, on average 0.05% rise in the industrial output. The result confirms that the deteriorating performance of the manufacturing sector (at the Large and Small Scale) would face acute shortage of the needed energy (Pakistan Economic Survey, 2010-11).

Table-4 exhibits the short run results based on the VECM. The result suggests that the electricity consumption and the use of oil products significantly affect the industrial output in the short run, as well. There has been considerable decrease in the oil consumption in the industrial sector (Pakistan Energy Yearbook, 2009) because of high oil prices and the availability of gas as a cheap alternative energy source. But in our results still the oil products could significantly influence the level of industrial output. Secondly, the 30.2% electricity is consumed by the industrial sector (Pakistan Energy Yearbook, 2009) which is sufficient indicator to confirm our result that the electricity consumption has short run significant effect on the industrial output. The statistically significant aspect of the negative sign of the coefficient of the error correction term indicates the long run association among the variables.

Furthermore, the coefficient of ecm(-1) is -0.35 which shows that when the industrial output would be in disequilibrium, it gets adjusted by 35% in the first of year. It can be concluded that the process of adjustment to the equilibrium is significantly quick enough to respond to any shock to the industrial value added equation.

The diagnostic tests are also conducted for the model which is presented at the bottom of the table-5. The result shows that we can't reject the null hypothesis of residuals are not serially correlated, residuals are normally distributed, residuals are homoscedastic, there is no arch effect and model is well specified. The R-squared is reasonably high to confirm the goodness of the model to be fit. At last, to check the stability of the model, we employ the cumulative sum of the residual and cumulative sum of square of the residual methods, the results presented in figure-2 and 3 confirm the stability of the coefficients since the plotted residuals are within the critical bounds at 5% level of significance.

The analyst and, more importantly, the policy makers are concerned about the direction of causality presented between the variables. In this regard, Table 5 exhibits the results of short run causality test based on the VECM. The results are obtained through the Wald Test of joint significance of the variables. The F-statistics show the presence of bidirectional causality between oil consumption and industrial output, whereas unidirectional causality running from electricity consumption to industrial output is obtained which is similar to the result of Aqeel and Butt (2001). The joint significance test is also applied by combining all disaggregate energy sources and confirms the unidirectional causality from energy usage to industrial output growth that is consistent with the Khan and Qayyum (2007). The results also identify the one way causality from output to coal consumption that is quite opposite to the Zahid (2002). This result concerns the Cement and Brick Kiln Industries because their combined coal consumption is about 80% of the total coal usage (Pakistan Energy Yearbook, 2009). There is no surprise to identify the causality from oil consumption to CPI; the rising oil import bill would significantly contribute to the domestic inflation.

Table-6 shows the joint short and long run causality results. It is observed that in industrial output equation; disaggregate energy variables, employment and CPI all are statistically significant combine with the error correction term. It is interesting to note that all disaggregate energy consumption significantly causes to the inflation of a country in combine short and long run. Furthermore, industrial output and employment are also play a significant role to cause the CPI. The unidirectional causality is identified from output to coal consumption in combine short and long run causality.

5. Conclusion

The energy shortage is one of the main reasons of the downturn of the industrial sector of Pakistan, particularly in the large-scale manufacturing. As a result, plenty of small-scale industries are shut down and many of large-scale industries are moving out of Pakistan. In this regard, the current study is about the relationship between the disaggregate energy consumption and the industrial output. The time series analysis is conducted for the period 1972–2010.

We have employed the Johansen cointegration test in order to realize the long-run relationship between the variables. The long-run estimated coefficients of disaggregate energy consumption are significant and positively affected to the industrial output. On the other hand, VECM is employed to obtain the short-run coefficients in which the oil and electricity consumption are found to be statistically significant. Furthermore, model proposed that the disequilibrium gets adjusted by 35% from last year to current year.

The causal tests based on VECM suggest bidirectional causality between the output and oil, whereas unidirectional causality has been identified which runs from electricity consumption to industrial output. At the aggregate level, one way causality is obtained that is from energy to industrial output. As a result, it is concluded that the energy conservative policies with respect to oil and electricity consumptions as well as at aggregate energy level would significantly affect the industrial growth. These findings deliver the positive signals to the policy makers in Pakistan to put timely efforts on the development of renewable energy sector. The alternative energy sources (solar and wind etc) would not only effectively respond to the rising energy demands of the industrial sector but at the same time would avert the ecological degradation.

At last, the short run unidirectional causality running from oil consumption to the CPI is observed. As Pakistan is highly dependent on the import of oil products therefore, it is recommended that government should reasonably revise the tariffs and quotas in order to discourage the imported oil and at the same time should encourage other energy sources besides oil by providing subsidies.

Acknowledgment: An earlier version of this paper was presented as a discussion paper No. 2012-29 for an open assessment at the Economics e-journal of Kiel Institute of World Economy.

References

Abosedra, S., Baghestani, H. (1989). New evidence on the causal relationship between United States energy consumption and gross national product. Journal of Energy and Development 14, 285–292

Akarca, A.T., Long, T.V. (1980) On the relationship between energy and GNP: a reexamination Journal of Energy and Development 5, 326–331

Altinay, G., Karagol, E. (2004) Structural break, unit root, and the causality between energy consumption and GDP in Turkey. Energy Economics 26, 985–994.

Alam S, Butt MS (2002) Causality between energy consumption and economic growth in Pakistan: an application of cointegration and error correction modeling techniques. Pacific and Asian Journal of Energy 12:151–165.

Asafu-Adjaye, J. (2000) The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. Energy Economics 22, 615–625

Aqeel A, Butt MS (2001) The Relationship between energy consumption and economic growth in Pakistan. Asia-Pacific Development Journal 8:101–10

CIA World Factbook

Chishti, S., and Fakhre Mahmud, (1990) The demand for energy in the large-scale manufacturing sector of Pakistan, Energy Economics, 12, pp. 251–254

DeVita,G., Endressen, K.,Hunt, L.C. (2006) An empirical analysis of energy demand in Namibia Energy Policy 34, 3447–3463

Dickey, D.A., Fuller, W.A. (1979) Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Society 75, 427–431

Erbaykal E. (2008) Disaggregate energy consumption and economic growth: evidence from Turkey. International Research Journal of Finance and Economics 20:172–179

Elliott, G., Rothenberg, T.J., Stock, J.H. (1996) Efficient tests for an autoregressive unit root. Econometrica 64, 813–836.

Engle, R., Granger, C. (1987) Co-integration and error correction: representation, estimation, and testing. Econometrica 55, 251–276

Erol, U., Yu, E.S.H. (1987) On the causal relationship between energy and income for industrialized countries. Journal of Energy and Development 13, 113–122

Ewing, B.T., Sari, R., Soytas, U. (2007) Disaggregate energy consumption and industrial output in the United States. Energy Policy 35, 1274–1281

Ghali, K.H., El-Sakka, M.I.T. (2004) Energy use and output growth in Canada: a multivariate cointegration analysis. Energy Economics 26, 225–238

Hondroyiannis G, Lolos S, Papapetrou E (2002) Energy consumption and economic growth: assessing the evidence from Greece, Energy Economics 24, 319_336.

Hwang, D.B.K., Gum, B. (1992) The causal relationship between energy and GNP: the case of Taiwan. The Journal of Energy and Development 16, 219–226

Johansen, S. (1988) Statistical analysis of cointegrating vectors. Journal of Economic Dynamics and Control 12, 231–254

Johansen, S. (1991) Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. Econometrica 59, 1551–1580.

Johansen, S. Juselius, K. (1990) Maximum likelihood estimation and inference on cointegration: with application to the demand for money. Oxford Bulletin of Economics and Statistics 52, 169–210

Khan AM, Ahmed U. (2009) Energy demand in Pakistan: a disaggregate analysis. The Pakistan Development Review; 47:347–455.

Khan AM, Qayyum A. (2007) Dynamic modeling of energy and growth in South Asia. The Pakistan Development Review 46:481–498.

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

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., Shin, Y. (1992) Testing the null hypothesis of stationary against the alternative of a unit root. Journal of Econometrics 54, 159–178.

Lee, C.C. (2005) Energy consumption and GDP in developing countries: a cointegrated panel analysis. Energy Economics 27, 415–427.

Lee, C.C. (2006) The causality relationship between energy consumption and GDP in G-11countries revisited. Energy Policy 34, 1086–1093.

Maddala, G.S., Kim, I. (1998) Unit roots, cointegration, and structural change. Cambridge University Press, Cambridge

Masih, A., Masih, R. (1996) Energy consumption, real income and temporal causality: Results from a multi-country study based on cointegration and error-correction modeling techniques. Energy Economics 18, 165–183

Ministry of Finance and Economic Affairs (various issues). Pakistan Economic Survey, Government of Pakistan

Ministry of Petroleum and Natural Resources (various issues). Energy Year Book. Government of Pakistan

Narayan, P.K., Smyth, R. (2005) Electricity consumption, employment and real income in Australia: evidence from multivariate Granger causality tests. Energy Policy 33, 1109–1116.

Ng, S., Perron, P. (2001) Lag length selection and the construction of unit root tests with good size and power. Econometrica 69, 1519–1554

Phillips, P.C.B., Perron, P. (1988) Testing for a unit root in time series regressions. Biometrica 75, 335–346.

Qazi MAH, Riaz S. (2008) Causality between energy consumption and economic growth: the case of Pakistan. The Lahore Journal of Economics 2008;13:45–58.

Riaz, T, (1984) Energy consumption and economic growth, Pakistan Development Review, 23, pp. 431-53.

Sari R., Soytas, U. (2004) Disaggregate energy consumption, employment, and income in Turkey. Energy Economics 26, 335–344

Sari R, Ewing T, Soytas (2008) The relationship between disaggregate energy consumption and industrial production in the United States: An ARDL approach, Energy Economics 30, 2302–2313

Siddiqui R, Jalil HH, Nasir M, Khalid M, Malik WS (2011) The cost of unserved energy: evidence from the industrial sector of Pakistan. PIDEWorking Paper No.75

Soytas, U., Sari, R. (2003) Energy consumption and GDP: causality relationship in G-7 countries and emerging markets. Energy Economics 25, 33–37.

Stern, D.I. (1993) Energy and economic growth in the USA, a multivariate approach. Energy Economics 15, 137–150.

Stern, D.I. (2000) A multivariate cointegration analysis of the role of energy in the US economy. Energy Economics 22, 267–283.

Stock, J.H., Watson, M.W. (2003).Introduction to econometrics. Addison Wesley, Boston.

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

Yu, E.S.H., Hwang, B.K. (1984) The relationship between energy and GNP: further results. Energy Economics 6, 186–190.

Yu, E.S.H., Choi, J.Y. (1985) The causal relationship between energy and GNP: an international comparison. Journal of Energy and Development 10, 249–272.

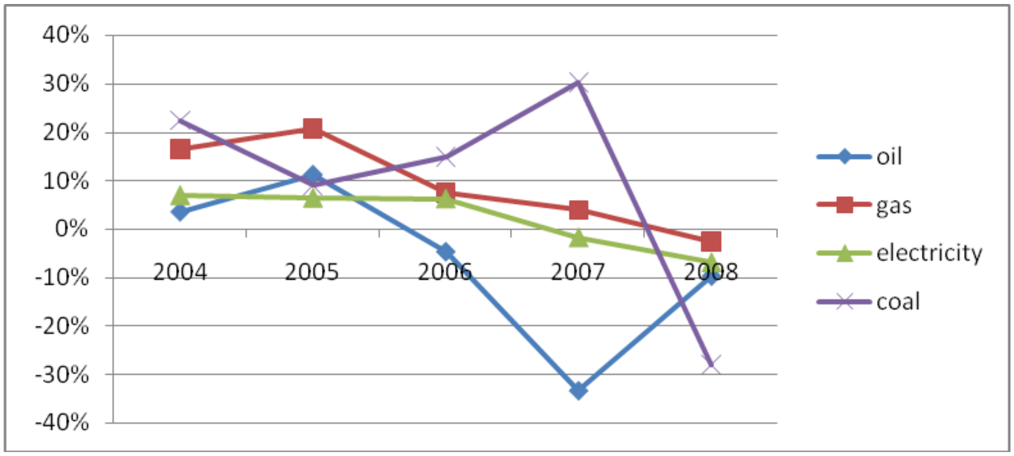
Yuan J, Kang J, Zhao C, Hu Z. (2008) Energy consumption and economic growth: evidence from China at both aggregated and disaggregated levels. Energy Economics 30:3077–3094.

Wolde-Rufael, Y. (2004) Disaggregated energy consumption and GDP, the experience of Shangai 1952–1999.Energy Economics 26, 69–75.

World bank databank.

First Author: *Ahmar Qasim Qazi* is a selected scholar from Pakistan to award Cultural Exchange Scholarship by the Pakistan-China Governments to pursue a PhD Program in the field of Industrial Economics at the Wuhan University of Technology, China. He is working on the topic "*R&D and Productivity Growth in the Hi-Tech Industry of China".* His research interests include *Industrial Productivity Growth, Efficiency, Innovation and Technological Change.*

Second Author: *Zhao Yulin* is a Professor at Wuhan University of Technology, Director of Research Center for Science and Technology Innovation and Economic Development and Director of Industrial Economy Institute. His research field covers industrial economics, innovation economics, especially focusing on the development of the hi-tech industry, technological innovation, industrial competiveness and the industrial growth mechanism. He is the author of *over 120 research papers* and *10 books.* He has been awarded several professional honors including *the State Building Material Administration Award for Young and Middle-aged Experts with Outstanding Contributions* in 1992.



Source: Pakistan Energy Year Book-2010

Figure 1: Disaggregate Energy Consumption Growth

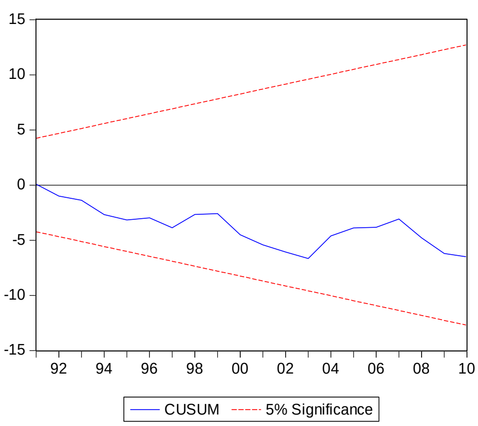


Figure 2: Cumulative sum of recursive residual

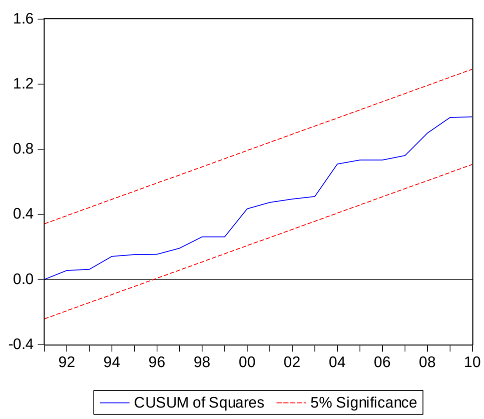


Figure 3: Cumulative sum of Square recursive residual

Table 1: Results of Unit Root Tests

Variables	ADF		PP		Integration Order
	Level	First Difference	Level	First Difference	
LINTV	-1.602795	-4.616108***	-1.44582	-4.61432***	I(1)
LEMP	-2.778589	-6.345296***	-2.79711	-6.3982***	I(1)
LCPI	-2.173726	-6.167524***	-2.15874	-6.16752***	I(1)
LOIL	-1.525963	-4.058571***	-1.48306	-4.20482***	I(1)
LGAS	-1.529622	-3.377733**	-1.45144	-2.84214**	I(1)
LELE	-0.637163	-5.854672***	-0.63716	-5.85467***	I(1)
LCOL	-0.280722	-7.082369***	-0.26664	-7.01123***	I(1)

Note: All the regressions of unit root with the Intercept term. *** and ** denote significance at the level of 1% and 5% , respectively

Table 2: Johansen Cointegration Test Results

Hypothesis	Trace Statistics	Maximum Eigen value
r = 0	168.4058***	57.83301***
r = ≤ 1	110.5728***	43.72134**
r = ≤ 2	66.85145	24.64831
r = ≤ 3	42.20314	15.52144
r = ≤ 4	26.6817	12.39947
r = ≤ 5	14.28223	9.653723
r = ≤ 6	4.628503	4.628503

*** & ** denote the rejection of null hypothesis at the level of 1% and 5%

Table 3: Long run Estimated Coefficients

Dependent variable: LINTV		
Regressors	Coefficients	t-statistic
LEMP	0.144	2.54**
LCPI	0.024	0.861
LOIL	0.206	6.47***
LGAS	0.572	5.93***
LELE	0.052	2.93*
LCOL	0.207	2.01*
INTERCEPT	11.87	17.1

***, ** and * denote significance at the level of 1%, 5% and 10%, respectively

Table 4: Estimated Short Run Coefficients

Dependent variable: Δ LINTV		
Regressors	Coefficient	t-statistic
Δ LEMP (1)	0.031	0.293
Δ LEMP (2)	0.087	0.830
Δ LCPI (1)	0.035	1.555
Δ LCPI (2)	0.002	0.186
Δ LOIL (1)	0.063	2.470**
Δ LOIL (2)	0.108	2.245**
Δ LGAS (1)	0.204	1.599
Δ LGAS (2)	-0.019	-0.10
Δ LELE (1)	0.041	2.475*
Δ LELE (2)	0.003	2.100*
Δ LCOL(1)	-0.15	-1.50
Δ LCOL (2)	-0.16	-1.79
INTERCEPT	0.071	4.000
ECM(-1)	-0.35	-2.959***
Diagnostic Test Statistic	Test- Stats	P-Value
Serial Correlation	1.440	0.6913
Normality	2.952	0.228503
Heteroskedasticity	0.761	0.5726
ARCH Test	0.0087	0.9247
Remsey	0.0002	0.9821
R-squared	0.5638	

***, ** and * denote significance at the level of 1%, 5% and 10%, respectively

Table 5: Short Run Causality Test Results based on VECM

Variable	F-stats								t-stat
	Δ INTV	Δ LEMP	Δ CPI	Δ OIL	Δ GAS	Δ ELE	Δ COL	Δ EN	ECT
Δ INTV	-	0.3640	1.336	4.098**	1.313	4.126*	1.630	4.285**	-2.953***
Δ LEMP	0.302	-	2.557	0.313	0.181	0.162	2.004	0.732	0.060
Δ CPI	0.339	0.064	-	4.789**	0.039	0.958	1.554	0.793	-2.782**
Δ OIL	2.640*	0.624	0.153	-	-	-	-	-	0.323
Δ GAS	0.677	2.259	2.836*	-	-	-	-	-	1.609
Δ ELE	0.735	0.578	0.136	-	-	-	-	-	-0.591
Δ COL	4.547**	1.195	1.199	-	-	-	-	-	3.288**

***, ** and * denote significance at the level of 1%, 5% and 10%, respectively. ECT represents the Error Correction Term

Table 6: Joint Short Run and Long Run Results (F-stat)

Variable	Δ INTV & ECT_{t-1}	Δ LEMP & ECT_{t-1}	Δ CPI & ECT_{t-1}	Δ OIL & ECT_{t-1}	Δ GAS & ECT_{t-1}	Δ ELE & ECT_{t-1}	Δ COL & ECT_{t-1}	Δ EN & ECT_{t-1}
Δ INTV	-	3.143**	3.027*	3.546**	3.103**	3.956**	4.013**	2.302*
Δ LEMP	0.207	-	2.275	0.255	0.155	0.110	1.501	0.744
Δ CPI	3.538**	2.606*	-	3.236**	3.562**	2.760*	4.480**	2.467**
Δ OIL	1.780	0.458	0.104	-		-	-	-
Δ GAS	1.014	2.318	2.451	-	-	-	-	-
Δ ELE	0.660	0.506	0.149	-	-	-	-	-
Δ COL	5.248***	2.391	1.882	-	-	-	-	-

***, ** and * denote significance at the level of 1%, 5% and 10%, respectively