Energy Consumption and Economic Growth: Evidence from Four Developing Countries

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ABSTRACT

The aim of this study is to investigate relationship between economic growth and energy consumption in Pakistan, India, Bangladesh and Sri Lanka by using instrumental variable regression analysis. In investigation process energy consumption, economic growth, urban population, FDI and trade data is used from 1981-2015. Several outcomes are presented in this paper, first, increase in economic growth tends to increase in energy consumption, second, these countries are energy dependent and sensitive to supply of energy shocks. Thirdly, increase in trade has negative correlation with energy consumption as it introduces the energy efficient technology. In these situations policy makers should find the ways to improve economy with efficient resources so that energy consumption will be lower. So, to improve the energy efficiency in developing countries this research provides the significant policy implications.

Keywords: Energy Consumption; Economic Growth; Urbanization; Trade

INTRODUCTION

During past few decades the importance of energy is increasing day by day as climate change. Despite the fact that in Pakistan, India, Bangladesh and Sri Lanka energy sector is severely underdeveloped and consumption of energy is comparatively very low. In developing countries average people are consuming very less energy as compare to developed countries. The inequality in consumption of energy is letting alone these developed countries in rest of the world. As energy consumption increases this becomes threat for the global ecosystem. To overcome this threat energy sources gradually more are mandatory in the world. Primary sources of energy which emit more pollution to the environment are needed to be shift towards green energy sources. Most of the advanced countries are establishing frame work to boost the use of renewable green energy which protect the environment.

Nowadays this is the major challenge for future generations how to protect the environment. Almost 81% of energy sources from worldwide derived from fossil fuels, 28.9% from coal, 21.4% from natural gas and 31.1% from oil (International Energy Agency. World energy outlook. 2015). Greenhouse gas emission is one the major causes of energy. Energy is also necessary for economic production, for development of society and economic growth. Many researchers concentrated on the important role of energy in reducing greenhouse gas emission and economic development. In developing countries for economic development a large amount of energy is being disbursed. According to World Bank 2017 Sri Lanka used 311.51 kg of oil equivalent per capita in 1981 and 501.53 in 2015, Pakistan 328.86 in 1981 and 486.43 in 2015, India consumes 294.67 in 1981 and 622.15 in 2015, Bangladesh consumes 102.41 in 1981 and 218.75 in 2015. Due to this energy consumption carbon dioxide in the environment also increased as economic growth increased. Hence we can say that energy consumption is the major cause...
of environmental pollution in developing countries like Pakistan, India, Bangladesh and Sri Lanka. From last few decades these countries are trying to impose different strategies and policies and to overcome the problems of environment due to energy consumption. Use of efficient resources, technology and development can lessen the environmental degradation. Renewable energies could get from different sources for example from sun, wind and from biomass. These are reliable and clean than fossil fuels.

For social and economic problems the availability of energy itself is not the solution for developing countries like Pakistan, India, Bangladesh and Sri Lanka. It is necessary to provide modern energy for social and economic development. Energy sources are necessary for social and economic development. Without clean energy sources these developing countries cannot get benefit from rest of the world. As in the world no country has succeeded in economy without access to modern energy sources. For economic productivity physical availability of energy and quality of energy are most of the important drivers (Toman and Jemelkova 2003). Development of economic process is essentially included transition from low level of energy consumption to high level of consumption, economic activity changed considerably as energy consumption increases in different stages of development (Toman and Jemelkova 2003). In African countries industrial sectors merely consume energy. Rapid increase in urbanization is likely to fasten the economic growth which lead to increase in energy consumption (Ebohon, Field et al. 2000).

In developing countries like Pakistan, India, Bangladesh and Africa expansion of modern energy in important in order to reduce the use of traditional fuel, which is the major cause of health problems due to use of charcoal and deforestation. The use of energy in developing countries cannot only minimize the dependence on imported energy but also save foreign exchange. Increase in investment in modern energy leads to promote economic growth. If proper energy conservations and energy policies are devised we can get knowledge of importance of economic growth and energy consumption.

We distinguished different relationships between energy consumption and economic growth in literature. To the previous studies our contribution is to investigate the relationship between economic growth and energy consumption in Pakistan, India, Bangladesh and Sri Lanka. Study period stretches from 1981-2015. To answer these questions are the purposes of this research.

Does economic growth affect the energy consumption? Does Urbanization affect the energy consumption? Does trade affect the energy consumption?

**LITERATURE REVIEW**

Our debated is related to energy consumption leads to economic growth. (Dunkerley 1982, Ebohon 1996, Templet 1999) said that use of modern energy is prerequisite for social, economic and technological progress where in production process they used capital and labour. In favour of this hypothesis for economic growth lack of energy is limiting factor for technological and economic growth. They believe that for betterment of people and to improve life style of advanced countries modern energy is a major source and is playing crucial role in advancement of countries (Rosenberg 1998).

(Soytas and Sari 2003) said that for Argentina there is a bidirectional causality, similar evidences were found by (Ghali and El-Sakka 2004) for the case of Canada. Different countries also found the same results in number of studies as for Turkey (Soytas and Sari 2007), (Yoo 2006) for Malaysia and Singapore explained bidirectional causality between energy consumption and economic output, for Thailand (Rafiq 2008), (Chang 2010) for China, for Malaysia (Tang and Tan 2015) also said bidirectional causality between energy consumption and economic output, for OECD countries (Belke, Dobnik et al. 2011), for Lebanon (Leit 2014), For the case of Malaysia (Tang and Tan 2015), for Sub-Saharan Africa (Behmiri and Manso 2013), for china (Zhang and Yang 2013), for MENA (Omri 2013), for India, China, Russia, South Africa, Turkey and Brazil (Bildirici and Bakirtas 2014), for Mediterranean countries (Esseghir and Khouni 2014), for the case of Italy (Ladu and Meleddu 2014), for GCC (Salahuddin and Gow 2014), for Vietnam (Tang and Tan 2015), for MENA (Al-Mulali and Ozturk 2015) and for Malaysia (Park and Yoo 2014) explained bidirectional causality between economic growth and oil consumption.

The studies by (Masih and Masih 1996) for the case of Thailand said there is no causality between energy consumption and real income, for Turkey (Begum, Sohag et al. 2015), for Malaysia (Rafiq 2008), for Malaysia (Behmiri and Manso 2014), Hussain et al. (2012) and for Latin America found granger causality between coal and oil consumption to economic growth and found unidirectional causality between economic growth and energy consumption, (Behmiri and Manso 2014) said that there is no causality between energy consumption and output. (Tang and Shahbaz 2013) also explained...
bidirectional causality between energy consumption and economic growth. The relation between energy consumption and economic growth in developing countries (Pakistan, India, Bangladesh and Sri Lanka) is inconsistent and scarce.

It has found that in poor countries use of electricity improves the educational and health standards of people. Some researches show that to improve welfare of poor people electricity service is one of the important services. In this modern world it is very difficult for any country to improve their economies at national level. Reliable and good infrastructure of energy is prerequisite for sustainable growth and increase in exports. But developing countries are unable to provide adequate and good energy to different sectors for their economic growth. Some researchers contend that role of energy is minimal for economic growth. With related to economic growth cost of energy is very low so energy do not has significant impact on economic growth. They also said that as economic growth increases production sector shifts to service sector where less energy is needed (Ghali and El-Sakka 2004). But US experience suggests that economy of US is becoming less energy intensive and more electricity intensive (Rosenberg 1998).

This contradictory results motivated many researchers to know the causality between economic growth and energy consumption. There are different results some say that there is bi directional causality and some say that no causality between energy consumption and economic growth (Fatari, Oxley et al. 2004, Ghali and El-Sakka 2004, Jumbe 2004, Wolde-Rufael 2004, Chontanawat, Hunt et al. 2008). These contradictory results have foremost implications. (Asafu-Adjaye 2000) said if there is causality which is unidirectional between economic growth and energy consumption then decrease in energy consumption would lead to decrease in economic growth and vice versa. If there is unidirectional causality between energy consumption and economic growth then it says that reduction in energy consumption has no or little effect on economic growth. And if there is no causality between energy consumption and economic growth then consumption of energy may not have impact on economic growth which may does not affect economic growth. Economic growth and energy consumption are complements and consumption of energy may has negative effects on economic growth (Asafu-Adjaye 2000, Jumbe 2004, Wolde-Rufael 2004).

From existing literature conflicting results have obtained which stimulate more interests of researchers in this field and increase in convention analysis have to add more demand supply equilibrium and economic development stages (Ma and Oxley 2012). (Ma, Oxley et al. 2010) carried a literature survey in which he said over time increase in studies carried out to check inter regional union of prices of energy consumption (Ma and Oxley 2012). To identify demand and supply relationship of energy prices also play crucial role. Over the past few years rapid growth in economy has taken place in East Asian countries lead to increase in energy consumption significantly (World Bank 2017). GDP and energy consumption found asymmetric relation with each other for economic development, urbanization and industrialization are major two components of it (Henderson 2003, Zhang and Shunfeng 2003, Sheng, Shi et al. 2013). GDP per capita is low at its pre industrialization stage due to which energy consumption per capita is low. Industrialization stage rises GDP increases in the economy. This improve further lead to produce more energy intensive products, improve life style of people, houses decoration. During this stage urbanization increases significantly. At this stage energy intensity increases. When industrialization increases people come up with more capital which they invest in high technology which bring the energy consumption down.

Some researchers like (Kraft and Kraft 1978) explained the unidirectional causality between output and energy consumption. He said that policy related to energy could not affect economic growth but change in economic growth could affect the energy consumption. Findings by (Gross 2012) for USA,(Saboori and Sulaiman 2013) for Italy and Korea, (Bastola and Sapkota 2015) for Nepal, (Salahuddin and Gow 2014) for Gulf Council Countries, (Saboori and Sulaiman 2013) for ASEAN and (Masih and Masih 1997) explained that bidirectional causality exists between economic growth and energy consumption. (Soytas and Sari 2003)for the case of Argentina explained bidirectional causality. Similar results were also provided by (Ghali and El-Sakka 2004), (Shahbaz, Chaudhary et al. 2017) they used data from 1972-2011 and used ARDL bounds test then VECM to confirm the causality between variables. Their results described that urbanization increases energy consumption. Increase in transport also has positive correlation with energy consumption. They also said that increase in economic growth also increases energy consumption.

These different empirical results of the roles which energy plays for economic growth do not only demands more methodologies but require further
research to know the relationship between energy consumption and economic growth. Instead of all the researches there is lack of research on developing countries like Pakistan, India, Bangladesh and Sri Lanka. Our main purpose is to fill this gap by estimating OLS Robust then instrumental variables regression analysis (IV). In this study second section contains the methodology. Section three contains empirical findings, conclusion and policy implications are presented in fourth section.

**METHODOLOGY**

This study used panel data of four countries Pakistan, India, Bangladesh and Sri Lanka of 35 years (1981-2015). In table 1 source and description of data is given. This study is purely based upon availability of data. To test the optimum relationship this study used following empirical model.

\[ LEC_t = \alpha + \alpha_1 LGDP_{it} + \alpha_2 LF DI_{it} + \alpha_3 LUP_{it} + \alpha_4 LTRADE_{it} + \eta_i + \delta_t + \epsilon_{it} \]

In this empirical model \( LEC \) is log of energy consumption, \( LGDP \) is log of economic growth, \( LF DI \) is log of foreign direct investment, \( LUP \) is log or urban population, \( i \) represent country, \( t \) represents time, \( \eta \) shows country fixed effects, \( \delta \) shows time fixed effect and \( \epsilon \) is error correction term.

**Table 1: Description and sources of data**

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>DESCRIPTION</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>GDP per capita growth annual %</td>
<td>WDI 2017</td>
</tr>
<tr>
<td>UP</td>
<td>Urban population (% of total)</td>
<td>WDI 2017</td>
</tr>
<tr>
<td>FDI</td>
<td>Foreign direct investment, net inflows (% of GDP)</td>
<td>WDI 2017</td>
</tr>
<tr>
<td>TRADE</td>
<td>Trade (% of GDP)</td>
<td>WDI 2017</td>
</tr>
<tr>
<td>EC</td>
<td>Energy use (kg of oil equivalent per capita)</td>
<td>WDI 2017</td>
</tr>
</tbody>
</table>

We used energy consumption per capita as dependent variable. In this research different estimation techniques were used to check the robustness of relation between energy consumption, GDP, foreign direct investment, urban population and trade. In this model we can see the effects of GDP, foreign direct investment, urban population and trade on energy consumption. This research first estimated OLS then used instrumental variable regression analysis in order to know the significant results.

**EMPIRICAL RESULTS**

To estimate our prescribed model we used stata 12.0. In table 2 summary of variables which are used in model are presented. In identifying potential outliers descriptive statistics proved nature and insight of data and direct us which may bias in econometric estimation. This research used log of all variables so these are elasticities. We performed Unit root test and data is stationary at first difference.

**Table 2: Data Summary**

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>MEAN</th>
<th>S.D</th>
<th>MIN</th>
<th>MAX</th>
<th>OBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEC</td>
<td>5.75</td>
<td>0.505</td>
<td>4.62</td>
<td>6.45</td>
<td>140</td>
</tr>
<tr>
<td>LGDP</td>
<td>1.59</td>
<td>0.42</td>
<td>0.01</td>
<td>2.32</td>
<td>140</td>
</tr>
<tr>
<td>LUP</td>
<td>3.21</td>
<td>0.24</td>
<td>2.76</td>
<td>3.65</td>
<td>140</td>
</tr>
<tr>
<td>LF DI</td>
<td>19.55</td>
<td>2.41</td>
<td>12.42</td>
<td>24.51</td>
<td>140</td>
</tr>
<tr>
<td>LTRADE</td>
<td>3.56</td>
<td>0.50</td>
<td>2.48</td>
<td>4.48</td>
<td>140</td>
</tr>
</tbody>
</table>

We performed different tests in this research to check heteroskedasticity and auto correlation of model. Modified wald test was used to check heteroskedasticity in given model and confirmed the heteroskedasticity as Prob>chi2 = 0.0000. To check autocorrelation we performed Wooldridge test for autocorrelation F(1,3) = 69.201, Prob>F = 0.0036 which rejected null hypothesis of no serial correlation. We also used multiples test of Breusch and Pagan Langrangian in this test prob > chibar2 = 1.0000. For group wise heteroskedasticity Modified Wald test performed and chi2 (4) = 154.38, prob > chi2 = 0.0000. This study used Doornik Hansen M=Normality check for its model chi2 (10) = 217.158, prob>chi2 = 0.0000 this rejected the null hypothesis of univariate normality in variables. That’s why this study go beyond the Ordinary Least Squares (OLS).

**Table 3: Correlation Matrix**

<table>
<thead>
<tr>
<th></th>
<th>LEC</th>
<th>LGDP</th>
<th>IUP</th>
<th>LF DI</th>
<th>LTRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEC</td>
<td>1.0000</td>
<td>0.1132</td>
<td>0.1845</td>
<td>0.5791*</td>
<td>0.3792*</td>
</tr>
<tr>
<td>LGDP</td>
<td>0.1132</td>
<td>1.0000</td>
<td>0.0000</td>
<td>0.7432</td>
<td>0.6752*</td>
</tr>
<tr>
<td>IUP</td>
<td>0.1845</td>
<td>0.0000</td>
<td>1.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>LF DI</td>
<td>0.5791*</td>
<td>0.7432</td>
<td>0.0000</td>
<td>1.0000</td>
<td>0.4132*</td>
</tr>
<tr>
<td>LTRADE</td>
<td>0.3792*</td>
<td>0.6752*</td>
<td>0.0000</td>
<td>0.4132*</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Note: * denotes significant at 5%

This correlation matrix is showing the relationship between energy consumption, GDP growth, foreign direct investment, urban population and trade. All these variables are showing positive correlation with each other. Given that as GDP increases energy consumption also increases but this result is not significant in this matrix. It is also important to note that increase in urban population and foreign direct investment also increases energy consumption in...
given economies. We further found positive correlation between trade and energy consumption as trade within the economy increases energy consumption also increases. But this is against some researches that as trade increases foreign countries come up with high or efficient technologies which consume less energy. So due to this ambiguity we further used methodology to come up with robust results. Due to the fact this correlation cannot provide mere results so this study further proceeded to empirical evaluation and provide support in favor of relationship between energy consumption, economic growth, urban population, foreign direct investment and trade. We also used alternative techniques to assure that possible measures are robust. We used fixed and random results and selected between fixed and random effects. The results of fixed and random estimations are presented in table 4.

Table 4: Fixed and random effect estimation (Energy Consumption is dependent variable)

| VARIABLES | FE | Y | P>| | RE | Z | P>| |
|----------|----|---|-----------------|-----------------|-----------------|-----------------|-----------------|
| GDP      |    | 0.09 | 0.027 | <0.001 | -0.11982258 | (0.0093255) | -1.24 | 0.215 |
| UP       |    | 0.0640452 | 0.10 | 0.921 | 0.126276 | (0.6477734) | 2.61 | 0.009 |
| FDI      |    | 0.293171 | 1.01 | 0.311 | 0.2262555 | (0.2262555) | 0.00000 | 0.51 |
| Trade    |    | 0.38 | 0.140 | 0.27 | 59.20 | 0.59 | 0.00000 | 140 |

Note: Standards errors are presented in parenthesis.

OLS robust results show that GDP (economic growth) has negative correlation with energy consumption but this is not significant in this case. Increase in urban population shows positive correlation with energy consumption this is same result as fixed effects estimation model. Increase in foreign direct investment also has positive correlation with energy consumption this result is also consistent in both cases. Trade shows positive correlation with energy consumption in robust OLS and negative correlation in fixed effect estimation model to confirm the best results we carried out IV (instrumental variable) regression analysis in table 6 which shows optimum results.

Table 6: IV regression analysis (Energy Consumption is dependent variable):

| VARIABLES | Coef. | t | p>| |
|----------|-------|---|-----------------|-----------------|-----------------|
| GDP      | 0.001783 | 0.09 | 0.927 | 0.51 | 0.7578 |
| UP       | 0.3523226 | 3.22 | 0.001 | 0.064812 | (0.1004985) | 0.000 |
| FDI      | 0.072137 | 10.02 | 0.000 | 0.128276 | (0.0015936) | 0.51 |
| Trade    | -0.0257906 | -0.73 | 0.464 | 0.225157 | (0.0016385) | 0.51 |

Note: Standards errors are presented in parenthesis.

Interesting results have found in IV (instrumental variable) regression. In this table it is shown that GDP has positive correlation with energy consumption. Because as economic growth increases energy consumption also increases. In this result we can say that economic growth strengthens the industries with help of new and efficient technology. Increase in urban population or urbanization has positive correlation with energy consumption this is consistent with (Shahbaz, Chaudhary et al. 2017). Because as people in urban areas increases their lifestyle will also be higher and they increase use of air conditioners and many other facilities in their houses due to which energy consumption will be higher.
Increase in foreign direct investment has positive correlation with energy consumption. This result describe that as foreign investment increases in the host country energy consumption will automatically be higher. Because foreign forms invest in the industries of firms due to which production will also be higher due to higher investment. Increase in trade also has negative correlation with energy consumption. Because as trade increases foreign countries come up with latest technology which consumes less energy and less pollute the environment. As trade increases demand for goods and service also increases in host country so energy consumption will be lower due to efficient technology transfer.

CONCLUSION & POLICY IMPLICATIONS

Results of this study have presented some important policy implications. This study is in the favour of the analysis that GDP growth has positive correlation with energy consumption. This research investigated the dependency of economic growth on energy consumption in Pakistan, India, Bangladesh and Sri Lanka. This study covers the time period from 1981-2015 with help of instrumental variable regression analysis. This study provides four outcomes (1) GDP growth has positive correlation with energy consumption, (2) FDI has positive correlation with energy consumption, (3) urbanization is positively correlated with energy consumption (4) trade has negative correlation with energy consumption. It is known that energy is the basic requirement for any country to do business and gain competitive advantage. Hence, policy makers should concentrate on prudent economic and energy policies which improve growth as well as energy efficiency due to which economy could grow quicker than the energy consumption rate. Policy makers should adopt several actions to improve energy efficiency. In order to control the excessive usage of energy government regulators should also recognize those divisions which consumes less energy. Those sectors which consume higher energy are suggested to improve their technology which should be energy efficient. If policy makers will not apply rules according to these suggestions then this may adversely affect the GDP growth. Moreover, this finding also suggest the policy makers to take steps to increase trade due to which foreign countries will introduce efficient sources in the host countries which may consumes less energy. Because by increasing trade technological innovation will be higher which can be helpful to upgrade and modernize the industries. Innovation in technology helps in switching to efficient production of technology but also replace poor quality technology to better quality which may be energy efficient and improve GDP growth.

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