

Energy Consumption and Economic Growth in South Asian Countries: A Co-integrated Panel Analysis

S. Noor and M. W. Siddiqi

Abstract—This study examines causal link between energy use and economic growth for five South Asian countries over period 1971-2006. Panel cointegration, ECM and FMOLS are applied for short and long run estimates. In short run unidirectional causality from per capita GDP to per capita energy consumption is found, but not vice versa. In long run one percent increase in per capita energy consumption tend to decrease 0.13 percent per capita GDP. *i.e.* Energy use discourage economic growth. This short and long run relationship indicate energy shortage crisis in South Asia due to increased energy use coupled with insufficient energy supply. Beside this long run estimated coefficient of error term suggest that short term adjustment to equilibrium are driven by adjustment back to long run equilibrium. Moreover, per capita energy consumption is responsive to adjustment back to equilibrium and it takes 59 years approximately. It specifies long run feedback between both variables.

Keywords—Energy consumption, Income, Panel co-integration, Causality.

I. INTRODUCTION

ENERGY is the engine of economic growth, as many production and consumption activities involve energy as basic input. On production side, conventionally, economists since Adam Smith have talked about land, labor, and capital as major inputs for economic activity. These inputs were significant ingredients of agrarian economies of 17th and 18th centuries. However, in 19th century, the growth of industrial nations has observed a fourth major input that is energy. On consumption side, in the Keynesian framework where consumption and income are significantly correlated, similarly energy consumption in all forms drives economic productivity. It leads to economic growth and prosperity which ensures expansion of the economy in terms of higher GDP and GDP per capita.

The preeminent case of the primary role of energy that it plays an important role in the economy was found in 1970s energy crisis. In 1st oil crisis OAPC restrained oil consignment to US and other countries as they supported Israel in conflict. Restricted supply got much higher prices

within few months. It inversely affected the US economy by influencing pressing demand of energy by high cost and scarcity of oil. In US alone, in 1974 GDP sharply turned down after two decades of steady growth. Moreover, at macro level economies have faced both inflationary and deflationary impacts on domestic economies [1]. Similarly, in 2nd oil crisis protests severely disrupted the Iranian oil sector and production being greatly curtailed and exports suspended. Later, oil exports were again started under the new regime. These were inconsistent and at a lower volume, which pushed up prices. It resulted in very high prices than expected under normal circumstances [2].

Therefore, the 1970s energy crisis attracted the analysts to investigate the relationship between energy consumption and economic growth, as it was argued that energy consumption directly causes GDP growth. Since the end of 1970s, many studies [3], [4], [5] have been conducted to support the arguments which suggest that energy use is highly positively correlated with GDP growth. But empirical evidence is varying and conflicting about direction of causality, whether economic growth leads to energy consumption or energy use boosts up the GDP growth.

From policy perspective, based on the direction of causality there are important policy implications. Because, the energy conservation policy may or may not be taken, depends on the direction of causality [6]. Unidirectional causality running from GDP to EC implies that income is the initial receptor of exogenous shocks and equilibrium is restored through adjustment in energy consumption. These are less energy dependent economies and energy conservation policies may be implemented without adverse effects on economic growth and employment [7]. On the other hand, if causality runs from energy consumption to GDP then it implies that the economy is energy dependent and energy consumption measures may stimulate economic growth [8]. Bidirectional causality indicates that both energy consumption and high level of economic activity mutually persuade each other. Finally, No-causality between energy consumption and economic growth referred as “neutrality hypothesis” [9] implies that energy conservation measure may pursued without affecting the economy.

South Asia is important to world energy markets as it experiencing rapid energy demand growth. The primary

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energy consumption has increase nearly 64 percent between 1992 and 2002 in south Asia. In 2002 south Asia, accounted for approximately 4.1 percent of world commercial energy consumption up from 2.8 percent in 1992 [10]. Therefore, South Asian nations are facing rapidly increasing demand for energy coupled with insufficient energy supply. They are energy-deficit countries and fighting with energy shortfalls in the form of recurrent, costly, and widespread electricity outages. Because of the economic and political effects arising from such shortfalls, improving the supply of energy, particularly the supply of electricity, is an important priority of regional governments.

To avoid energy crisis and efficient utilization of energy recourses, USAID South Asia Regional Initiative for Energy (SARI/Energy) program has been in operation since 2000. Afghanistan and Pakistan joined the SARI/Energy program in 2004. The USAID is an eight country program that promotes regional energy security through three activities areas: (1) cross border energy trade, (2) energy market formation, and (3) regional clean energy development. Through these activities, SARI/Energy facilitates more efficient regional energy resource utilization, improves the environmental impacts of energy production, and increases regional access to energy, works toward transparent and profitable energy practices. SARI/Energy countries include: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka [11].

The following sections of the paper set out literature review, model, data, empirical results and conclusion, policy implications.

II. LITERATURE REVIEW

The pioneer study by Kraft and Kraft [3] found evidence of unidirectional causality from GNP growth to energy consumption in case of the US for period 1947-1974. Yu and Choi [9], Yu and Hwang [12] and Erol and Yu[13] found no link for US economy when they used Granger method. However, Yu and Hwang [12] detected that energy consumption negatively affected employment by using Sim's techniques. Yu and Choi [9] also deducted causality from GDP to energy in Republic of Korea, reversed in the case of the Philippines.

Masih and Masih [7] found bidirectional causality in Pakistan. Aqeel and Butt [14] and Zahid [15] supported existence of unidirectional causality from GDP to energy consumption while inverse causality evidence is found by Khan and Qayyum [16]. Zahid [15] also found unidirectional causality from GDP to energy consumption for Bangladesh and SriLanka. In Case of India Asafu-Ajaye [17] and Khan and Qayyum [16] found unidirectional causality from energy consumption to income while Neutrality hypothesis is supported by Zahid [15]

Similarly, Unidirectional casualty from economic growth to energy consumption is also found by Asafu-Adjaye [17] in Philippine and Thailand, Wolde-Rafael [6] in Egypt, Gabon

and Morocco, Yoo [18] and Tang [19] in Malaysia and Apergis and Payne [20] in six Central American Countries.

There are mixed results from one study to another for individual countries and regions. Thus, this study is aimed to investigate the core relationship between per capita energy consumption and per capita GDP for five selected South Asian countries.

III. DATA AND VARIABLES

The study uses panel data consists of 5 South Asian countries (N=1....5) for the period 1971 to 2006 (T=1....31). The selected countries are Bangladesh (BGD), India (IND), Nepal (NPL), Pakistan (PAK) and SriLanka (LKA).

The variables used in the model are Gross domestic product per capita (current US \$), per capita energy use (kiloton of oil equivalent), gross fixed capital formation (current US \$) and total labor force. The data was sourced from World Development Indicators (2008) [21].

IV. MODEL SPECIFICATION

The following multifactor neoclassical production function framework proposed by Ghali and El-Sakka [22] is used to find out the relation between different factors of production (including energy) and output:

$$\ln GDP = f \{ \ln (EC, K, L) \} \quad (1)$$

The double Ln model is used to represent the growth model, so that all variables can be explained in growth terms. The panel version of equation (1) can be written as follows:

$$\ln GDP_{it} = \alpha_{0i} + \beta_{1i} \ln EC_{it} + \beta_{2i} \ln K_{it} + \beta_{3i} \ln L_{it} + \varepsilon_{it} \quad (2)$$

where, i is Cross-Sections. t denotes time period. ε_{it} is the error term with the usual statistical properties while α and β are coefficients.

It is difficult to obtain significant t-ratio or F-statistics for regressions while estimating samples with very few observations. It is common problem of time-series when annual data is used for estimations, since there are very few annual series which extended more than fifty years. To overcome this problem an efficient solution is to pool data into a panel of time series from different cross-sectional units. Hence, use of panel data has advantage that it can exploit both the cross sectional and time series dimensions of data and provide more efficient estimations of parameters by considering broader sources of variation [23].

V. METHODOLOGY

To estimate (2) study uses panel cointegration framework. The cointegration analysis of panel data consists of four steps:

A. Panel Unit Root Tests

The purpose of unit root tests is to check the stationarity of data. Four different statistics proposed by Phillips-Perron [24], Maddala and Wu [25], Levin *et al.* [26] and Im *et al.* [27] are adopted each claiming more power against the null of unit root in a variable.

B. Cointegration Tests

Cointegration test is primarily used to investigate the problem of spurious regression, which exists only in the presence of non-stationary. Therefore after application of unit root tests, if each of the variables is stationary then issue arises whether there exists a long-run equilibrium relationship between the variables. For this heterogeneous panel cointegration test developed by Pedroni [28] is employed. It allows the cointegration vector to vary across different sections of the panel, and also for heterogeneity in errors across cross-sectional units. The Kao [29] test is also used to check cointegration of data.

C. Panel Fully Modified OLS estimates

The study estimates the long run relationship by using fully modified ordinary least square (FMOLS) technique developed by Pedroni [30] for heterogeneous cointegrated panels.

D. Granger Causality Test

Finally, once the panel cointegration is implemented, a panel error correction model (ECM) is established to study short-run and long-run causalities between GDP per capita and EC per capita.

The two-step procedure of Engle-Granger [31] is performed as: firstly, estimation of the long-run model for (2) in order to obtain the estimated residuals ε_{it} . Secondly, to estimate the Granger causality model with a dynamic error correction:

$$\Delta \ln GDP_{it} = \theta_{1j} + \lambda_{1i} \varepsilon_{it-1} + \sum_k \theta_{11ik} \Delta \ln GDP_{it-k} + \sum_k \theta_{12ik} \Delta \ln EC_{it-k} + \sum_k \theta_{13ik} \Delta \ln K_{it-k} + \sum_k \theta_{14ik} \Delta \ln L_{it-k} + \mu_{1it} \quad (3)$$

$$\Delta \ln EC_{it} = \theta_{2j} + \lambda_{2i} \varepsilon_{it-1} + \sum_k \theta_{21ik} \Delta \ln GDP_{it-k} + \sum_k \theta_{22ik} \Delta \ln EC_{it-k} + \sum_k \theta_{23ik} \Delta \ln K_{it-k} + \sum_k \theta_{24ik} \Delta \ln L_{it-k} + \mu_{2it} \quad (4)$$

$$\Delta \ln K_{it} = \theta_{3j} + \lambda_{3i} \varepsilon_{it-1} + \sum_k \theta_{31ik} \Delta \ln GDP_{it-k} + \sum_k \theta_{32ik} \Delta \ln EC_{it-k} + \sum_k \theta_{33ik} \Delta \ln K_{it-k} + \sum_k \theta_{34ik} \Delta \ln L_{it-k} + \mu_{3it} \quad (5)$$

$$\Delta \ln L_{it} = \theta_{4j} + \lambda_{4i} \varepsilon_{it-1} + \sum_k \theta_{41ik} \Delta \ln GDP_{it-k} + \sum_k \theta_{42ik} \Delta \ln EC_{it-k} + \sum_k \theta_{43ik} \Delta \ln K_{it-k} + \sum_k \theta_{44ik} \Delta \ln L_{it-k} + \mu_{4it} \quad (6)$$

where, Δ denotes first differencing. λ is the lag length and is chosen optimally for each country using a step-down procedure up to a maximum of two lags.

The sources of causation between GDP per capita and EC per capita are identified by testing for the significance of the coefficients of dependent variables in (3) and (4). For short-run causality, study test $H_0: \theta_{12i,k} = 0$ for all i and k in (3) or $H_0: \theta_{21i,k} = 0$ for all i and k in (4). While, the long-run causality is tested by looking at the significance of speed of adjustment λ , which is the coefficient of the error correction term, ε_{it-1} . The significance of λ indicates the long-run relationship of the cointegrated process, and so movements along this path can be considered permanent. For long-run causality, test $H_0: \lambda_{1i} = 0$ for all i in (3) or $H_0: \lambda_{2i} = 0$ for all i in

(4) is used. Similarly, sources of causation between GDP per capita and other two variables (capital and labour) are identified through (5) and (6).

The rational to adopt these tests is; the panel unit root and panel cointegration approach avoids the problem of spurious regression through investigating the order of integration of the variables. If the variables are non-stationary, testing whether the variables are cointegrated. If the variables are cointegrated, it follows that a linear combination of the non-stationary variables will be stationary. The panel cointegration framework also has the advantage that because it tests whether there is a long-run relationship between the variables or not. It allows distinguishing between short-run and long-run impacts, which is not possible with conventional panel data analysis.

VI. EMPIRICAL RESULTS

A. Panel Unit Root Results

Results of the panel root tests are reported in table I. Its show that all tests do not reject the null hypothesis of non-stationary in the level form for all variables by considering both individual effect and individual linear trend effect. All tests reject null-hypothesis of non-stationary when variables are used at first difference. This implies that series of variables GDP per capita, EC per capita, K and L are integrated of order one, and I (1) process. These results are consistence with notation that most of macroeconomics variables are non-stationary at level, but become stationary after first differencing [32]. Consequently, as pooled data is stationary at first difference, the series follow stochastic trends and therefore can be cointegrated as well.

TABLE I
PANEL UNIT ROOT TESTS RESULTS

| Test Statistics | | | | |
|----------------------------------------------------------------------|-------------|-------------|--------------|-------------|
| | LLC | IPS | MW(ADF) | PP(Fisher) |
| A: Level | | | | |
| Model Specification: Individual Effects | | | | |
| Ln GDP | 3.45 (0.99) | 7.02 (1.00) | 0.53(1.00) | 0.46 (1.00) |
| Ln EC | 0.30 (0.99) | 7.09 (1.00) | 0.43(1.00) | 0.44(1.00) |
| Ln K | 0.09 (0.46) | 2.21 (0.98) | 1.97(0.99) | 1.81(0.99) |
| Ln L | 1.53 (0.32) | 4.81 (0.50) | 1.413 (0.29) | 16.1(0.49) |
| Model Specification: Individual Effects and Individual Linear Trends | | | | |
| Ln GDP | 0.66 (0.70) | 2.31 (0.98) | 4.74(0.90) | 4.58 (0.91) |
| Ln EC | 0.07 (0.52) | 1.47 (0.98) | 4.74(0.90) | 4.58 (0.91) |
| Ln K | 2.05 (0.52) | 1.85 (0.31) | 21.1(0.02) | 6.24 (0.79) |
| Ln L | 3.45 (0.99) | 0.75 (0.22) | 16.3(0.91) | 5.96 (0.81) |
| B: First Differences | | | | |
| Model Specification: Individual Effects | | | | |
| $\Delta \ln GDP$ | 6.55 (0.00) | 7.76 (0.00) | 74.1(0.00) | 108.1(0.0) |
| $\Delta \ln EC$ | 12.5 (0.00) | 11.3 (0.00) | 107.1(0.00) | 109.9(0.0) |
| $\Delta \ln K$ | 8.51 (0.00) | 8.14(0.00) | 78.2 (0.00) | 84.6 (0.00) |
| $\Delta \ln L$ | 5.46 (0.00) | 5.03 (0.00) | 53.5(0.00) | 106.4(0.0) |
| Model Specification: Individual Effects and Individual Linear Trends | | | | |
| $\Delta \ln GDP$ | 10.3(0.00) | 11.3 (0.00) | 108.8 (0.00) | 157.2(0.0) |
| $\Delta \ln EC$ | 12.1(0.00) | 11.5(0.00) | 112.1(0.00) | 334.1(0.0) |
| $\Delta \ln K$ | 7.80(0.00) | 7.50(0.00) | -6.33(0.00) | 67.4(0.00) |
| $\Delta \ln L$ | 4.79(0.00) | 9.28(0.00) | 115. (0.00) | 152.1(0.0) |

Notes: LLC, IPS, MW and PP indicated the Levin *et al.* (2002), Im *et al.* (2003), Maddala and Wu (1999) and Phillips-Perron (1992) panel unit root and stationary tests. All tests examine the null hypothesis of non-stationary

(unit root). The four variables were grouped into one panel with sample $N = 5$, $T = 35$. The parenthesized values are the probability of rejection. Probabilities for the MW (ADF Fisher Chi-square) and PP (Fisher chi-square) tests are computed using an asymptotic χ^2 distribution, while the other tests follow the asymptotic normal distribution.

B. Cointegration

Pedroni seven tests based on residuals from (2) are reported in table II. Results show existence of cointegration between variables at 10 percent significant level as for all three models these reject the null of no cointegration. Therefore, it is concluded that the variables are cointegrated and a long run relationship exist for group as a whole and the members of the panel.

TABLE II
HETEROGENEOUS PANEL COINTEGRATION RESULTS

| Test Statistics | No Deterministic Trend | Deterministic Intercept and Trend | No Deterministic Intercept and Trend |
|---------------------------------------------------------------|------------------------|-----------------------------------|--------------------------------------|
| Panel Cointegration Statistics (Within-Dimension) | | | |
| Panel v-statistics | 0.758 (0.099) | 0.498 (0.052) | -0.270 (0.084) |
| Panel pp type ρ -statistics | -1.375 (0.054) | -1.024 (0.056) | -0.415 (0.065) |
| Panel pp type t-statistics | -2.464 (0.019) | -2.495 (0.017) | -1.085 (0.021) |
| Panel ADF type t-statistics | 0.065 (0.098) | 0.345 (0.035) | -0.072 (0.073) |
| Group Mean Panel Cointegration Statistics (Between-Dimension) | | | |
| Group pp type ρ -statistics | -0.744 (0.023) | 0.149 (0.075) | -0.364 (0.073) |
| Group pp type t-statistics | -2.402 (0.022) | -2.197 (0.035) | -1.697 (0.094) |
| Group ADF type t-statistics | -0.0918 (0.097) | 0.402 (0.067) | 0.415 (0.090) |

Note: This table reports Pedroni (2004) residual cointegration tests. The number of lag truncations used in the calculation of statistics is fixed at 1. The null hypothesis is no cointegration. Probability values are in parenthesis.

From the Kao residual cointegration result reported in table III, strong evidence is found to reject the null hypothesis of no cointegration at one percent level of significance. Therefore, it is concluded that there exist a strong evidence of long-run cointegration relationship between the variables for the multi-country panel. These results are consistent with Lee [33], sadorsky [34] and Apergis and Payne [21].

TABLE III
KAO RESIDUAL COINTEGRATION TEST RESULT

| Model Specification : No Deterministic Trend | |
|----------------------------------------------|-----------------|
| ADF t-statistics | -1.6411 (0.001) |

Notes: This table reports Kao (1999) residual cointegration test. The number of lag truncations used in the calculation of statistics is fixed at 1. The null hypothesis is no cointegration. Probability values are in parenthesis and computed using asymptotic Chi-square distribution.

C. FMOLS Estimates

The long run estimates based on Pedroni's group mean FMOLS estimators for individual and panel are reported in table IV. On per country basis, the results are mix for all five countries. Magnitude of coefficients denotes long-run elasticities of output with respect to energy consumption, capital and labor. In long run, elasticity of energy

consumption ranges from -1.477 (SriLanka) to 2.4141(India). However for three countries (Bangladesh, India and Nepal), coefficient of EC per capita is significantly positive, that is an increase in energy consumption tends to promote GDP per capita, while remaining two (Pakistan and SriLanka) have negative elasticity which mean an increase in EC per capita tend to decrease GDP per capita in long-run. From the elasticities it can also be inferred that due to increase in EC per capita growth goes down more in Pakistan rather than in Sri Lanka ($1.247 > 0.477$). Moreover for individual countries it is noted that magnitude of EC per capita is larger than magnitude of K and L, it implies that energy is an important ingredient for economic growth and strong energy policies are required to attain sustained economic growth and that may vary for individual countries.

TABLE IV
FULLY MODIFIED OLS ESTIMATES
(DEPENDENT VARIABLE IS $\Delta \ln GDP$)

| Countries | Independent Variables | | | |
|-------------|-----------------------|----------------------|--------------------|-----------------------|
| | Intercept | $\Delta \ln EC$ | $\Delta \ln K$ | $\Delta \ln L$ |
| BNG | 5.136 (2.291) | 1.517 (9.930)* | -0.022 (-1.009) | -0.347 (-1.929)*** |
| IND | 5.417 (2.251) | 2.414 (10.97)* | 0.036 (1.201) | -0.752 (-1.929)* |
| NPL | -12.67 (-7.979)* | 0.526 (1.483)*** | 0.001 (0.009) | 0.928 (5.119)* |
| PAK | 0.302 (0.280) | -1.247 (-9.502)* | 0.082 (4.793)* | -0.201 (-1.867)*** |
| LKA | -13.65 (-14.47)* | -0.477 (-8.807)* | 0.110 (5.791)* | 0.947 (10.09)* |
| Panel Group | 4.033 (8.510)* | -0.132 (-2.911)** | 0.610 (14.43)* | -0.635 (-13.11)* |

Notes: The number of lag truncations used in calculation is 2. The values in parentheses denote the t-statistics following a standard normal distribution. Asterisk *, ** and *** indicate statistical significance at 1% , 5% and 10% levels, respectively.

The coefficient of capital is positive and significant for 2 countries out of 5. Only for Pakistan and SriLanka it positively affects GDP per capita while for remaining countries no long-run relationship is found. The sign of labor is negative for Bangladesh, India and Pakistan while positive for Nepal and SriLanka only.

For panel results of regression equation with GDP per capita as dependent variable show that coefficients of EC per capita and L are negative and statistically significant and coefficient of K is positive and significant. These results suggest that one percent increase in energy consumption per capita tends to decrease 0.13 percent GDP per capita; it implies that EC per capita discourage GDP per capita in the long-run. It may be because the South Asian nations are poor in energy sector. Their energy production capacity is unable to meet rising demand of energy. Increase in GDP enlarges economy with the expansion of different sectors (Agriculture, industries, household etc.). Energy consumption also goes up in different forms in growing sectors where it is used as basic input. Therefore increase in energy consumption coupled with insufficient energy supply lead to shortage, energy crisis and eventually power-cut off. That energy crisis negatively effects

economic growth and hence, an increase in energy consumption tend to decrease economic growth.

The coefficient of labor for whole region is also negative that indicate a negative effect of labor on GDP per capita. It may be due to brain-drain, uneducated, unskilled and low productivity of labor force. Moreover results show that labor tends to decrease GDP per capita more than EC per capita. Although this may be due to the fact that in developing countries, labor tends to be abundant and relatively cheaper. These results are similar with the findings of Sari and Soytaş [35]. Capital plays a significant and positive role in GDP per capita that one percent increase in capital rise GDP per capita by 0.61 percent. It is consistent with theory that more capital accumulation ensures the economic growth.

D. Granger Causality Test Results

The short-run and long-run panel Granger causality results from estimating panel based error correction model set out in (3), (4), (5) and (6) are reported in Table: V. The optimal lag length is obtained (2) by using Schwartz Information Criteria (SIC).

TABLE V
PANEL GRANGER CAUSALITY RESULTS

| Dependent Variable | Source of Causation (Independent Variables) | | | | |
|-------------------------|---------------------------------------------|------------------------|-----------------------|-----------------------|-----------------------|
| | Short-run | | | | Long-run |
| | $\Delta \ln \text{GDP}$ | $\Delta \ln \text{EC}$ | $\Delta \ln \text{K}$ | $\Delta \ln \text{L}$ | ECM_{t-1} |
| | χ^2 -statistics (p-value) | | | | Coefficient (t-ratio) |
| $\Delta \ln \text{GDP}$ | --- | 0.097 (0.952) | 2.731 (0.255) | 3.691 (0.157) | -0.016 (-4.502*) |
| $\Delta \ln \text{EC}$ | 4.102 (0.028)** | --- | 0.413 (0.813) | 1.822 (0.402) | -0.008 (-2.241*) |
| $\Delta \ln \text{K}$ | 0.944 (0.623) | 1.395 (0.497) | --- | 7.505 (0.023)** | 0.066 (2.933*) |
| $\Delta \ln \text{L}$ | 2.450 (0.293) | 2.886 (0.236) | 0.623 (0.732) | --- | 0.005 (1.540) |

Notes: Wald Chi-square tests reported with respect to short-run changes while error term coefficient as long-run changes. Parentheses values are the probability of rejection of Granger non-causality. Asterisks * and ** indicate statistically significant at 1 % and 5% level respectively.

Results suggest that GDP per capita is causing EC per capita through error correction term but not the vice versa. This implies that there is significant unidirectional causation from GDP per capita to EC per capita in the short-run. Moreover, there is existence of unidirectional causality from labor to capital, while among other variables no statistically significant causal relationship is found.

In long-run, for GDP per capita equation, the estimated coefficient on error correction term is negative and statistically significant. It shows that short-term adjustments to equilibrium are driven by adjustment back to long-run equilibrium through error correction term. It takes 59 years (calculated as the inverse of the absolute value of coefficient on the error correction term). For EC per capita equation, the estimated coefficient on error correction term is negative and statistically significant indicating that per capita energy consumption is responsive to adjustments back to equilibrium.

It specifies long-run feedback between GDP per capita and EC per capita.

VII. SUMMARY AND POLICY IMPLICATIONS

The objective of study is to investigate causal relationship between energy consumption and economic growth by applying a multivariate model in five South Asian countries over period 1971-2006. Recently developed panel cointegration technique is applied while long run relationship is estimated using fully-modified ordinary least square.

The findings of the study have important policy implications. A unidirectional causality is found from GDP per capita to EC per capita in short-run. While, negative relation exists between the two in the long-run. Thus, according to the results, South Asian countries are benefited to adopt energy conservation policy to avoid the shortage of energy. Otherwise energy crisis may seriously endanger the development of economies in the long-run. Thus, it is quite important that along with the high energy consumption, the energy production raises to that extent to ensure sustained economic growth.

To stay away from the energy crisis there should be some short-term and long-term planning, modified policies and enormous investment needed. Avoid the import of crude oil at a massive cost of foreign reserve. South Asian countries are rich in hydro resource of energy. Therefore, there is need to build new dams, installation of wind power plant and tidal energy projects to explore the energy production. Moreover, policy orientation needs a drastic modification to utilize endogenous resources. There must be short-term and long-term decisions regarding the state of natural resources of the economy.

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