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Energy Consumption, Economic Growth, Trade and Financial Development Nexus in South Asia

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Abstract

This study contributes to the literature by exploring the impact of energy consumption, trade and financial development on growth in five South Asian countries over 1980-2010. The panel co-integration approach is employed to examine the long run association and granger causality analysis for direction. The PMG estimation approach is used to address the problem of heterogeneity. Panel co-integration test expresses a long run relationship between growth, energy, trade and financial development. Our findings express that financial development, energy and trade positively affect the economic growth. In long run, bidirectional relationship exists among growth and energy, unidirectional causality is running from trade and financial development to growth.

Key words: Economic growth, Energy consumption, South Asia

Financial development

1. Introduction

Economic growth is the symbol of progress; it refers to increase in the productive capacity of a country. Energy is considered as an ordinary intermediate and an accelerating factor of production. Energy is indispensable to the economy and important for economic growth. It is fundamental to human survival and economic growth, and it is the base of modern societies. It is the lifeline and back bone of economic development. It is playing the pertinent role in increasing trade and boosting the growth level. According to literature trade increases the level of growth. The dynamic relations involving economic growth, trade, energy and financial development have got attention in the economic literature. Hassan et al. (2011) determined that financial development increases economic growth in a large sample of countries. Calderon and Liu (2003) found that financial development normally raises economic growth. They argued that there more opportunities of financial development are in developing countries as compared to industrial countries. Bojanic (2012) investigated a long run association among real GDP, financial development and openness.

Understanding the growth process in relation to energy and trade has led many scholars to determine the short as well as long run relationships (Sadorsky, 2012). Most of the studies have shown that trade and energy are helpful to enhance the growth process in an economy.

However, some studies also noted a negative relationship between trade and economic growth (e.g. Gries & Redlin, 2012). Bourdon et al. (2011) find that the countries exporting high quality good having a positive impact on growth and the countries exporting low quality goods having a negative impact on growth.

Our study is an attempt to fill the gap in the literature and it is different from previous studies. We have incorporated the important determinants of economic growth, and applied different techniques for the analysis of South Asian region. Our detailed analysis of economic growth has incorporated energy, trade and financial development together.

Our study explores the simultaneous effect of energy, trade and financial development on growth. We have applied different relevant techniques for our analysis such as pooled mean group estimation method (PMG) which is very helpful technique in the heterogeneous panel data. Through PMG we have explained the results of individual countries in our panel.

The purpose of our study is to explore the dynamic effects of financial development, energy and international trade on economic growth. We have screened Afghanistan, Bhutan and Maldives due to the unavailability of complete data series. Our analysis includes five South Asian economies named as Bangladesh, Pakistan, India, Sri Lanka and Nepal for the period of 1980 to 2010.

In recent years, the South Asian economies have witnessed rapid growth. The empirical results show a rising tendency of GDP in South and East Asia over 1985-2009 (Perera and Lee, 2013). As the emerging economies exploit energy resources more rapidly due to relative inefficiency of utilization process so per unit energy consumption is higher for them. In the recent years, the South Asian economies have witnessed rapid economic growth. According to the World Bank data, growth rate of GDP per capita had been around 7.5% in these South Asian countries in 2007. Meanwhile per capita energy consumption for these economies is also showing an increasing trend for this region (Srivastava & Misra, 2007).

We believe that our study is first of its kind for following reasons. First, it addressed the theme of "the impact of energy consumption, trade and financial development on economic growth" which is not yet focused in the previous studies for South Asian region. Second, available studies used time series data set while we focus on panel data set. Third, we address the problem of cross country heterogeneity using pooled mean group estimation technique.

The study is planned as follows. Section 2 describes the history of energy and section 3 explores the review of relevant literature. Section 4 consists of methodology. In section 5 and 6, we have discussed the data and empirical findings respectively. At the end, section 8 contains conclusion and policy implications.

2. History of Energy

Energy is fundamental to human survival and economic growth. It is the basis of life, for millions of years, animals in form of food and meat are using for survival of human lives. Plants capture and convert some of this energy through the process of photosynthesis and it is providing the base for animal food chain. The life on earth is basically depends on solar energy. The sun provides, on average, 1366 watts per square meter per second, which is approximately 170,000 terawatts on earth, equal to 128,000,000 million tonnes of oil (Ruddiman, 2001).

Gradually people moved through different processes and techniques towards modification of the use of energy from previous time periods to the future. Due to the innovations in technologies there occurred a huge shift from an organic energy to the fossil fuel energy. It raised the consumption of energy for heating purposes such as iron, other metals and then, in producing power, light and transport (Nordhaus, 1996; Fouquet and Pearson, 2006; Fouquet, 2008).

Today, energy markets need to be considered not only at a local, national and regional level, but as a single global entity. Now, markets are integrated and interdependent on other world through energy consumption and production.

3. Literature Review

The dynamic links exist between energy consumption, economic growth, trade and financial development, and the links get attention in the previous literature. This section briefly reviews the literature related to these dynamic links.

The origin of trade is driven on the basis of difference in resources among the countries. By nature, some countries have abundant labour and some are rich in capital. Foreign trade is an accelerating factor for economic growth as well as jobs opportunities.

In the recent literature, a stable and significant relationship exists between trade and economic growth, and this relationship is explained using evidence from past literature. Bourdon et al. (2011) examined the relationship between growth and trade and measured this relationship incorporating trade quality and variety of product. They find that the countries exporting high quality of goods having positive impact on growth and the countries exporting low quality of goods having negative impact on growth. They also suggested that countries export extensive range of goods will grow more rapidly.

Gries and Redlin (2012) investigated the causality among GDP per capita growth and openness in the panel of 158 economies. They examined the positive and negative bidirectional causality in long and short run respectively. Liu et al. (1997) also concluded bidirectional causality between exports plus imports and GNP for china. These causation results are consistent with the protected export promotion development strategy of china. Awokuse (2005) investigated the two-way causality among real exports and real GDP in Korea.

3.1 Economic Growth and Financial Development

In this section we have explored the relationship between financial development and economic growth with the help of previous literature. Gregorio and Guidotti (1995) found that financial development positively affects economic growth in a large countries sample but its impact fluctuates across countries.

The causality direction and relationship between financial development and economic growth is very essential for policy makers. Demetriades and Hussein (1996) examined the granger causality relationship between financial development and real GDP. They found the bidirectional causality between financial development and per capita GDP and also find the unidirectional causality in some cases. The causality pattern varies country to country.

Calderon and Liu (2003) investigated the causality between economic growth and development of financial sectors. They found that financial development normally raises economic growth.

Hassan et al. (2011) also examined the relationship between domestic credit and growth by using different proxies for financial development for middle and low income countries. Their results show that economic growth and financial development are positively linked in developing countries. There should be a good and stable financial system for accelerating economic growth in developing countries.

Different proxy variables have used for financial development in previous study. Adu et al. (2013) inferred the growth effect of financial development for Ghana. They used eight proxy variables for financial development which cannot enter in a single equation due to the severe correlation among them. They have used the principal component analysis for tackling this kind of problem. They proposed that whether financial development is good or bad for economic growth is based on the selection of proxy variable for finance.

3.2 Economic Growth and Energy Consumption

Recently, energy and economic growth has become an important relationship as well as emerging issue. Many research studies have been devoted to explore this relationship. Akkemik and Goksal (2012) observed the bidirectional causality in 57 countries, unidirectional in 7 countries and no causality in 15 countries.

Mohammadi and Parvaresh (2014) also found a stable feedback causal association among energy and output using a panel of fourteen oil exporting economies. Pesaran et al. (1999) suggested that the dynamic fix effect agrees to different intercepts through groups. The PMG estimator agrees heterogeneity in the short run coefficient, intercept and error variances through groups while homogeneity in long run coefficients. Aissa et al. (2013) inferred that renewable energy and trade are increasing factors of output in the long run. Similarly, Rufael (2010) analysed the relationship between real GDP and coal consumption in six main coal consuming economies. They found out the presence of a unidirectional causality from economic growth to coal consumption in South Korea and China, from coal consumption to economic growth in India and Japan. Tang & Tan (2014) also found a bidirectional association among energy and growth.

3.3 Energy Consumption and Trade

The production process is playing an important role in promoting international trade, and energy is the crucial and basic factor of production. Sadorsky (2011) found bidirectional causality between imports and energy consumption and unidirectional causality from exports to energy consumption in 8 Middle Eastern countries. These results have concluded that increasing trade trend affects the demand of energy. Sadorsky (2012) also found bidirectional causality among energy and exports and unidirectional causality from energy to imports. The results showed the long run causal relationship between energy consumption and openness.

3.4 Energy Consumption and Financial Development

It is necessary to identify the casual direction among financial development and energy. Here we analyzed the relationship between financial development and energy consumption. Shahbaz and Lean (2012) found that co-integration exists among energy, growth and financial development, and these variables increase the usage of energy in Tunisia.

Coban and Topcu (2013) inferred the dynamic links in Europe and their empirics showed the strong substantiation of the influence of financial improvement on energy in old members, and development in finance increase the consumption of energy.

Al-Mulali and Lee (2013) also described the role of financial development in increasing the energy use in GCC countries. They inferred that financial development, GDP and total trade have been increased the consumption of energy.

4. Methodology and Empirical Models

Energy is considered to be an indispensable tool and crucial factor in production process. The relationship among energy and growth has become a very attractive issue after energy crises 1970s. Some intellectuals and researchers argue that energy is an essential for production. In traditional production function, output is produced through two basic and initial inputs i.e. labor and capital.

$$Y = f(K, L) \tag{1}$$

Here, Y is output, f for function, K and L for capital and labor, respectively. Output Y depends on K and L, and K and L both are substitutes for each other.

Pokrovski, V. (2003) extended the traditional production function and considered energy as an essential and very basic input in production, where output is produced through three basic inputs capital, labor and energy as work of production tool. Later many researchers incorporated energy consumption in their production function (see, for example, Khan and Qayyum, 2006; Lee and Chang, 2008 among others). Pokrovski considered K, L and E as dependent inputs, and incorporated energy as a factor of production and equation 1 can be expressed as;

$$Y = f(K, L, E) \tag{2}$$

Where, Y is output, K for capital, L for labor and E is used for energy consumption. The technology decides how much labor and energy sources are necessary for production. The capital K is an intermediate agent to attract energy.

Trade is also used as a key determinant of growth in the literature and it has significant role in increasing economic growth. Awokuse (2005), Bourdon et al. (2011), Gries and Redlin (2012), Liu et al. (1997) and many other researchers used trade as an input in production function. Exports increase production level and growth as well as employment opportunities. A country can import goods and services from other countries at very low prices, especially in the case of scarce factor of production.

The relationship among financial development and growth also exists but it varies from country to country. This relationship is inconclusive in the literature because in some countries it is positive and negative in others. Gregorio and Guidotti (1995) found that financial development positively affect the growth in a large countries sample and inversely affect in Latin America. If trade T and financial development F are incorporated in equation 2, the functional form is as follows;

$$Y_{it} = f\,(K_{it}, L_{it}, E_{it}, T_{it}, F_{it}) \quad (3)$$

Our proposed functional form is consistent with the past literature (e.g. Shahbaz, M., 2013). According to our functional form the general Cobb-Douglas production function will establish in the given way;

$$Y_{it} = A\ K_{it}^{\alpha_{it}}\ L_{it}^{\alpha_{it}}\ E_{it}^{\alpha_{it}}\ T_{it}^{\alpha_{it}}\ F_{it}^{\alpha_{it}} \quad (4)$$

We have taken natural logarithms of equation 4 to linearize the nonlinear production functions.

$$ln(Y_{it}) = \alpha_0 + \alpha_1 ln(K_{it}) + \alpha_2 ln(L_{it}) + \alpha_3 ln(E_{it}) + \alpha_4 ln(T_{it}) \alpha_5 ln(F_{it}) + \mu_{it} \quad (5)$$

Where,

ln = Natural logarithm;
Y = Economic growth;
E = Energy consumption;
T = Trade (export plus imports);
F = Financial development;
K = Capital;
L = Labor;
α_0 = Intercepts;
α_1 = elasticity of energy with respect to growth;
α_2 = coefficients of trade;
α_3 = elasticity of financial development with respect to economic growth;
α_4 = coefficients of capital formation;
α_5 = elasticity of labor force with respect to economic growth;
t = 1, 2 ….. 31 periods;
i = 1, 2…5 countries; and
μ = error term.

We are interested to find out the relationships of economic growth with their respective determinants and variables. The relevant techniques, methods and estimation procedure for panel data are discussed in this section. The panel co-integration is applied to examine the relationship. In co-integration analysis our aim is to:

- identify the underlying long run relationship
- trace out the variation in short run
- Reconcile the long and short run analysis, in particular to determine whether short run variation contributes to establish the long run relationship.

In co-integration for long run relationship, variables must have same order of integration. So first we determine the non-stationary of variables by using unit root test. After this we have applied the co-integration approach and the procedure is given in the following sections.

After the discussion on the procedure of co-integration relationship, furthermore, we will discuss the panel granger causality analysis for direction and casual relationship between all variables. Then long and short run elasticities are examined. At the end we will discuss the group mean and pool mean group estimates for whole panel as well as separate parameters of each cross sections.

4.1 Panel Unit Root Test

As we have discussed, the first step which involves in the co-integration approach is to check the non-stationary by using panel unit root tests. It is necessary that the variables should have same order of integration for proceeding co-integration. Here we apply two tests i.e. 1st is Levin, Lin and Chu test and 2nd is Im, Pesaran and Shin test. These two tests are normally used in the literature and these tests are better as compared to others.

4.2 Panel Co-Integration Test

We use co-integration approach to trace the long run relationship of economic growth with their independent variables. There are different co-integration methods discussed in the literature e.g. Engle and Granger (EG) approach (1987), ARDL approach and Pedroni co-integration approach (1997, 1999) etc. Panel co-integration approach is better than individual on time series data. Here the properties of panel data hold; we can raise the sample size as well as degree of freedom. EG approach is simple and useful for understanding the procedure of co-integration. It is a single equation approach. Pedroni (1997, 1999) has modified EG approach for panel data set.

4.2.1 The Pedroni Co-integration Tests

Pedroni (1997, 1999) developed some panel co-integration tests and incorporated heterogeneity. Pedroni allows multiple $(k = 1, 2, \ldots. K)$ regressors for co-integration vector to vary across different cross sectional units of panel. The error terms across the cross sections are allowed to have heterogeneity. The proposed panel regression equation is as follows:

$$Y_{i,t} = \beta_i + \delta_t + \sum_{k=1}^{K} \gamma_{ki} X_{mi,t} + \mu_{i,t} \quad (6)$$

For Pedroni co-integration, equation 5 is estimated by OLS for each cross section and the residual $(\hat{\mu}_{it})$ gained is used to estimate the given equation:

$$\hat{\mu}_{it} = \rho_i \hat{\mu}_{it-1} + \xi_{it} \quad (7)$$

Here ρ_i is an autoregressive parameters and, ξ_{it} represents an error. The null hypothesis of equation 7 is as follows:

$$H_O: \quad \rho_i = 1, \qquad (i = 1,2 \ldots \ldots N)$$

The null hypothesis is no co-integration and the alternatives means co-integration exists. The acceptance of null means no co-integration relationship while rejection of null hypotheses means existence of co-integration relationship between cross sections of panel.

He has developed seven different co-integration statistics for testing null hypotheses in heterogeneous panel data framework. The test has two classifications; the first is 'panel statistics (within dimension)' that does not allow heterogeneity across countries and it is analogous to a unit root statistic in opposition to the homogeneous alternative. The AR coefficient across the countries is pooled to employ unit root test on the residual obtained through the given process. Further there are four tests under within dimension category i.e. panel v-Statistic, rho-Statistic, PP-Statistic and ADF-Statistic. The null of these tests is no co-integration against alternative hypothesis of these tests that is given below:

$$H_O: \quad \rho_i = \rho < 1, \qquad (i = 1,2 \ldots \ldots N)$$

The second is 'group mean statistics (between dimensions)' that allow heterogeneity across countries and equivalent to a panel unit root test against the heterogeneous alternative. Furthermore, there are three tests under 'between dimension' category i.e. group rho-Statistic, PP-Statistic and ADF-Statistic. The null of these tests is no co-integration against alternative hypothesis of these tests that is given below:

$$H_O: \quad \rho_i < 1, \qquad (i = 1,2 \ldots \ldots N)$$

The null hypotheses are identical for both 'within dimension' and 'between dimensions' classes while the alternative hypotheses are different for both categories.

4.3 ECM for Short Run Dynamics

After examining the relationship among variables, next step is to investigate marginal impact of independent variables on growth. It is called short run relationship between variables. For this, we have used the ECM and the equation 5 is written in the following way:

$$\Delta(lnY_{it}) = \alpha_0 + \alpha_1\Delta(lnK_{it}) + \alpha_2\Delta(lnL_{it}) + \alpha_3\,\Delta(lnE_{it}) + \alpha_4\Delta(lnT_{it}) + \alpha_5\,\Delta(lnF_{it}) + \Delta\,\theta\hat{\mu}_{it-1} + e_{it} \quad (8)$$

It is beneficial because we have included the long as well as short run information in this way. In our models the coefficients $(\alpha_1 \ldots . \alpha_5)$ are the impact multipliers and θ is the adjustment effect. We have handled the spurious regression problem because of using non-stationary data, while all variables in the equation 8 are stationary.

4.4 Panel Granger Causality Test

When co-integration exists between variables, there exists an ECM. We can examine the ECM by applying Engle Granger causality approach. According to this approach, a change in dependent variable is regressed on the independent variables using difference form and optimal lag lengths. The panel VECM for equation 5 is given below and all variables are in natural logarithm form:

$$\Delta Y_{it} = \alpha_{1i} + \sum_{j=1}^{p}\beta_{11ij}\,\Delta Y_{it-j} + \sum_{j=1}^{p}\beta_{12ij}\,\Delta K_{it-j} + \sum_{j=1}^{p}\beta_{13ij}\,\Delta L_{it-j} + \sum_{j=1}^{p}\beta_{14ij}\,\Delta E_{it-j} + \sum_{j=1}^{p}\beta_{15ij}\,\Delta T_{it-j} + \sum_{j=1}^{p}\beta_{16ij}\,\Delta F_{it-j} + \beta_{17i}\,\mu_{it-1} + \xi_{1it} \quad (9a)$$

$$\Delta K_{it} = \alpha_{2i} + \sum_{j=1}^{p} \beta_{21ij}\, \Delta Y_{it-j} + \sum_{j=1}^{p} \beta_{22ij}\, \Delta K_{it-j} + \sum_{j=1}^{p} \beta_{23ij}\, \Delta L_{it-j} + \sum_{j=1}^{p} \beta_{24ij}\, \Delta E_{it-j} + \sum_{j=1}^{p} \beta_{25ij}\, \Delta T_{it-j} + \sum_{j=1}^{p} \beta_{26ij}\, \Delta F_{it-j} + \beta_{27i}\, \mu_{it-1} + \xi_{2it} \quad (9b)$$

$$\Delta L_{it} = \alpha_{3i} + \sum_{j=1}^{p} \beta_{31ij}\, \Delta Y_{it-j} + \sum_{j=1}^{p} \beta_{32ij}\, \Delta K_{it-j} + \sum_{j=1}^{p} \beta_{33ij}\, \Delta L_{it-j} + \sum_{j=1}^{p} \beta_{34ij}\, \Delta E_{it-j} + \sum_{j=1}^{p} \beta_{35ij}\, \Delta T_{it-j} + \sum_{j=1}^{p} \beta_{36ij}\, \Delta F_{it-j} + \beta_{37i}\, \mu_{it-1} + \xi_{3it} \quad (9c)$$

$$\Delta E_{it} = \alpha_{4i} + \sum_{j=1}^{p} \beta_{41ij}\, \Delta Y_{it-j} + \sum_{j=1}^{p} \beta_{42ij}\, \Delta K_{it-j} + \sum_{j=1}^{p} \beta_{43ij}\, \Delta L_{it-j} + \sum_{j=1}^{p} \beta_{44ij}\, \Delta E_{it-j} + \sum_{j=1}^{p} \beta_{45ij}\, \Delta T_{it-j} + \sum_{j=1}^{p} \beta_{46ij}\, \Delta F_{it-j} + \beta_{47i}\, \mu_{it-1} + \xi_{4it} \quad (9d)$$

$$\Delta T_{it} = \alpha_{5i} + \sum_{j=1}^{p} \beta_{51ij}\, \Delta Y_{it-j} + \sum_{j=1}^{p} \beta_{52ij}\, \Delta K_{it-j} + \sum_{j=1}^{p} \beta_{53ij}\, \Delta L_{it-j} + \sum_{j=1}^{p} \beta_{54ij}\, \Delta E_{it-j} + \sum_{j=1}^{p} \beta_{55ij}\, \Delta T_{it-j} + \sum_{j=1}^{p} \beta_{56ij}\, \Delta F_{it-j} + \beta_{57i}\, \mu_{it-1} + \xi_{5it} \quad (9e)$$

$$\Delta F_{it} = \alpha_{6i} + \sum_{j=1}^{p} \beta_{61ij}\, \Delta Y_{it-j} + \sum_{j=1}^{p} \beta_{62ij}\, \Delta K_{it-j} + \sum_{j=1}^{p} \beta_{63ij}\, \Delta L_{it-j} + \sum_{j=1}^{p} \beta_{64ij}\, \Delta E_{it-j} + \sum_{j=1}^{p} \beta_{65ij}\, \Delta T_{it-j} + \sum_{j=1}^{p} \beta_{66ij}\, \Delta F_{it-j} + \beta_{67i}\, \mu_{it-1} + \xi_{6it} \quad (9f)$$

Here in the above equations Δ is used for the first difference, α is intercepts, p is for appropriate lag length, ξ for error term. All variables used in natural logarithm form such as used in equation 5. The error correction terms μ is obtained by the residual estimated of equation 5. The coefficients of explanatory variables describe variation in short run and causality. The EC terms interpret long run causality and error adjustments.

4.5 The Pooled Mean Group (PMG) Estimator

Sometimes a problem of common slopes occurs and we have to find out the heterogeneous slopes. Pesaran and Smith (1995) argue that it is controversial to have common parameters for all countries in panel but it may possible in long run. Pesaran et al. (1999) proposed the PMG estimator that is very inclusive giving the consistent results and keeps the efficiency of pooled estimation. The PMG method follows the mean group estimator i.e. allows the fluctuating slope coefficients and intercepts across the countries. In long run coefficients are identical across all countries. We are engaged to check the short run dynamics of all countries because countries have different characteristics and dynamics of economic growth, energy and environment. The policies of some countries are in the favour of friendly environment and minimizing the pollution level while others want to increase the production level irrespective of pollution and other flaws.

According to fixed effects model, the slopes are non-variable and intercepts vary across different countries. The pooled mean group estimator holds the features and characteristics of both mean group estimator and fixed effects model.

5. Data

The time series unbalanced data is used for following selected South Asian economies: Pakistan, Sri Lanka, Nepal, Bangladesh and India for 1980 to 2010.

The variables are included per capita GDP (constant 2005 US$) as a proxy for growth, energy use (kg of oil equivalent per capita), per capita CO_2 emissions (metric tons) as a proxy for environment, trade (% of GDP), financial development (domestic credit to private sector as a share of GDP), gross capital formation (% of GDP), total labor force participation rate (% of total population ages 15+), and urban population (% of total) used as urbanization. The data on all variables are taken over 1980 to 2010 from WDI 2014 of World Bank which is essential database.

Economic growth is calculated by per capita GDP (constant 2005 US dollar). Following other researchers such as Farhani et al. (2014), Khan et al. (2014), Omri and Kahouli (2014) and Omri, A. (2013) used GDP per capita to analyse the relationship between growth and energy.

Gross capital formation as a share of GDP is used for capital, as Shahbaz, et al. (2013) also used. Labor force participation rate (% of total population ages 15 years and older) is used to measure labor force. The data of energy consumption is collected in kg tons of oil equivalent per capita. Trade is measured by the sum of imports and exports of goods and services as a percentage of GDP.

Financial development is calculated by domestic credit to the sector of private as a percentage of GDP. Following the studies (Al-mulali and Lee, 2013; Islam et al., 2013; Ozturk and Acaravci, 2013; Shahbaz et al., 2013; Shahbaz and Lean, 2012) have also used same indicator for financial development.

The data on all variables are taken over 1980 to 2010 from WDI 2014 of World Bank which is essential database.

In this section we have explained the general characteristics of variables used in our study. Descriptive statistics includes averages, the standard deviation, minimum and maximum values of all variables in Table 1. We have six variables, the variable labor has 105 observations and others have 155 observations.

The mean value of economic growth (GDP per capita) is 525.08 and standard deviation is 291.74. The minimum value of economic growth (GDP per capita) is 185.13 that relates to Nepal in 1980 and the maximum value is 1610.08 which belongs to Sri Lanka in 2010.

The standard deviation of capital (share of GDP at constant 2005 US$) is 4.15 and the mean value is 21.05. The maximum value of capital is 32.91 which belong to the India in 2007 and the lowest value is 13.93 relates to Pakistan in 1999. The average value of labour force (as share of total population ages 15+) is 64.90 and the standard deviation is 12.31. The highest value of labour is 86.2 which relates to Nepal in 1999 and the lowest value is 49.2 which belongs to Pakistan in 1995.

Table 1: Descriptive Statistics

Variable	Obs.	Mean	S.D	Minimum	Maximum
Y	155	525.08	291.74	185.13	1610.08
K	155	21.05	4.15	13.93	32.91
L	105	64.90	12.31	49.2	86.2
E	155	333.31	116.52	101.14	600.30
T	155	40.51	19.28	12.00	88.63
F	155	24.43	9.71	5.77	59.17

The standard deviation of energy consumption is 116.52 and the mean value is 333.31. The maximum value of energy consumption is 600.30 which belong to the India in 2010 and the lowest value is 101.14 relates to Bangladesh in 1981. The standard deviation of trade is 19.287 and the mean value is 40.51. The maximum value of trade is 88.63 which belong to the Sri Lanka in 2000 and the lowest value is 12.00 relates to India in 1986.

The average value of financial development is 24.43 and the standard deviation is 9.71. The highest value of financial development is 59.17 which relates to Nepal in 2009 and the lowest value is 5.77 which belong to Bangladesh in 1980.

5.1 Correlation between Variables

In this section we have examined the correlation between dependent and independent variables for the period of 1980 to 2010. Economic growth and CO_2 emissions are our dependent variables and the correlation among dependent and their independent variables are given in Table 2.

Table 2 shows the correlation between economic growth and independent variables. The results show that the highest positive correlation of economic growth with energy consumption while lowest correlation with labor force. It means the energy is requisite for enhancing growth. Economic growth is positively correlated with trade, capital formation and financial development and negatively correlated with labor.

Table 2: Correlation for the Panel

	Y	***E***	***T***	***F***	***K***	***L***
Y	1.00					
E	0.57	1.00				
T	0.55	0.18	1.00			
F	0.19	0.26	0.13	1.00		
K	0.37	0.13	0.35	0.48	1.00	
L	-0.65	-0.54	-0.04	0.04	-0.03	1.00

(Observations = 105)

6. Empirical Findings

This section consists of empirical findings and arguments. The panel unit root test is applied on all variables in level form as well as their first difference form, and Δ is used for difference. The lag lengths are selected with respect to Schwartz information criterion (SIC) for unit root tests. The values of t-statistics with their corresponding probability values are displayed in Table 3. The null hypothesis is the presence of unit root (non-stationary). The results show that unit root is present in all series except labor at 5% level of significance. The, Lin and Chu test shows that labour is stationary at level, while Im, Pesaran & Shin and PP - Fisher Chi-square test shows the presence of unit root in labour. In this case we have followed the Im, Pesaran & Shin and PP - Fisher Chi-square tests.

So our variables are not stationary at level and co-integration exists between them. The null hypothesis is not accepted for variables at their 1st difference.

6.1 Results of Panel Co-integration Test

After stationary condition, the next step is to find out the co-integrated relationships between variables applying the Pedroni co-integration. Firstly, we have estimated the models 5 and 7 using to Pedroni co-integration approach. We have reported the results in Table 4. The results suggest that all variables are significant.

Table 3: Panel Unit Root Test

Method	lnY		$\Delta(lnY)$		lnL		$\Delta(lnL)$	
	Statistic	Prob.*	Statistic	Prob.*	Statistic	Prob.*	Statistic	Prob.*
Null: Unit root (suppose unit root process is common)								
Levin, Lin and Chu	6.14	1.00	-3.07	0.00	-3.57	0.00	-0.79	0.21
Null: Unit root (suppose unit root process for individual)								
Im, Pesaran and Shin W-stat	8.28	1.00	-3.99	0.00	-0.38	0.34	-1.28	0.09
ADF - Fisher Chi-square	0.58	1.00	38.56	0.00	18.39	0.04	17.04	0.07
PP - Fisher Chi-square	0.99	0.99	64.79	0.00	10.58	0.39	35.34	0.00
Method	lnK		$\Delta(lnK)$		lnF		$\Delta(lnF)$	
	Statistic	Prob.*	Statistic	Prob.*	Statistic	Prob.*	Statistic	Prob.*
Null: Unit root (suppose unit root process is common)								
Levin, Lin and Chu	0.44	0.67	-3.28	0.00	0.86215	0.8057	-2.27003	0.01
Null: Unit root (suppose unit root process for individual)								
Im, Pesaran and Shin W-stat	-0.29	0.38	-6.13	0.00	1.12	0.86	-4.38	0.00
ADF - Fisher Chi-square	13.27	0.20	54.45	0.00	10.12	0.42	38.43	0.00
PP - Fisher Chi-square	15.61	0.11	106.40	0.00	9.35	0.49	70.93	0.00
Method	lnE		$\Delta(lnE)$		lnT		$\Delta(lnT)$	
	Statistic	Prob.*	Statistic	Prob.*	Statistic	Prob.*	Statistic	Prob.*
Null: Unit root (suppose unit root process is common)								
Levin, Lin and Chu	3.22	0.99	-4.66	0.00	1.74	0.95	-2.56	0.01
Null: Unit root (assumes unit root process for individual)								
Im, Pesaran and Shin W-stat	5.46	1.00	-4.88	0.00	1.98	0.97	-4.34	0.00

ADF - Fisher Chi-square	1.69	0.99	44.51	0.00	4.06	0.94	38.31	0.00
PP - Fisher Chi-square	3.35	0.97	82.92	0.00	8.60	0.57	99.97	0.00

* Probabilities for Fisher tests are calculated employing an asymptotic Chi-square distribution. All variables are in natural logarithm form. The unit root tests performed including intercept and user specification lag at 1.

Table 4: OLS Results of Basic and Residual Model

Variables	Dependent Variable: lnY	Dependent Variable: $\hat{\mu}_{it}$
Constant	10.60*	0.0109*
Prob.	(0.00)	(0.092)
lnK	0.588*	
Prob.	(0.000)	
lnL	-2.037*	
Prob.	(0.000)	
lnE	0.0827*	
Prob.	(0.096)	
lnT	0.397*	
Prob.	(0.000)	
lnF	0.118*	
Prob.	(0.031)	
$\hat{\mu}_{it-1}$		0.968*
Prob.		(0.000)

*for significance: shows that variable is significant.

The null (no co-integration) equation 7 is rejected which means co-integration exists between variables across the countries for economic growth model. After confirming the co-integration relationship now co-integration test is applicable. The results are presented in Table 5.

Table 5 shows the result of Pedroni co-integration of within-dimension and between-dimension. The null hypothesis is not accepted in the case of 'panel PP-Statistic' and in the case of 'group PP-Statistic' at 5% level of significance. Therefore, a panel co-integration relationship exists among economic growth, capital formation, energy, labor, trade and financial development.

Now our co-integration results have confirmed that in long run the error is connected by the short run dynamics. Furthermore, we want to check for error corrections and granger causality after short and long run analysis by error correction mechanism.

Table 5: Pedroni Panel Co-Integration Results

Alternative hypothesis: common AR coefficients (within-dimension)				
Tests	Statistic	Prob.	Weighted Statistics	Prob.
Panel v-Statistic	-0.01	0.50	-0.10	0.54
Panel rho-Statistic	1.55	0.93	1.01	0.84
Panel PP-Statistic	-1.50	0.06	-1.59	**0.05**
Panel ADF-Statistic	-1.29	0.09	-0.41	0.34
Alternative hypothesis: individual AR coefficients (between-dimension)				
Tests			Statistic	Prob
Group rho-Statistic			1.93	0.97
Group PP-Statistic			-1.58	**0.05**
Group ADF-Statistic			-0.03	0.48
Null hypothesis: No cointegration Trend assumption: No deterministic trend Lag selection: automatic SIC with fixed at 1				

7. Long Run and Short Run Analysis

This section discussed the long run elasticities and short run relationships of our relevant variables. We have applied ordinary least square (OLS) technique for long run elasticities and ECM for short run dynamics. The results are displayed in Table 6 and 7 and discussed into two sub section.

7.1 Results of OLS for Long Run Elasticities

Here we have discussed OLS results which are estimated for economic growth. Table 6 covers the results of long run elasticities. We have used 10%, 5% and 1% level of significance for interpretation of empirical results.

The results show that the coefficient of trade, energy consumption, and financial development are significant at 1%,10%, and 5% levels of significance, respectivly. The empirics express that a 1% increase in energy use, trade and financial development increase economic growth by .08%, .39% and .11%, respectively.

Table 6: Results of Long Run Elasticities

Variables	Dependent Variable lnY
Constant	10.60*
Prob.	(0.000)
lnK	0.588*
Prob.	(0.000)
lnL	-2.037*
Prob.	(0.000)
lnE	0.0827*
Prob.	(0.096)
lnT	0.397*
Prob.	(0.000)
lnF	0.118*
Prob.	(0.031)

* Shows that the variable is significant.

There long run relationship exists among growth, energy, trade and financial development. Our results are consistent with Sadorsky (2012) and Shahbaz (2013).

The sign of labor is negative, it may be possible that we have used GDP per capita as economic growth and GDP per capita is inversely related with population (labor is a part of population). In the literature, Omri (2013) exposed the inverse relationship between economic growth and labour.

7.2 Results of Short Run Dynamics with ECM

In this section we have discussed the ECM results and displayed the results in Table 7. The results show that capital, labor, energy and financial development positively affect the economic growth. The coefficients of capital formation and energy consumption are significant at 1% level. Our findings are consistent with earlier findings in the literature (Shahbaz et al., 2013; Mohammadi and Parvaresh 2014).

Table 7: Results of Short Run Elasticities

Variables	Dependent Variable $\Delta(\boldsymbol{lnY})$
Constant	0.0256*
Prob.	(0.000)
$\Delta(\boldsymbol{lnK})$	0.112*
Prob.	(0.001)
$\Delta(\boldsymbol{lnL})$	0.0137
Prob.	(0.929)
$\Delta(\boldsymbol{lnE})$	0.333*
Prob.	(0.000)
$\Delta(\boldsymbol{lnT})$	-0.00868
Prob.	(0.720)
$\Delta(\boldsymbol{lnF})$	0.0156
Prob.	(0.186)
$\widehat{\boldsymbol{\mu}}_{\boldsymbol{it-1}}$	0.0213*
Prob.	(0.063)

* Shows that the variable is significant.

Shahbaz et al. (2013) found the positive effect of energy, capital and financial development on growth in the short run. Mohammadi and Parvaresh (2014) also found that energy consumption effects output in short run and trade has inverse relationship with economic growth. The coefficient of error ($\widehat{\mu}_{it-1}$) is significant at 10% level of significant, it means capital formation, labor, energy consumption, trade and financial development contribute for established long run relationship of economic growth.

7.3 Granger Causality Results for VECM

Investigating the causality direction among economic growth and respective independent variables (energy, trade, financial development and urbanization) is helpful for energy and environmental policies.

The procedure of granger causality is discussed in detail in section 4.4. The two steps' Engle and Granger (1987) approach has been used to trace the short run causality. At first, we have estimated equation 5 and saved its residual while equations 9a to 9f discussed in section 4.4 are estimated in second stage.

Table 8 shows the granger causality results and it contains the t-statistics with their probability value. We have also reported the results of coefficients of lagged error terms with their probability value which indicates the speed of adjustment or feedback effect after a shock in long run equilibrium. The short run causality relationship exists in case of significant (contains p-value equal or less than 0.10) coefficients of lagged difference independent variables while coefficients of lagged error terms indicate the long run causality relationship.

Table 8: Granger Causality Results

From	To					
	$\Delta(\boldsymbol{lnY})$	$\Delta(\boldsymbol{lnE})$	$\Delta(\boldsymbol{lnT})$	$\Delta(\boldsymbol{lnF})$	$\Delta(\boldsymbol{lnK})$	$\Delta(\boldsymbol{lnL})$
Con	0.02*	-0.00	0.01	-0.01	-0.02*	-0.00
Prob.	(0.00)	(0.71)	(0.70)	(0.64)	(0.03)	(0.93)
$\Delta(\boldsymbol{lnY})$		0.57*	-0.16	1.19	0.99*	0.01
Prob.		(0.00)	(0.71)	(0.18)	(0.00)	(0.93)
$\Delta(\boldsymbol{lnE})$	0.33*		0.48	-0.05	-0.26	-0.09*
Prob.	(0.00)		(0.14)	(0.94)	(0.27)	(0.10)
$\Delta(\boldsymbol{lnT})$	-0.01	0.04		0.52*	0.25*	-0.01
Prob.	(0.71)	(0.14)		(0.01)	(0.00)	(0.62)
$\Delta(\boldsymbol{lnF})$	0.01	-0.00	0.12*		-0.03	-0.01
Prob.	(0.18)	(0.94)	(0.01)		(0.33)	(0.49)
$\Delta(\boldsymbol{lnK})$	0.11*	-0.05	0.53*	-0.29		0.02
Prob.	(0.00)	(0.27)	(0.00)	(0.33)		(0.36)
$\Delta(\boldsymbol{lnL})$	0.02	-0.32*	-0.33	-0.93	0.41	
Prob.	(0.92)	(0.10)	(0.61)	(0.49)	(0.36)	
$\boldsymbol{\mu_{t-1}}$	0.02*	-0.03*	-0.01	-0.07	0.04	-0.01
Prob.	(0.06)	(0.09)	(0.77)	(0.47)	(0.20)	(0.15)

The results of short run Granger causality approach have been described in Table 8. The bidirectional causality exists between growth and energy at 1% level of significance.

The feedback hypothesis exists between trade and financial development at 1% level of significance. Al-mulali and Lee (2013) investigated the feedback hypothesis between total trade and financial development while Menyah et al. (2014) exposed the limited causal link between trade and financial development. Our results are identical with the empirics of earlier study (see, for example, Aissa, et al., 2013).

The long run causality is interpreted by the coefficient of lagged error term of equations 9(a) to 9(f). The signs of all coefficients of error terms are negative except economic growth and capital. The negative sign show the degree of correction in error towards equilibrium in long run.

The coefficient of error (lagged) of equation 9a is significant which shows the long run causal relationship from energy, trade and financial development to growth. So policies should design for economic growth with incorporating very important determinants such as energy, trade and financial development.

The coefficient of error (lagged) of equation 9b is negative and significant which explains the long run causality from growth, trade and financial development to energy. Komal & Abbas (2015) found the positive effect of FD on energy in course of growth. The negative sign of significant coefficient (-0.03) shows the long run adjustment in errors and 3% error is corrected in one year. In the long run feedback relationship exists between economic growth and energy.

The sign of coefficients of error (lagged) of trade and financial development are also negative, and the coefficients are -0.01 and -0.07, respectively. The long run adjustment in errors is corrected by 1.3% in one year in the case of trade but 7.3% error is corrected in the case of financial development. But coefficients of both variables are insignificant at any level.

Our results are unswerving with the findings of Aissa, et al. (2013), Al-mulali and Lee (2013), Menyah et al. (2014), Mohammadi and Parvaresh (2014), Omri (2013), Sadorsky (2012), Shahbaz (2012) and (2013).

7.4 Results of Pooled Mean Group (PMG) Estimators

Due to the panel heterogeneity biasness, we have applied the pooled mean group estimators and results of PMG are discussed in this section for our panel. The PMG estimator explains the panel results as well as short run individual country results, so we can easily compare the panel results with individual country results. We can observe the whole analysis of individual country and panel set.

Table 9 contains the PMG results. We have discussed and interpreted the results of PMG of our panel as well as individuals countries.

In case of panel set, the coefficient of labor, energy consumption and trade are significant. The sign of the coefficient of EC is negative but insignificant. Here, we have discussed and interpreted both the panel results and individual countries results.

The energy consumption is one of the key independent variable which is significant for our panel and as well as individual countries. The panel coefficient of energy consumption 1.73 implies that 1 percent increase in energy consumption causes almost 1.73% raise in economic growth. The energy consumption enhances growth level in all countries of our sample except India.

Table 9: PMG Results

Panel Results		**Individual Countries Results**					
Dependent Variable: lnY			**Bangl-adesh**	**India**	**Nepal**	**Pak-istan**	**Sri Lanka**
$\boldsymbol{lnK}$	0.04	$\Delta(lnK)$	0.14	0.11	0.02	0.11*	0.11*
Prob.	(0.81)	*Prob.*	(0.12)	(0.12)	(0.72)	(0.01)	(0.01)
$\boldsymbol{lnL}$	1.16*	$\Delta(lnL)$	0.32	-0.05	-0.85	0.06	0.11
Prob.	(0.01)	*Prob.*	(0.49)	(0.93)	(0.52)	(0.86)	(0.33)
$\boldsymbol{lnE}$	1.73*	$\Delta(lnE)$	0.09*	-0.54*	0.60*	0.55*	0.06
Prob.	(0.00)	*Prob.*	(0.08)	(0.03)	(0.02)	(0.00)	(0.39)
$\boldsymbol{lnT}$	0.29*	$\Delta(lnT)$	0.01	-0.13*	0.05	0.01	0.04
Prob.	(0.00)	*Prob.*	(0.53)	(0.01)	(0.17)	(0.84)	(0.39)
$\boldsymbol{lnF}$	-0.06	$\Delta(lnF)$	-0.06*	0.07	0.03	-0.02	0.01
Prob.	(0.47)	*Prob.*	(0.00)	(0.31)	(0.14)	(0.69)	(0.55)
$\boldsymbol{ec}$	-0.13	ec	-0.09*	-0.52*	0.02	-0.09	0.03
Prob.	0.19	*Prob.*	(0.00)	(0.00)	(0.68)	(0.23)	(0.25)

*Shows that the variable is significant and 'ec' is used for error correction term.

The coefficient of trade is 0.29 which is positive and significance at any level. The coefficient 0.29 shows that 1% rise in trade causes nearly 0.3% increases in growth. The individual country results expressed that trade has negatively effect on economic growth in India while others have very minute positive and insignificant impact on growth.

The panel results show that the coefficient of financial development is negative but insignificant. India, Nepal and Sri Lanka raise economic growth through financial development while statistically insignificant. Bangladesh and Pakistan have inverse relationship between financial development and economic growth.

The coefficient of EC is negative for our panel and all individual countries except Nepal and Sri Lanka. The negative sign shows the speed of correction towards equilibrium. The coefficients are insignificant for our panel and individual countries namely Pakistan, Nepal, and Sri Lanka. The coefficients of EC term are correct in sign and significant only in case of Bangladesh and India and coefficients are -0.09 and -0.52, respectively. It means that the long run adjustment in errors is corrected by 9 percent and 52 percent in Bangladesh and India, respectively.

8. Conclusion and policy implication

Energy is an emerging and challenging issue of the world. In south Asia, countries have limited resources but they are not extracting due to the heavy cost of exploration. Some of them have more resources of energy and enough capacity to control the energy crises but they are not playing an effective role in this field due to different reasons. For example Pakistan is not politically enough strong to resolve this problem and also lacks government funding.

Some of developing countries are not consuming energy in an efficient way. The inefficient use of energy has caused environmental problems such as increasing level of pollution. Clean and friendly environment is a basic need of the society for a quality life of its citizens. Intellectuals and researchers are working on how we can fulfil the energy requirement and make efficient use of energy. They are also trying to explore the problems which inhibit the provision of clean and healthy environment.

In recent years, the south Asian economies have witnessed rapid growth. The empirical results show a rising tendency of GDP in south as well as East Asia over 1985-2009 (Perera and Lee, 2013). Similarly, the World Bank reported that per capita GDP growth rate had been around 7.5% for these south Asian countries in 2007. Meanwhile per capita energy consumption for these economies is also showing an increasing trend for this region. We have conducted our study for south Asian economies because they are facing energy crises and have limited resources. So there is a need to investigate the solutions which this region is facing e.g., why our environment is polluting and what are the main factors.

Here, we have concluded the empirical findings of our study. Our findings indicate that the long run relationships exist among economic growth, energy, trade and financial development in south Asia. These indicators have a significant role in enhancing growth. Our findings express 1% increase in use of energy, trade and financial development increase the growth by 0.08 percent, 0.39 percent and 0.11 percent, respectively.

The trade increasing policies are necessary for the promotion of long run economic growth. The trade protection policies will retard economic growth progress in south Asia. Financial development acts a pertinent role in increasing economic growth; it gives the opportunity of investment and business for people of an economy.

The short run results express that energy and financial development boost the growth. The coefficient of energy turns out to be significant at 1% level of significance. In short run, trade has inverse relationship with economic growth. The coefficient of error (lagged) indicates that energy, trade and financial development contribute to establish the relationship with economic growth.

The results for casual relationship are as follows: in the short run, the results applying granger causality tests show that the feedback relationship exists between growth and energy. Similarly, the feedback relationship holds between international trade and financial development.

The results also show the existence of no causality among growth and trade, and among growth and financial development. In short run, causality does not exist among energy and financial development, and among energy and trade.

In long run, feedback relationship takes place among growth and energy consumption. The one way causality is growing from trade to growth.

The one-way causality is growing from trade to energy and from finance development to energy in long run. The negative sign of significant coefficient of energy consumption (-0.0251) shows the long run adjustment in error and 2.5% error is corrected in one year towards long run equilibrium.

8.1 policy implications

As growth hypothesis is valid, an energy conservative policy will harm to the economic growth in south Asia as well as emerging economies. Similarly, the feedback hypothesis among energy and growth implies that the conservative policy is not suitable for growth. The feedback association between trade and financial development suggests that financial development creates investment opportunities and trade growing opportunities in south Asia.

The feedback hypothesis between trade and capital recommends that capital is a main source of trade. The capital and financial development play an important role in enhancing trade and then trade increases economic growth. Therefore, trade policies should not be very restricted in this region as well as in the global world.

8.2 limitations and future prospects

Our study has incorporated very important determinants of co_2 emissions and economic growth, and applied different techniques for the analysis of south Asian region. The countries have different intensities of energy consumption but we have focused on total energy. There is need to do analysis taking the energy consumption at disaggregate level according to its intensity. Moreover, the researchers should work on energy intensity and energy efficiency which might be helpful in reducing energy consumption and pollution. The need is that to reduce the energy consumption because it increases the carbon dioxide emissions which may be the main cause of global warming. We suggest to environmental policy makers that they may devise regional friendly policies which are favorable for regional trade and economic growth.

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