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ENERGY SECURITY AND ECONOMIC GROWTH IN PAKISTAN

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Abstract

Energy is a crucial input in the process of economic growth. Sustainable economic growth necessitates the sufficient and continuous availability of energy. Pakistan is confronting energy insecurity which is seriously hindering the economic development and this study is an attempt to investigate the relationship between energy security and economic growth. The major concern of energy security is associated with the availability of suitable energy supply in cheap and consistent way to fulfill energy demand in the future. In this study, the demand and supply gap of energy is used as a proxy variable for energy security. The data source is the Energy Information Administration (EIA) where data is available at disaggregate level for different sources of energy (i.e., oil, gas, coal and electricity) for the period of 1980 to 2012. Therefore, aggregate variables are generated by converting data into unified unit of measurement. The Error Correction Model (ECM) is used to analyze the short-run and long-run causality between energy gap and the economic growth. The results show that unidirectional causality runs from energy demand and supply gap to economic growth in short-run as well as in the long-run. This relationship is negative and statistically significant in both the short- run and the long run which indicates that low energy security (i.e., increasing energy gap) halts the economic growth of Pakistan. Consequently, the study concludes that government should focus on better management of energy demand and energy supply.

Key words: Energy Demand, Energy Supply, Energy Security, Economic Growth, Time series.
JEL Classification: O4, Q00, Q4.

I. Introduction

Energy security is defined as, ‘it is reliable and suitable supply of energy at reasonable prices’ [Belicki (2002)]. Reliable and suitable supply indicates the continuous supply of energy in order to fulfill its demand. The major concern of energy security is associated with the availability of suitable energy supply at cheap and in consistent way to fulfill energy demand in the future days; while, worries for energy security was first felt after the 1970s oil price shock, but some energy economists believed that issues related to energy sector were solved through market, and there was no need to

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worry about the energy security. However, the continuous high oil price period came back again and the equilibrium of energy demand and supply again diverted attention of the world towards increasing the energy security. Many energy economists and the governments believe that energy insecurity problem would not be solved without the demand side management [Bhattacharyya (2011)].

For developing countries, it is essential to manage the energy demand because their share in the energy demand is more, as compared to the developed countries. According to the World Economic Outlook (2008), the worldwide energy demand is estimated to increase at the rate of 1.6 per cent, during 2006 to 2030; where the share of Asian developing countries in this demand will be around 38 per cent. In 2030 the primary energy demand in the non-OECD countries would increase to 63 per cent. The energy demand of the world would remain to around 65 per cent during 2007 to 2030. In 2005, the investment of US$26 trillion, were needed for the energy sector. Energy crisis is a severe issue in the South Asian countries because due to increase in population of the whole region its energy demand increases on daily basis. Saez (2007) contends that future energy consumption of South Asia will increase further due to the demographic trends. Increase in energy demand of Pakistan, India and Bangladesh will be a threat to their energy security because the south Asian countries did plan to increase their energy supply and thus their shortfall gap become wider between the energy demand and its supply.

Energy security plays a very important role for growth in transitional economies, such as Pakistan and energy demand and supply gap is increasing in the country. The electricity crisis for the last three decades is a failure of government, poor administration of the institutions, besides corruption in the energy sector. As a result of the current power outage situation the country is not only creating problems for residents/households but is also the cause of many industries shutdown. This will decrease the production and slow down the economy [Kessides (2013)]. According to Valasai, et al. (2017) there are many energy security concerns for Pakistan. Electricity shortfall is major issue of the country because of the increasing energy gap which further widens in the summer seasons. During the last decade, power shortage in the country varies from 8 to 12 hour in urban areas and for more than 18 hours, in rural areas. This shortfall is due to low investment and the political instability of ruling governments. This study also finds that due to global problem in supply, Pakistan is facing a challenge of meeting its electricity demand. The study suggests that policy makers should review their current strategies to minimize the electricity gap of supply and demand of the country [Valasai, et al. (2017)].

The main objective of this study is to analyze relationship between energy security and economic growth in Pakistan. For this purpose the energy demand and supply is used as a proxy variables for energy security. The error correction model (ECM) is used to analyze the short-run and long-run causality between energy gap and economic growth. The results show that, unidirectional causality exists from energy demand and supply gap to the economic growth. This relationship is negative and statistically significant in both the short-run and in long-run, indicating that low energy security halts economic growth of Pakistan.

The rest of paper is organized as follows: Section II presents the theoretical and graphical analysis of energy sources of Pakistan; Section III outlines the literature review on energy security and economic growth; and Section IV explains the methodology and estimation procedure. Data set is presented in Section V and Section VI presents the results. In the last part of the paper, Section VII concludes the discussion with policy suggestions.

II. Energy Sources of Pakistan

According to the U.S. Energy Information Administration (EIA)[1] the energy demand share of Pakistan in different energy sources was around 7 per cent in coal, 10 per cent in electricity, 39 per cent in petroleum, and 44 per cent in natural gas (Table 1), during the period 1980 to 2012. Power and transport sectors are leading consumers of oil; therefore, oil and natural gas are the two major sources of energy, covering 70 per cent of the energy demand in Pakistan.[2] In the past, the energy supply share of Pakistan was approximately 8 per cent in coal, 14 per cent in electricity, 27 per cent in petroleum and 51 per cent in natural gas. This statistics shows that Pakistan energy depends more on petroleum and natural gas.

TABLE 1

Energy Demand and Supply Share of Pakistan
for the period 1980 to 2012

Energy Source	Energy Demand	Energy Supply
Coal	07 per cent	08 per cent
Electricity	10 per cent	14 per cent
Natural gas	44 per cent	51 per cent
Petroleum	39 per cent	27 per cent

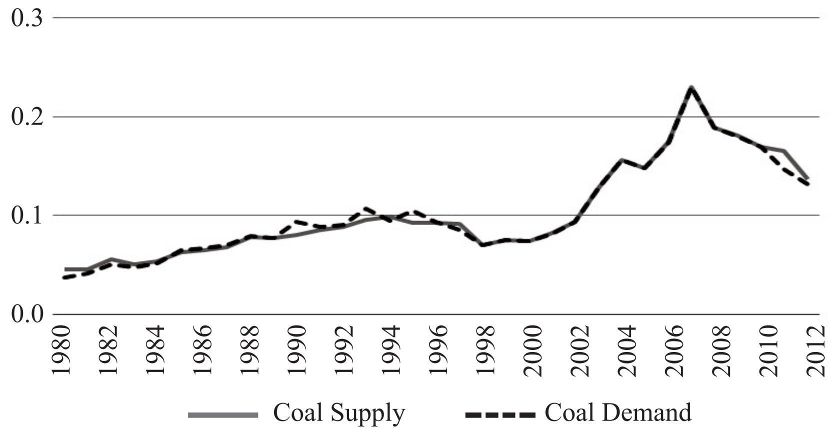
Source: https://www.eia.gov/beta/international.

1. Coal

Figure 1 shows the demand and supply of coal (in Quadrillion BTU) in Pakistan. It demonstrate very interesting results that during 1980 to 1984 coal demand was less than its supply, but between 1990 to 1997 its demand was greater than its supply, because as compared to consumption of coal our domestic production was low in this period. From 1998 onwards the consumption and supply of coal was almost the same, because thereafter its consumption decreased after 1997. The Economic survey of Pakistan 2014-15 coal resources of Pakistan were around 185 billion tones, which were estimated at 2 per cent of the world coal reserves. The government of Pakistan believes that coal expansion is very necessary for energy security. The main objective of 'Vision 2030' is to increase its production and use it in power generation.

[1] https://www.eia.gov/beta/international.

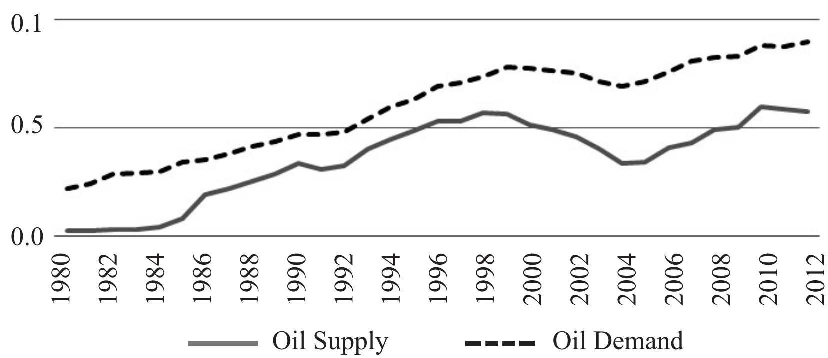
[2] Pakistan Economic Survey, Government of Pakistan, (2014-2015).



Source: Authors' vision.

FIGURE 1

Coal Demand and Supply



Source: Authors' vision.

FIGURE 2

Oil Demand and Supply

2. *Oil*

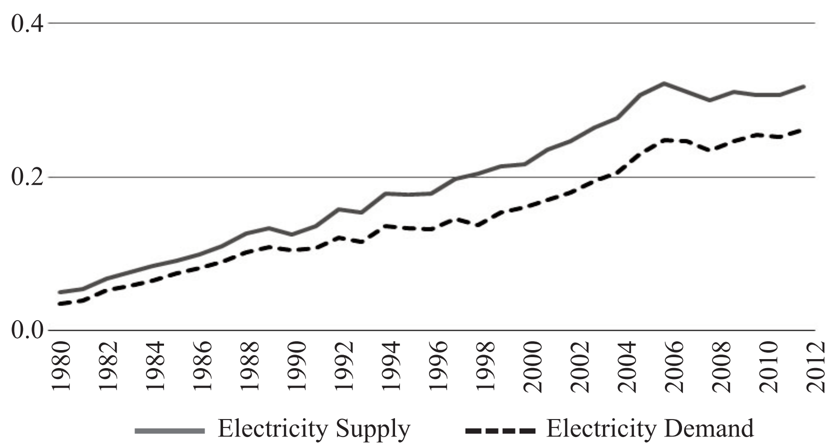
Figure 2 shows the demand and supply of oil (petroleum). From 1980 to 2012 the demand of the petroleum was greater than the supply of the country, but due to increase in crude oil prices the demand of oil showed a substantial decline during 2000 to 2006. In 2001 the average price of oil was US$22.99/barrel but in 2006 it increased to US$50.04/barrel; which was more than double as compared to the price of 2001. The crude oil price was at its highest (record) prices of US$140/barrel in

2008. Due to this volatility in prices the annual petroleum consumption started shifting to other energy sources i. e., coal, electricity and gas [Economic Survey of Pakistan (2014-15)]. In 2014, the oil share started rising again, because of the gas load management and decrease of oil prices. The oil prices fell to its lowest level of US$28/barrel level in February 2016. The fall in oil prices tends to increase international savings and people would spend this saved money on consumption of other goods and services.

3. Electricity

In Pakistan, electricity is the secondary source of energy which is essential for household consumers as well as the other domain like transport industry, etc. The electricity sector face many problems due to power generation theft, inadequate accumulation rates, line losses, undersupply and very high subsidy on natural gas. These issues have brought the financial losses for generation companies which leads to widespread the power shortage. Load shedding is the major concern of the people of Pakistan because it is not only creating disturbance for the society but it also, worsen the economy and real GDP growth rate.

Figure 3 shows the electricity supply and demand in Quadrillion BTU, from 1980-2012. It indicates that electricity supply is more than its demand but in spite of that Pakistan is facing heavy shortfall of electricity; due to transmission and distribution losses of electricity. Malik (2012) argues that in 2009-10 electricity distribution and transmission losses were around 22 per cent, which was entirely higher



Source: Authors' vision.

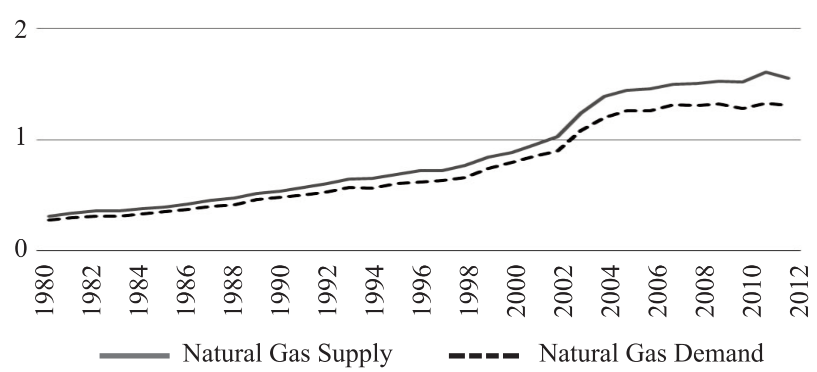
FIGURE 3

Electricity Demand and Supply

than the other Asian countries. Transmission and distribution losses in China are 8 per cent and in Korea they are 3.6 per cent. According to the International Energy Agency (IEA), the installed capacity of electricity in Pakistan is 23,000 Megawatt (MW) and the annual electricity demand of the country is 17,000 MW; whereas, the available capacity of electricity is only 14,000 MW, which is far behind the electricity demand of Pakistan.

4. Natural Gas

Natural gas is one of the most established energy sectors of Pakistan; and its distribution system is also very well settled, throughout the country. The natural gas supply and demand remained unchanged from 1980 to 1995 (Figure 4); but due to increase in the share of energy usage, the difference in its demand and supply increased suddenly. This gap started when there was high increase in petrol prices in 2005-06; and also, because of cheap price of gas people substituted to use gas against petrol. According to the Pakistan Economic survey 2014-15, it was estimated that during the fiscal year of 2015-16, roughly 419,445 new consumers were entitled for the gas connection, which was also given, as well. Pakistan natural gas production was 4000 million cubic feet and the demand of natural gas was 6000 million cubic feet, which was expected to increase to 8000 million cubic feet by 2015-16. Due to reduction in the natural gas resources there is a threat for the sector because finding of new gas resources is very sluggish.



Note: Demand and Supply of Natural Gas is in Quadrillion BTU (1980-2012).

Source: Authors' vision.

FIGURE 4

Natural Gas Demand and Supply

III. Literature Review

Energy is considered to be a central input in the process of economic growth. Sustainable economic growth necessitates sufficient and continuous availability of energy input [Kraft and Kraft (1978), Yu and Hwang (1984), Stern (1993)]. Many energy economists investigated the relationship between energy usage and economic growth. Their views, opinions and arguments differ and lead to occurrence of different results. These studies used diverse econometric techniques to investigate the relationship between energy and economic growth, and therefore, their results were dissimilar. Some studies found that no relationship exist between energy usage and the economic growth [Yu and Hwang, (1984), and Stern (1993)[; while, others found that the bidirectional causality exist between energy and growth [Soytas and Sari (2003), and Ghali and El-Sakka (2004)]. However, from the Pakistan's perspective, energy is one of the main determinants of economic growth. Studies by Kakar and Khilji (2011), and Chaudhary, et al. (2012) found a unidirectional causality running from energy consumption to economic growth. Another study by Shahbaz and Feridun (2011) observed a long-run relationship between the power consumption and economic growth.

During the time period of 2002 to 2025 the energy demand is expected to increase by 57 per cent, and on the other hand, global energy supply is facing many challenges. Due to these imbalances in energy supply and demand the energy security is at stake. The extent to which the energy security relates to economic growth has received a lot of attention in the economic literature [Lu, et al. (2014), Cherp and Jewell (2014), and Awan and Khan (2014)] which give theoretical framework on relationship between the energy security and economic growth. This study, empirically investigate the energy security and economic growth in Pakistan; the road map is that by 3016 its economic growth would recover, gradually to 4.6 per cent. Further progress depends on tackling the key growth constraints, such as frequent energy shortage. The current energy crisis in Pakistan arises due to the rising trend in energy supply and the demand gap. Therefore, due to this gap energy security is at risk in Pakistan. The focus of the state is on the supply side; but the energy efficiency and energy conservation (EEEC) policy can reduce the demand of energy which would be more cost-effective, than increasing the energy supply. For energy security of Pakistan, it is also important to use the alternate energy sources and increase the domestic energy production. The energy supply and demand is not only important for economic prosperity but it is also essential for the society’s living standards [Khalil and Zaidi (2014)].

Due to power shortage in Pakistan the economic growth is affecting adversely, in all spheres of peoples’ lives. Electricity is the major source of energy sector, which is going through the worst condition. As a result of this crisis, socio-economic and industrial growth slowdown in the country, will lead to affect the economy of Pakistan and create many other problems, like unemployment and poverty. The best way to solve this calamity is to use alternative energy resources which will not only solve the current energy crisis but will also reserve the energy security for future generations of Pakistan. If government follows its target of National Energy Security Plan (NESP), then this issue might be solved early [Shaikh, et al. (2015)]. In order to improve the living standard of people, the focus of government should shift towards the renewable energy, because it plays a significant role to get rid from the electricity crisis of the country. For progress of any country, industrial growth is very important but it depends on consistent supply of energy while, Pakistan is going through the energy crisis which will badly affect the people lives [Awan and Khan (2014)].

IV. Methodology

1. Theoretical Model

The relationship between energy and economic growth is complex. Some researchers believe that energy is not the part of production because it has small cost share while others believe that energy is a fundamental part of production function. The study by Ayres, et al. (2013) and Vlahinic and Zikovic (2010) found that energy is as important as labor or capital in economic growth. It is not possible for labor and capital to function without the use of energy. Stern and Cleveland (2004) and Provoski (2003) showed the relationship between energy and economic growth, and explained that energy plays a very vital role in economic growth. The human work can be replaced by other appliances/machinery with the help of energy sources.

The construction of new production theory with addition of energy factor in production function has many benefits. It explains the structure of growth by stating the peripheral sources of energy, if the Solow (1994) argument can be used, i.e., “to show the endogenous segment of innovative advancement as a necessary part of the hypothesis of economic development.” The production factor has three factor of production; capital, labor and energy. Capital and labor are predictable while energy can explain the productivity growth.

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

The above production function shows that output is a function of capital, labor and energy; whereas, in many economic studies energy is not utilized effectively. Energy is a preserved quantity which is not replenished, or it will run out in the economic process, or it will not be included in the factor of production. Therefore, energy is replaced by the exergy. This refers to as part of energy which is used in the economic process. The major difference between exergy and energy is that exergy is not the conserved quantity [Nokicenovic, et al. (1995)]; whereas, some studies illustrate that energy is used in the factor of production and, it plays an important role in economic development [Ebohon (1996), and Stern and Cleveland (2004)].

Although, energy is an important input in production process, it is also considered as one of the main determinants of economic growth. However, it could have adverse effect on developing economies where energy demand is higher than the energy supply, and therefore the governments have to depend on energy imports. In these developing economies, an increase in demand of energy could enlarge the energy demand and supply gaps. These gaps may have potential to halt economic development in the long-run. A study by Asafu-Adjaye (2000) supports the above argument and observed that in Thailand and Philippine, increase in energy consumption does not raised the economic development, because (at that time) the energy supply of these countries was less than the energy demand. Another study by Aqeel and Butt (2001) observed neutrality hypothesis between energy consumption and economic development in Pakistan, and specified that increase in energy consumption does not affect economic growth because of energy shortfall in the country.

However, in developed countries where energy gaps are small, adding more energy demand may increase the economic growth. In established countries like Sweden, Canada and USA, increase in energy usage will lead to increase the economic development [Ghali and El-Sakka (2004), Chima and Freed (2005), and Stern and Enflo (2013)]. In these countries energy demand affects economic progress positively, in the long run; as they focus on energy supply and manage their energy sector more efficiently as compared to the developing countries. The transmission and distribution loss in developed countries is very low as they make policies which reduce the the energy demand. Hence, the argument that high energy insecurity (i.e., Energy Gap>0) could halt economic growth in the long-run and can be tested for Pakistan by following the estimation procedures.

2. *Estimation Procedure Relationship between Energy Security and Economic Growth*

Pakistan is a developing country where energy gaps are high, due to energy supply constraints and the rising energy demand. In this study energy gaps are used as proxy for energy security. Therefore, it is necessary to analyze the relationship between these energy gaps and the economic growth. As a first step, the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests are used to find the order of integration of GDP and the energy gap. Since both these series are non-stationary in nature, they may have long-run or co-integrating relationship. Therefore, these series can be represented and estimated in the following error correction model (ECM).

$$\Delta \ln y_t = \alpha_0 + \sum_{p=1}^{m} \alpha_1 \Delta \ln y_{t-p} + \sum_{q=1}^{m} \delta_1 \Delta \ln egap_{t-p} + \varphi \hat{e}_{t-1} + u_t \quad (2)$$

$$\Delta \ln egap_t = \beta_0 + \sum_{p=1}^{m} \beta_1 \Delta \ln y_{t-p} + \sum_{q=1}^{m} \rho_1 \Delta \ln egap_{t-p} + \phi \hat{e}_{t-1} + v_t \quad (3)$$

The variable is the growth rate of GDP and $\Delta ln\ egap_t$ is the growth of energy gap at time period t; and $\hat{e}_{t-1}$is one period lag of residuals from the long-run co-integrated relationship ($ln\ y_t = \alpha_1\ \alpha_2\ ln\ egap + e_t$) which is estimated using fully modified ordinary least squares. T-test on the point estimate for φ [from Equation (2)] would be a test on long-run Granger-causality from *egap* to *y*, and accordingly, a T-test on the point estimate for φ [from Equation (3)] would be a test on long-run Granger-causality from *y* to *egap*.

The simultaneity of economic growth and energy security needs a specific analysis that gives role to the two-ways predictability evident. The error correction model is used to find the short-run and long-run, as well as the causality between energy gaps and GDP with time series data from Pakistan, for the years 1980 to 2012. On the assumption that lag length *m* is correctly specified by using AIC in the short-run causality, the variable energy $\Delta ln\ egap$ says no to Granger cause. Variable $\Delta ln\ y$ which is not significantly different from zero, if ($\delta_1 = 0$ for $l = 1,\ldots, m$). In other words, if history of $\Delta ln\ egap$ does not improve the prediction of $\Delta ln\ y$, given the history of $\Delta ln\ y$; then the growth of energy gaps do not cause the growth rates of GDP. Similarly, growth rates of GDP do not cause growth of energy gap, if in the energy gap equation $\beta_1 = 0$ for all $l = 1, \ldots, m$.

V. Data and Variable Construction

This section covers the internationally comparable Energy Information Administration (EIA) dataset for the period of 1980 to 2014. It provides data on energy at disaggregate level (i. e., petroleum, natural gas, electricity and coal) in different units. All disaggregate data in the same unit of British thermal unit (BTU) is converted. The unit conversion factor is as under:

Description	Conversion Factor
1 cubic foot of Natural gas	= 1,028 BTU
1 kilowatt-hours of Electricity	= 3,412 BTU
1 Barrel (42 gallons) of crude oil	= 5,800,000 BTU

Source: https://www.eia.gov/beta/international.

The data on GDP is taken from the World Development Indicators with constant US$. 2005. The time period used for analysis was from 1980 to 2012. In the second stage, energy demand and energy supply series were generated as under.

1. Energy Supply at Aggregate Level

The International Energy Agency [IEA (2004)] is followed to make the energy supply function:

$$ES_t = EP_t + (EI_t - EE_t) \tag{4}$$

where, ES_t is energy supply, EP_t is energy production, EI_t is energy imports and EE_t is energy exports at time *t*.

2. Energy Supply at Disaggregate Level

a) Electricity

The data on electricity production, its import, export and consumption is taken from the U.S Energy Information Administration (EIA). The unit of data is billion kilowatt-hours, which is converted in quadrillion BTU by using unit convertor.

$$ElecS_t = ElecP_t + (ElecI_t - ElecE_t) \tag{4a}$$

where, $ElecS_t$ is electricity supply, $ElecP_t$ is electricity production, $ElecI_t$ is electricity imports and $ElecE_t$ is electricity exports.

b) Coal

Coal is also used for production, consumption, export and import to generate coal supply series. The data of coal consumption and production is available in quadrillion BTU. We construct the supply of coal as follow:

$$CLS_t = CLP_t + (CLI_t - CLE_t) \tag{4b}$$

where, CLS_t is coal supply, CLP_t is coal production, CLI_t is coal imports and CLE_t is coal exports at time *t*.

c) Natural Gas

Natural gas is an established sector of Pakistan. The distribution system of gas sector is well established. This study uses the natural gas consumption and production data which is also in quadrillion BTU. Its supply function is mentioned below:

$$NGS_t = NGP_t + (NGI_t - NGE_t) \tag{4c}$$

where, NGS_t is natural gas supply, NGP_t is natural gas production, NGI_t is natural gas Imports, and NGE_t is natural gas exports.

d) Petroleum Products

Data on petroleum products is available in thousand barrel per day which is first transformed into annual data base and multiplied by 365 days; thereafter, ot os converted in quadrillion BTU.

$$PetrlS_t = PetrlP_t + (PetrlI_t - PetrlE_t) \tag{4d}$$

where, $PetrlS_t$ is petroleum supply, $PetrlP_t$ is petroleum production, $PetrlI_t$ is petroleum imports and $PetrlE_t$ is petroleum exports.

3. Energy Demand

Energy consumption is used as a proxy variable for energy demand [Wolde, (2005)]. Therefore, the total primary energy consumption is used as a proxy variable for energy demand. The data of total primary energy consumption is taken from the U.S. Energy Information Administration (EIA).

$$ED_t = NGD_t + ElectD_t + CLD_t + PetrlD_t \quad (5)$$

where, ED_t is energy demand, NGD_t is natural gas demand, $ElectD_t$ is electricity demand, CLD_t is coal demand and $PetrlD_t$ petroleum demand.

4. Energy Gap and Energy Security

In this study, energy gap is used as a proxy variable for energy security. When there is a gap between the energy demand and supply increase, it indicates that energy insecurity is increasing. The energy gap equation is given in Equation (6).

$$e\ gap_t = ED_t - ES_t \quad (6)$$

where $egap_t$ is energy gap and ES_t is energy supply.

VI. Estimation and Results

1. Relationship between Energy Security and Economic Growth

According to the theory of co-integration there is at least one long-run equilibrium relationship among existence of variables. In this case, Granger causality exist among these variables in at least one way [Engle and Granger (1987)]. In this study the error correction model (ECM) is used to analyze the long-run, as well as the short-run causalities between the energy security and economic growth. Therefore, as a first step, there is a need to know the integration order of both series. The Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) are used to test the unit roots. Results of Table 2 shows that gross domestic product (GDP) and energy gap, both are integrated to order one [I (1)] because both series are stationary at first difference.

Based on the results of Table 2 gross domestic product y_t and series of energy gap ($egap_t$) are the best characterized as $I(1)$, where the long-run or co-integrating relationship between these two series is followed. The residual series ($\hat{e}_t$) is generated from the long-run co-integrated relationship ($ln\ y_t = \alpha_1 + \alpha_2\ ln\ egap + + e_t$), which is estimated by using ordinary least squares. Table 3 shows the long-run relationship between the energy gap and GDP.

TABLE 2

The Results of Unit Root Tests

Test	$ln\ y_t$		$\Delta\ ln\ y_t$		$ln\ egap_t$		$\Delta\ ln\ egap_t$	
	Test value	p value	Test value	p value	Test value	p value	Test value	p value
ADF-test	8.10	0.98	24.65	0.000***	3.05	0.17	42.30	0.022***
PP-test	4.80	1.00	-44.01	0.000***	1.37	0.25	401.01	0.024***

Source: Authors' estimation.
Notes: Automatic selection of lags based on minimum AIC: 0–3.
***, **, and * denote rejection of null hypothesis at 1, 5 and 10 per cent level of significance.

Results of long-run equilibrium relationship presented in Table 3 shows the coefficient of energy gap (-0.03) which is negative and significant at one per cent level of significance. This means that an increase of one per cent in energy demand and its supply gap will reduce GDP by 0.03 per cent for Pakistan in, the long-run. After examining the long-run relationship between energy gap and GDP the next step is to investigate the direction of causality between energy gaps and economic growth in short-run and in the long run. For this purpose the error correction model (ECM) motioned in Section IV [Equations (2) and (3)], is used where, ($\hat{e}_{t-1}$) is a one period lag of residual from the long-run co-integrated relationship ($ln\ y_t = \alpha_1 + \alpha_2\ ln\ egap + + e_t$), which is estimated by OLS. A T-test on point estimate for φ [from Equation (2)] would be a test on long-run Granger-causality from *egap* to *y*, and accordingly, a T-test on point estimate for φ [Equation (3)] would be a test on long-run Granger-causality from *y* to *egap*. Results of Table 4 shows that coefficient of $\hat{e}_{t-1}$ (φ) is negative and significant but the coefficient of $\hat{e}_{t-1}$ (ϕ) is statistically not significant. Therefore, significance of φ shows the long-run Granger-causality which runs from energy demand and supply gap (*egap*) to gross domestic product (*y*).

TABLE 3

Results for Long Run Relationship

$ln\ y_t = \alpha_1 + \alpha_2\ ln\ egap + + e_t$ Dependent Variable: $ln\ y_t$	
Variable	Coefficient
C	0.82***
$ln\ egap_t$	-0.03***
No. of Observations	0.33
R^2	0.26

Source:Authors' Calculations.

On the other hand short-run dynamics also reveal that unidirectional causality runs from energy demand and supply gap to the economic growth. The coefficients on lag value of energy gap (-0.004^{***} and -0.0260^{***}) are negative and statistically significant. This shows that an increase in energy gap (i.e., decrease in energy security) would decrease the economic growth. The upsurge in economic growth is caused by decrease in energy security. The negative impact of energy demand and supply gap on economic growth could be a result of high energy demand or decreasing energy supply in Pakistan. This argument is supported by the Asian Development Bank; and this study finds that due to increase in power shortages economic growth is decreased in Pakistan by 2 per cent. Another study by Morimoto and Hope (2004) also found significant relationship between electricity supply and economic growth in Sri Lanka. A study by Khan and Ahmed (2012) highlighted the role of rising energy demand and supply gap for economic growth and argues that energy consumption and production gap is one of the main determinants of slow growth of Pakistan. Due to increase in energy demand, energy security will be in danger in future. The government is focusing on short term policies, which will not fulfill the future energy demand of the country.

VII. Conclusion

The objective of this study is to investigate relationship between energy security and economic growth in Pakistan. Energy demand and supply gap was taken as a proxy for energy security. Data of energy (i.e., natural gas, coal, electricity and petroleum products) was taken at disaggregate level from the U.S. Energy Information Administration (EIA). The disaggregated energy data was used to generate energy demand and supply gap at aggregate level; as the data was in different units it became one of the main obstacle which was solved by converting in same unit of British thermal unit (BTU).

In this study error correction model (ECM) is used to analyze long-run as well as the short-run causalities between energy security (i.e., energy demand and supply gap) and the economic growth. The results of long-run equilibrium relationship shows that an increase of one per cent in energy demand and energy supply gap will reduce the GDP by 0.03 per cent for Pakistan in the long-run. It implies that economic growth is decreasing due to energy insecurity. After examining the long-run relationship between energy gap and GDP, the next step is to investigate the direction of causality between energy gaps and economic growth in short-run and the long run.

The short-run dynamics also reveal that unidirectional causality run from energy demand, and the supply gap to economic growth. The coefficient on lag value of energy gap (-0.004^{***} and -0.0260^{***}) are negative and statistically significant (Table 4). This implies that an increase in energy gaps (i.e., decrease in energy security) would decrease the economic growth. The results indicate that rising energy demand and supply gaps halts the economic growth. The negative relationship between energy gaps and economic growth could be a result of increasing energy demand or decrease in energy supply. Therefore, it is important to know the remedies to narrow down the energy demand and supply gaps (i.e., raise energy security) for development in Pakistan.

Therefore, the proposed objective of the study is to overcome the problem of energy insecurity and make necessary policy recommendations. The government of Pakistan should focus on both the supply and demand management and theories on energy demand should be based on importance of energy efficiency. Energy efficiency refers to the effective and efficient utilization of the available energy resources and if this is improved, it will produce the same amount of output by using less energy. This is one way to improve energy security by lowering energy demand. A study by Ozturk (2014) also highlighted the importance of energy efficiency for energy security. This study

TABLE 4

Results for Equations (2) and (3), (T=34, 1980–2014)

OLS Method on Equation (2)		OLS Method on Equation (3)	
Dependent Variable: $\Delta\, ln\, y_t$		Dependent Variable: $\Delta\, ln\, egap_t$	
Lag Length m =2		Lag Length m =2	
Variable	Coefficient	Variable	Coefficient
C	0.02***	C	0.55
	[2.24] (0.03)		[0.64] (0.61)
$\Delta\, ln\, y_{t-1}$	0.43***	$\Delta\, ln\, y_{t-1}$	-0.8
	[2.30] (0.03)		[-0.85] (0.40)
$\Delta\, ln\, y_{t-2}$	0.51	$\Delta\, ln\, y_{t-2}$	-0.83
	[0.29] (0.77)		[-0.39] (0.67)
$\Delta\, ln\, egap_{t-1}$	-0.004*	$\Delta\, ln\, egap_{t-1}$	0.024
	[-1.56] (0.09)		[0.13] (0.89)
$\Delta\, ln\, egap_{t-2}$	-0.026***	$\Delta\, ln\, egap_{t-2}$	0.25*
	[-2.30] (0.04)		[1.56] (0.09)
R(-1)	-0.024***	R(-1)	-0.15
	[-2.25] (0.06)		[-0.25] (0.98)
No. of observations	30	No of observations	30
R^2	0.46	R^2	0.48
F-statistic (p-value)	-2.28	F-statistic (p-value)	1.02
D.W. statistic	1.87	D.W. statistic	1.97

Source:Figure is based on Authors' Calculations.
Notes: Automatic selection of lags based on minimum AIC: 0–2.
t- statistics in parenthesis [..] and probability or p-value in small brackets (...).
***, **, and * denotes rejection of null hypothesis at 1, 5 and 10 per cent level of significance, respectively.

points that if government increase the energy efficiency, then it will not only save the exchequer but will also reduce the energy import dependency which will lead to boost the economy [Qzturk (2014)]. On the other hand, theories based on energy supply would give more importance to reliance on renewable energy resources for sustainable development. The government should use the alternative energy resources (i.e., solar energy, wind power and hydro power energy) to produce electricity in relatively cheap and efficient way.

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