ENERGY CONSUMPTION AND ECONOMIC GROWTH
AN ANALYSIS OF CENTRAL ASIAN STATES

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Abstract

Energy is critical, directly or indirectly, in the entire process of evolution, growth and survival of all living beings and plays a vital role in the socio-economic development and human welfare of a country. It is seen as a 'strategic commodity' and any uncertainty about its adequate availability can threaten normal functioning of an economy, predominantly those which are developing. Realizing the energy security in its strategic sense, is of fundamental importance not only to economic growth but also for the human development objectives that aims at the alleviation of poverty, unemployment and meeting the Millennium Development Goals (MDGs). Thus, energy is thought 'the lifeblood of modern economies' as there exists a strong link between the energy consumption and economic growth. Central Asian countries comprising Kazakhstan, Turkmenistan, Uzbekistan, Kyrgyzstan and Tajikistan are among those countries which are blessed with significant energy resources. In view of their existing potential, the harnessing of energy wealth in these Central Asian countries will not only fulfill their domestic demand but also leave a large share for export. In order to sustain the long run growth, the Central Asian Countries known for inefficient energy consumption pattern have to bring efficiency and spend judiciously the earnings realized through surplus energy exports. For maintaining and enhancing energy exports, they should also invest in areas of renewable energy like solar and wind. Importantly , in view the vital and crucial role of energy in the process of economic growth, and the link between energy consumption and real output for five Central Asian countries suggests that inefficient energy consumption pattern, if continues, may negatively effects their economic growth which eventually would results a fall in income and employment. Thus, according to the results, Central Asian countries would be in large profit by adopting energy conservation policy to avoid any kind of energy shortages. In this backdrop, the present study has been undertaken to study the energy consumption pattern of Central Asian countries and suggest for the pattern, which is efficient and sustainable. However, the study is delimited to hydrocarbon and hydropower of five Central Asian States.

Introduction

Energy is the engine of economic growth, as all production and consumption activities involve energy as basic input[1]. On the 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 18th and 19th centuries. However, in 20th century, the growth of industrial nations has observed a fourth major input i.e., energy. On consumption side, in the John Maynard 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 Gross Domestic Product (GDP) and GDP per capita. Economic growth and prosperity, however, does not simply depend upon the availability of energy input, but how energy be utilized. In the current global competitive atmosphere, it is the judicious use of resource which matters and same is true of energy input.

Conspicuously energy consumption and economic growth are interrelated in two respects as energy is consumed for two purposes. One, it is a production input and the other, is one of the important means of human comforts. As a production input it is a causeway to development process. An increase in its consumption means a higher level of economic activity and greater production of goods and services and vice versa. As a means of providing comforts it is necessary fallout/outcome of development[2] process. Such a relationship between energy use and economic growth are often exposed in terms of the relations between energy consumption to gross domestic product or E/GDP ratio or energy intensity. However, the main aim of this study is to testify whether energy consumption (EC) leads to economic growth or economic growth causes the energy consumption.

Importantly the growing pattern of global economic development has influenced the whole world so much so that energy security has emerged as one of the major developmental goals of any nation whether it is in the economic *Take off Stage*[3] or has reached the Stage of *High Mass Consumption(Walt Whitman Rostow)*.[4] Without having sufficient energy resources "nations can neither initiate the process of economic growth and development nor sustain it for long".[5] It is because of this realization of the importance of energy security that nations all over the world are now developing sophisticated and appropriate *technology* to harness both the renewable and non-*renewable sources of energy*. While doing so these nations are not only involved domestically but also externally through bilateral and multilateral ties in their immediate and extended neighborhoods as well as in the far off regions and continents. However, nearer the source of energy to a country, the greater is comparative advantage in actualizing that resource potential.[6]

In recent years, as the list of countries among the emerging economies

category are increasingly characterized by high rates of economic growth, which has also led to difficulties in achieving a sound balance between demand and supply of energy resources necessary to maintain their national economic growth and development. Although, they are trying hard to arrive at an appropriate energy mix, increase in their energy efficiency and diversify their sources of supply and the question of maintaining a stable supply of fossil fuels continue to pose several security challenges. One is to boost one's own production, another to diversify one's sources of import, and a third to secure the transportation of hydrocarbons (oil and natural gas) on vulnerable sea routes or overland through pipelines that depend on long-term strategic relationships with the producing countries. This may result in the formation of such a system of mutual relations in the world that in totality of its volume and scope may most effectively serve the interests of both the manufacturers of energy resources as well as their consumers.[7] However, Central Asia,[8] a land locked region, bestowed with vast energy resources especially hydrocarbon reserves. It also possesses a significant and diversified resource base for its power industry although resources are unevenly spread throughout the region. Apart from vast volumes of proven recoverable resources of hydrocarbon raw materials, the region has huge hydropower capacity, large deposits of uranium and favorable conditions for the development of nonconventional renewable energy. A large part of proven recoverable oil reserves are found in Kazakhstan, natural gas in Turkmenistan and Uzbekistan while Kyrgyzstan and Tajikistan is the hub of hydropower resources. The energy sector holds an important place in the economies of this region as it provides required fuel to the respective economies and surplus energy for export.[9]

Notably energy plays an important role both on the demand and the supply sides of the economy. On the demand side, energy is one of the products which a consumer decides to buy to maximize his utility. On the supply side, energy is the critical factor of production in addition to labour, capital and other raw materials. Energy is considered to be the crucial element in the socio-economic development of a country as it helps to improve the living standards of the society through the increase in economic growth. This implies that there is a causal link running from energy consumption to economic growth. However, the 1970s energy crisis attracted the analysts to investigate the relationship between the energy consumption and economic growth, as it was argued that energy consumption directly causes GDP growth. Since, the end of 1970s, many studies[10, 11, 12] have been conducted to support the arguments which suggest that energy use was 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.

Predominantly, if causality runs from energy consumption (EC) to Gross Domestic Product (GDP) then it implies that an economy is energy

dependent and hence energy is a stimulus to economic growth.[13] Shortage of energy may negatively affect the economic growth or may cause poor economic performance leading to a reduction of income and employment. On the other hand, if causality runs from Gross Domestic Product (GDP) to energy consumption (EC), this implies that economy is not energy dependent, and hence energy conservation policies may be implemented without adverse effects on economic growth and employment.[14] Bidirectional causality indicates that both energy consumption and high level of economic activity mutually persuade each other. If there is no causality between energy consumption and Gross Domestic Product (GDP), implies that energy conservation policies may pursue without affecting the economy.[15] The existence of relationship between real output, energy consumption, capital and labour, has now been implementing autoregressive distributed lag (ARDL) model to examine the long-run and short-run relationship between the real output, energy consumption, capital and labour of all the Central Asian countries.

Database and Methodology
The present work is primarily based on secondary sources of data; therefore, the data has been collected from publications of the prestigious international organizations such as, International Energy Agency (IEA), Energy Information Administration (EIA), British Petroleum Statistical Review of World Energy (BP), Asian Development Bank (ADB) and the World Bank (IBRD). Also the information has been used from various reliable journals, international reports and published books. The data thus, collected has been analyzed and interpreted and inferences have been drawn with the help of following statistical tool of analysis know as Autoregressive Distributed Lag (ARDL) Model. This model has been applied to examine the long-run and short-run relationship between the real output, energy consumption, capital and labour by the given equation of the model for all the Central Asian countries:

$$Y_t = \emptyset_o + \sum_{i=1}^{k} \emptyset_1 \, y_{t-1} + \sum_{i=0}^{k} \emptyset_2 \, enrg_{t-1} + \sum_{i=0}^{k} \emptyset_3 \, k_{t-1} + \sum_{i=0}^{k} \emptyset_4 l_{t-1} + \eta_t$$

Results and Discussion

Kazakhstan
The results (table-1) reported in the case of Kazakhstan suggest that energy, capital and labour exerted positive impact on real output. However, the relative impact of labour and capital is more on the output. The magnitude of energy is equal to (0.19) which is low as compared to the magnitude of labour (0.37), but higher than the magnitude of capital (0.05) in the long-run. The short-run impact of energy growth is significant and more in terms of size as compared to capital, while the short-run impact of energy is less

than that of labour. This implies that in the short-run labour and energy are the key factors playing a dominant role in enhancing economic growth in Kazakhstan. The error-correction coefficient is -0.79 which is highly significant suggesting the existence of long-run causality running from energy to economic growth. Furthermore, in the short-run the coefficient of energy is positive and significant, indicating that the presence of causality running from energy to economic growth. This result has important policy implications that Kazakhstan's economy is energy dependent and the shortage of energy would adversely affect its economic growth and employment. Presently, Kazakhstan faces the wastage of energy given their technologic knowhow. In June 2015 its demand for primary energy was equal to 58.1(BP Statistical Review of World Energy June 2015, p. 41) million tons of oil equivalent(mtoe) while supply has been equal to 157.8(BP Statistical Review of World Energy June 2015, pp. 3-32) mtoe and the surplus stood the republics at 99.7 mtoe respectively. This surplus could give more push to the sustainable growth process if the wastage could be controlled through the energy efficiency.

Table-1
Long – run and Short – run Estimates of Energy Consumption and Real GDP of Kazakhstan

Kazakhstan	**Long-run estimates**
	$y_t = 0.19 enrg_t + 0.05k_t + 0.37l_t + 0.07 trend.$ (5.05)* (1.56) (8.43)* (11.33)*
	Short-run estimates
	$\Delta y_t = 0.09 enrg_t + 0.05\Delta k_t + 0.37\Delta l_t + 0.03\Delta trend - 0.79 Ecm_{t-1}$ (4.31)* (1.53) (4.69)* (5.29)* (-6.01)*
	$\overline{R^2} = 0.89$ $F - Statistic = 13.17$ $S.E. = 0.07 Dorbin - Watson = 5.37$

Note: * indicate significant at 5% level of significance

Turkmenistan
In the case of Turkmenistan both energy and capital has been positively related to real output in the long-run(table-2). However, capital remained the dominant factor in determining the output in the long-run as indicated by the size of the coefficients of the energy (0.39) and capital (0.75). However, in the short-run energy (0.89) has positive and strong impact on growth and the relative impact of energy consumption has more than the real capital stock. The key ingredient of economic growth in Turkmenistan has been the energy and capital stock (0.57). But, labour plays a minor role in the economic growth process in Turkmenistan. The error–correction (-0.79) term was negative and significant supporting the evidence of long-run causality between economic growth and the energy. The coefficient of energy is positive and significant in the short-run also support the presence of short-run causality between energy and growth. This result suggests that Turkmen economy is heavily energy dependent. In fact, the gap between energy consumption and energy production has been consistently increasing.

Table-2
**Long – run and Short – run Estimates of Energy Consumption
and Real GDP of Turkmenistan**

	Long – run estimates
Turkmenistan	$y_t = 0.39enrg_t + \mathbf{0.001}l_t + 0.75k_t + 0.07trend$ (5.53)* (2.62)** (1.31)
	Short-run estimates
	$\Delta y_t = 0.89\Delta enrg_t + 0.57\Delta k_t + 0.002l_t + 0.007\Delta trend - 0.79Ecm_{t-1}$ (4.33)* (3.83)* (0.97) (-3.04)
	$\overline{R^2} = 0.77$ $F - Statistic = 6.13$ $S.E. = 0.09 Dorbin - Watson = 7.23$

*Note: *, ** Indicate significant at 5% level of significance*

Uzbekistan

The results (table-3) suggest that both energy consumption and capital exerted positive impact on real output and the impact of energy is relatively higher. This result suggests that real GDP and energy consumption has been significantly interrelated and the shortage of energy may retard economic growth process. Surprisingly labour effect on real output was negative in the long-run. This could be due to the large proportion of old and underage population not able to work. Although, labour plays a significant role in Uzbekistan's economic development, but the large share of children and old people offset the positive impact of labour.

Table-3
**Long – run and Short – run Estimates of Energy Consumption
and Real GDP of Uzbekistan**

	Long-run estimates
Uzbekistan	$y_t = 3.89inpt + 0.69enrg_t + 0.32k_t - 0.17l_t + 0.05trend$ (2.20)* (4.84)** (3.84)* (-2.81)** (7.77)*
	Short-run estimates
	$\Delta y_t = 1.01\Delta inpt + 0.37\Delta enrg_t + 0.33\Delta k_t + 3.15\Delta l_t + 0.11\Delta trend - 0.71Ecm_{t-1}$ (2.03)** (2.81)** (6.58)** (3.41)* (3.88)* (-3.90)*
	$\overline{R^2} = 0.89$ $F – Statistic = 19.71$ S.E. = 0.17 $Durbin – Watson Test = 3.34$

*Note: *, ** Indicate significant at 5% level of significance*

In the short-run energy, capital and labour play a positive role in boosting the real output. The coefficient of energy(0.37) has been relatively low as compared to the coefficient of labour (3.15) and capital stock(0.33), implying that labour play dominant role in the process of development in the short-run. This result has very important implications for Uzbekistan. Uzbekistan reconsiders its employment policy and concentrates not only on the development of energy sector but also takes necessary measures to improve the quality of labour force. The error-correction coefficient(-0.71) is found negative and significant supporting the evidence for the existence of long-run causality between real output, energy consumption and other factors entering in the model the causality has been running from energy to real output. The

significance of the coefficient of energy consumption in the error-correction equation implies the existence of causality running from energy consumption to real output in the short-run. Thus, in order to enhance economic growth, the authorities need to further develop the energy sector and improve the quality of labour force.

Tajikistan

In case of Tajikistan, it has been found that there has been positive evidence with respect to the relationship between real output and energy consumption, capital and labour(table-4). The impact of labour is higher than the impact of energy and capital on real output in the long-run. In short-run, energy and labour growth play a significant role in the promotion of domestic productivity. The significance of the error- correction term and the energy consumption coefficient in the error-correction equation supports the evidence of long-run as well as short-run causality between economic growth and energy consumption. Development of the energy sector is seen very vital for the enhancement of economic growth in Tajikistan.

Table-4
Long – run and Short – run Estimates of Energy Consumption and Real GDP of Tajikistan

	Long-run estimates
Tajikistan	$y_t = 0.79 enrg_t + 0.81 k_t + \mathbf{5.16} \boldsymbol{l_t} + 0.51 trend$ (3.07)* (6.52)* (10.03)* (2.39)**
	Short-run estimates
	$\Delta y_t = 0.73 \Delta enrg_t + 0.17 \Delta k_t + \mathbf{2.78} \boldsymbol{l_t} + 0.11 \Delta trend - 0.69 Ecm_{t-1}$ (2.84)* (0.91) (3.98)* (2.15)* (-4.22)*
	$\overline{R^2} = 0.79$ F – Statistic = 7.59 S.E. = 0.07 $Dorbin - Watson\ test = 3.67$

*Note: *, ** Indicate significant at 5% level of significance*

Kyrgyzstan

In case of Kyrgyzstan (table-5), it has been found that there has been positive evidence with respect to the relationship between real output and energy consumption, capital and labour. The impact of labour is seen higher than the impact of energy and capital on real output in the long-run. In short-run, energy and labour growth play a significant role in the promotion of domestic productivity. The significance of the error-correction term and the energy consumption coefficient in the error-correction equation supports the evidence of long-run as well as short-run causality between economic growth and energy consumption. Development of the energy sector seems very vital for the enhancement of economic growth in Tajikistan and Kyrgyzstan.

Table-5
Long – run and Short – run Estimates of Energy Consumption
and Real GDP of Kyrgyzstan

	Long-run estimates		
Kyrgyzstan	$y_t = 0.53enrg_t + 0.27k_t + \mathbf{3.12}l_t + 0.15trend$ $\quad$ (2.04)* $\quad$ (5.34)* $\quad$ (8.07)* $\quad$ (1.27)**		
	Short – run estimates		
	$\Delta y_t = 0.71\Delta enrg_t + 0.32k_t + \mathbf{1.69}l_t + 0.03\Delta trend - 0.59cm_{t-1}$ $\quad$ (2.13)* $\quad$ (0.19) $\quad$ (3.79)* $\quad$ (2.75)* $\quad$ (-3.32)*		
	$\overline{R^2} = 0.61 \qquad\qquad F - Statistic = 5.59$ $S.E. = 0.39 Dorbin - Watson = 5.31$		

*Note: *, ** Indicate significant at 5% level of significance*

Conclusion

Energy, no doubt, has attained the status of a 'strategic commodity' and any uncertainty about its supply can threaten the functioning of the entire world economy, including economies like Central Asian countries. Central Asia's substantial and sustained economic growth is, however, placing enormous demand on its energy resources. The demand and supply imbalance in energy sources is pervasive requiring serious efforts by government of these countries to augment energy supplies as Central Asia may face possible severe energy supply constraints given their consumption pattern. Energy requirements in this region has been increasing at a very rapid rate. Achieving energy security in this strategic sense is of fundamental importance not only to their economic growth but also for their human development objectives that aim at alleviation of poverty, unemployment and meeting the Millennium Development Goals (MDGs).

In view of the vital and critical role of energy in the process of economic growth, it was revealed proved that there is strong link between energy consumption and real output for five Central Asian countries including Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan and Tajikistan. The overall results suggest that the economy of each country is energy dependent and the apprehensions of energy shortage may negatively effect the economic growth which eventually results a fall in income and employment. Thus, according to the results, Central Asian countries would be largely benefited to adopt energy conservation policy to avoid the energy shortage. Shortfall in energy would otherwise seriously endanger the growth and development of these economies in the long run. Thus, it is quite important that along with high energy consumption, the energy production raises to that extent to ensure sustained economic growth.

From the above analyses and discussion, it could be safely concluded that in order to achieve rapid and stable economic growth, Central Asian countries should devise and adopt a sound policy of energy sector development. Besides, they should also look at other strengths of their economies. For instance,

Uzbekistan having large young population should take care of labour force upgradation. In Turkmenistan labour plays a little role in the development process. Hence, Turkmenistan being rich in hydrocarbons, should take necessary measures to utilize cheap and surplus labour in most efficient way in the process of economic development, besides the development of energy sector. Kazakhstan and Tajikistan should accelerate their rate of capital accumulation. All these initiatives and policies should be pursued in a systematic manner so as to bring economic growth and development in all these Central Asian countries on sustainable basis.

References & Notes

1. Energy is an important production factor and, therefore, should be managed in parallel with land, labour and capital. Here, energy refers two types, i.e. hydrocarbons and hydropower of Central Asian countries, namely, Kazakhstan, Turkmenistan, Uzbekistan, Tajikistan and Kyrgyzstan. It is known as bedrock of modern development. The successful deployment of energy carriers in the services of humanity since the last part of the 18th century has greatly altered the way. There is hardly any aspect of modern life that does not have the imprint of energy input, be it entertainment, recreation, agriculture, commerce, industry, transport, education, communication, health, architecture etc. As the very basis of development, energy use is closely related to the level of productivity in the industry, commerce, agriculture and even in office activities. Energy consumption per capita is one of the indicators or benchmarks for measuring the standard of living. The unprecedented use of energy which began with the industrial revolution certainly brought about massive increase in productivity and change in lifestyle.

2. Development implies that the standard of rising is rising and people live in greater comfort (if not happiness) than before. Unless more energy is allowed to be consumed, the objective of providing a comfortable living cannot be fulfilled.

3. This is the crucial stage which covers a relatively brief period of two to three decades in which the economy transforms itself in such a way that economic growth subsequently takes place more or less automatically. "The take-off" is defined as "the interval during which the rate of investment increases in such a way that real output per capita rises and this initial increase carries with it radical changes in the techniques of production and the disposition of income flows which perpetuate the new scale of investment and perpetuate thereby the rising trend in per capita output." Thus, the term "take-off" implies three things: first the proportion of investment to national income must rise from 5% to 10% and more so as to outstrip the likely population growth; secondly, the period must be relatively short so that it should show the characteristics of an economic revolution; and thirdly, it must culminate in self-sustaining and self-generating economic growth. Thus, during the take-off stage, the desire to achieve economic growth to raise the living standards dominates the society. Revolutionary changes occur in both agriculture and industry and productivity levels sharply increase. There is greater urbanization and urban labour force increases. In a relatively short period of a decade or two, both the basic structure of the economy and social and political structure is changed so that a self-sustaining growth rate can be maintained. It is worth noting that in the opinion of W. W. Rostow, the rise of

new elite (i.e. new entrepreneurial class) and establishment of a nation state are crucial for economic development.

4. In this stage of development per capita income of country rises to such a high level that consumption basket of the people increases beyond food, clothing and shelters to articles of comforts and luxuries on a mass scale. Further, with progressive industrialization and urbanization of the economy values of people change in favour of more consumption of luxuries and high styles of living. New types of industries producing durable consumer goods come into existence which satisfies the wants for more consumption. These new industries producing durable consumer goods become the new leading sectors of economic growth.

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8. Refers here the republics of Kazakhstan, Turkmenistan, Uzbekistan, Tajikistan and Kyrgyzstan.

9. Energy is one of the Central Asia's crucial resources and the region intends to harness this potential as an integral part of its economic development. The development of energy sector is expected to usher in huge economic benefits in the form of infrastructure development, industrialization and huge revenue. With the increase in hydrocarbons and generation of hydropower and improvement in energy efficiency in Central Asia, the republics of the region aims not only to provide domestic energy at affordable cost; but also turn into a net energy exporter in near future. These energy rich republics of the Central Asia have a large scope to transform their economies with the proper development and use of then energy sector.

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