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Determinants of Energy Productivity by Independent Power Producers in Pakistan: A Time Series Analysis from 1990 to 2018

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Abstract: Energy in the form of electricity has important contribution in the economic prosperity of any country. Almost all sector of the economy directly or indirectly relies on electricity, which is the lifeline of any economy. To fulfil energy requirements, different countries use different sources of energy. Since, independence, energy crises are prevailing in Pakistan and it is worsening as development proceeds, energy demand increases both domestically and commercially. Different effort has been made in the past to increase energy, but the requirements of energy always exceed its production. To increase energy supply in the country, Pakistan had invited different Independent Producers (IPPs) in 1985 to overcome this issue.

The current study highlights the role of IPPs to increase the supply of energy and its effect on economic growth in the country. Gross fix capital formation, oil prices, labor productivity, Energy Balance and foreign direct investment is taken as controlled variables while Productivity of energy by IPPs as dependent variable. Energy supply is taken as proxy for energy productivity by IPPs. For this purpose, data is taken from 1990 to 2018 from NAPRA, IPPs yearly book, PPIB and WDI. The period is chosen because the first agreement between IPPs and Pakistani government were signed in 1990. To know the association between determinants of energy productivity, Autoregressive distribution lag model is used. It is concluded that FDI, Labor productivity and Energy balance significant and positively affect energy supply by IPPs in the short and long-run while oil prices affect energy supply negative and significantly in the long-run. The GFCF shown positive but insignificant result both in short and long-run with energy supply.

Key words: Independent Power Producer, Energy supply, Gross fix capital formation, labor productivity, energy balance, FDI and Oil Prices

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1. Introduction

Energy has significant role in the economic growth of any country. All the three sectors of the economy i.e., agriculture, industries and Service sector totally rely on energy, not only that it become an important constituent for domestic electrification. Since 1980, total annual world investment on energy sector have been changed between 21 and 24 percent of world GDP but in developing countries the share of investment in this sector was slightly lower (UNCTAD, 2007). Thus, to increase investment in energy sector was big challenge for developing countries, where most of the investment is made to fulfil the basic needs, in such situation many countries try to find cheapest source of energy in the form of hydropower, which need more finance to build. Consequently, demand for energy, supply and their pricing policy have huge impact on the economy productivity, living standard, social uplift, and overall welfare of the population.

The energy crisis is big issue of Pakistan just like other developing countries, even though the electricity pricing is so expensive and there always exist supply shocks. The main reason of this deficiency is the sources of electricity in Pakistan i.e., hydel. Almost 80 percent electricity is produced through oil and gas, that is mostly imported from middle east mainly Saudi Arabia and Iran. In addition, LPG, LND, coal and nuclear power, which constitute only 1.9 percent and hydropower which share 13 percent of total install capacity are used to produce energy.

In the socio-economic development of low-income countries, energy plays an important role because the access to energy sources in these countries are trifling and frequent utilization of biomass and high reliance on imported energy account for a significant impediment to socioeconomic development (Ali, and Beg, 2007).

To increase energy supply in Pakistan, different effort has been made in the country, but the requirement was always exceeding the production which results in energy crisis and effected economic growth negatively. While looking this miserable situation, government of Pakistan in collaboration with United State of America signed an agreement in 1985 to solve this issue. In this agreement it was decided to invite private sector all over the world and Pakistan to invest in this sector because Pakistan was not able to invest billions of dollars in energy sector with GDP rate of 1.2 percent from 1985 to 1990. At that time only 40 percent of population had access to electricity. To overcome this shortage, it was not an easy task for the government to overcome this issue, hence, they started to encourage investors to invest in this sector to fulfil the required energy shortfall (Siddiqui, 1998). In the meanwhile, it was identified that the country possesses huge potential of renewable source of energy and proper exploration of these natural resources will bring prosperity and economic growth in the country (Javaid, et al., 2011).

The first power policy was formulated for Pakistan in the year 1994. In 1996, in addition to the HUBCO Power Company, 14 other companies started. In 1997, the following year, the new government reviewed the previous government's plans and canceled several agreements with it. Between 1990 and 1997, the private sector contributed $ 48 billion, or 17 percent of Pakistan's power output (Nazir, and Qayyum, 2014). Pakistan has a total generation capacity of 21,593 MW of electricity from all sources, however, actual production is about 15,000 MW against a demand for power of 22,000 MW, leaving a shortage of 7200 Mega Watt to fulfill the demand of energy in peak periods (Energy Yearbook 2000, 2015).

To meet the demand of energy in Pakistan electricity is produced from different sources. Mostly hydropower, thermal and Nuclear are consider the large source which constitute 33.3 percent, 64.4 percent, and 2.4 percent respectively, in the total generation of electricity in Pakistan (Shah, 2002;

Parish, 2006). Most of the IPPs are thermal, which use oil and gas to produce electricity. In an agreement it was written that government will pay them according to their capacity, even though the IPPs produce below their actual capacity (Shah, 2002). That is why, Pakistan is losing 1 billion rupees per year to pay IPPs according to their actual capacity. Currently, 38 thermal power plants with a total installed power of 15663 MW and seven hydroelectric power plants with a total installed power of 372 MW are in operating in Pakistan (PPIB, 2020).

Like Pakistan, most of the developing countries face the same power outages and weak power infrastructure that retard the timely achievement of Millennium Development Goals (MDGs) (Andersen and Dalgaard, 2012). It is therefore imperative to frame a viable energy policy and ensure its timely implementation for improvement in the economic wellbeing of the people. For increasing GDP, improving technology and various power projects are needed to increase the supply of electricity (Samuel, and Lionel, 2013).

To enhance economic development, the energy as well as industrial production be given equal importance, because both are interrelated with each other. Moreover, proper budget allocation is needed to escalate electricity supply in the country. The variables have a positive and significant effect on the per capita income (Nwankwo, and Njogo 2013).

The current study investigates the factors responsible for the supply of energy in Pakistan for the period 1990 through 2018. The study examines the effect of numerous macroeconomic variables such as capital formation, labor productivity, FDI and oil prices on the energy productivity of IPPs.

2. Method

2.1 Description and data source

The current paper employs time series data set of electricity generation by IPPs, ranging from 1990 through 2018. For this purpose, data was collected from NAPRA, IPPs yearly book, PPIB and WDI. All variables have been transformed to logarithmic before estimation.

2.2 Model Specification

Endogenous growth model is employed in this study. The model establishes that productivity occurs because of several macroeconomic variables outside the economy. The assumption is that energy productivity occurs through external factors rather than internal factors (Romer, 1994).

The following models have been utilized though co-integration analysis, to explore bases of electricity supply (ES) in Pakistan,

$$ES = a_0 + a_1 GFCF_t + a_2 LPR_f + a_3 Eb_t + a_4 FDI_t + a_5 OP_t + V_i$$

Where,ES stands for supply of electricity by IPPs.$GFCF_t$ stands for (gross fixed capital formation) of IPPs. LPR_f is equal to Labor force participation in IPPs. *Eb*stands for Energy balance (obtained by subtracting energy supply from energy demand),FDI_t is Foreign direct investment in IPPs. OP_t stands for oil prices in Pakistan. *While* $V_i$is the stochastic or random error.

3. Findings and Discussions

3.1 Stationarity Test

The important step in time series analysis is to convert all non-stationary variables into stationary before estimation. For this purpose, the study use Unit Root Test to get stationarity in the data by employing the Augmented Dickey Fuller test.

The below table 1 presents the results of ADF test in level and first difference. Practically all variables are stationary at first difference except GFCF with is stationary at level. Due to different integration of variables i.e. I (0) and I (1) the current study use ARDL model.

Table 1:Stationaritytestresults

Variables	Determination of lags selection	Level form	1st difference form	Cointegration order
ES	0 (AIC)	-2.078	-4.930**	I (1)
GFCF	8 (AIC)	-4.605**	----	I (0)
LP	0 (AIC)	-3.804	- 4.184**	I (1)
FDI	0 (AIC)	-3.33	- 4.349**	I (1)
EB	0 (AIC)	-2.12	- 3.214**	I (1)
OP	0 (AIC)	-1.33	- 3.953**	I (1)

Source:author'sestimates

3.2 ARDL and Determinants of Energy Supply

The study use ARDL model to examine the determinants of energy supply. In this regards GFCF, FDI, LP, Eb and OP are taken as control variable. All the variables are converted into log before estimation to avoid the problem of Heteroscedasticity and non-linearity of the variable.

3.3 Existence of long run and short run relationship among variables

The table 2 below depicts the association of different independent and dependent variables in the short as well as in the long run. It shows that there exists both short and long-run relation among the variables. The existence of long run co-integration relationship confirms through the negative sign of co-integration equation.

The Table also depicts that except GFCF and OP, all the other variables in the model are significantly and positively associated with each other at a significance level of 5 percent. The results indicate that 1 percent increase in FDI, EB and LP significant and positively increase ES by 0.35, 0.133 and 1.411 percent respectively in the short run. It also shows that GFCF has positively but insignificant while OP shows insignificant and negative association in short run.

In the long-run, FDI, LP and EB shows positive and significant association with dependent variable while OP shows negative and significant with the dependent variable in the long-run. The GFCF shows positive but insignificant result.

Table 2: ARDLandlongrunrelationshipamongvariables

Co-integratingForm				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
d(lGFCF)	0.081	0.181	0.449	0.658
d(lFDI)	0.355	0.124	2.875	0.010
d(lLP)	0.133	0.046	2.893	0.009
d(lOP)	-0.078	0.151	-0.516	0.612
d(lEB)	1.411	0.184	7.639	0.000
Cointegration Eqn(-1)	-1.459	0.182	-8.025	0.000

*Cointegration eqn = lES - (0.056*lGFCF + 0.244*lFDI + 0.091*lLP -0.053*lOP + 0.966*lEB + 13.283)*

Long Run estimates				
Variable	Coefficients	Std. Err	t-Stat	Pro.
lGFCF	0.055	0.122	0.454	0.654
lFDI	0.243	0.084	2.873	0.011
lLP	0.092	0.026	3.497	0.002
lOP	-0.054	0.103	-0.517	0.011
lEB	0.966	0.082	11.712	0.000
C	13.283	2.040	6.512	0.000

Source:*Author'sestimates*

3.4 Serial-correlation: LM Test

In the below table 3 the results of serial correlation are given. It depicts that there is no problem of serial correlation in the model, which can be confirm from the results of F statistics and Chi square. Similarly, it also shows that there is no problem of auto correlation as the value of Durbin Watson test is 2.082.

Table 3: Breusch-Godfrey LM Test to check serial correlation

F-statistic	1.265	Prob. F(2,16)	0.308
R-squared	3.414	Prob. Chi_square (2)	0.182

Source: *Author's estimates*

3.5 Stability diagnosis

In the time series analysis, stability diagnosis test plays an important role. For this purpose, the current study use CUSUM and CUSUM of square test. Both figure 1 and 2 below show that variables are stable and there is no issue of instability in the data at 5 percent significant level.

Figure 1:Stabilitytestusing(CUSUMTest)

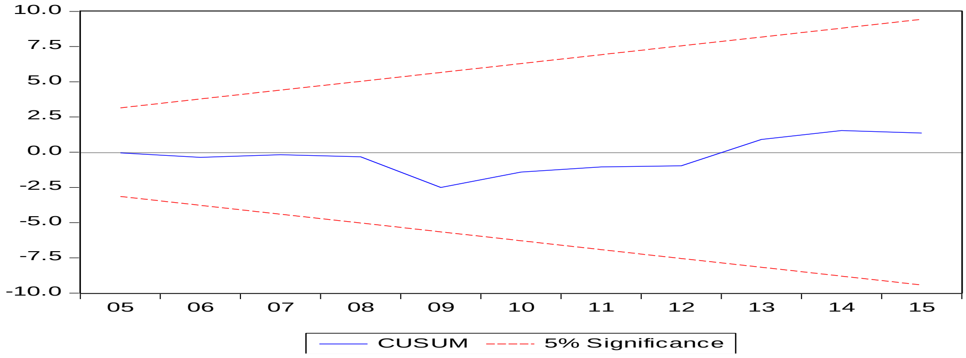
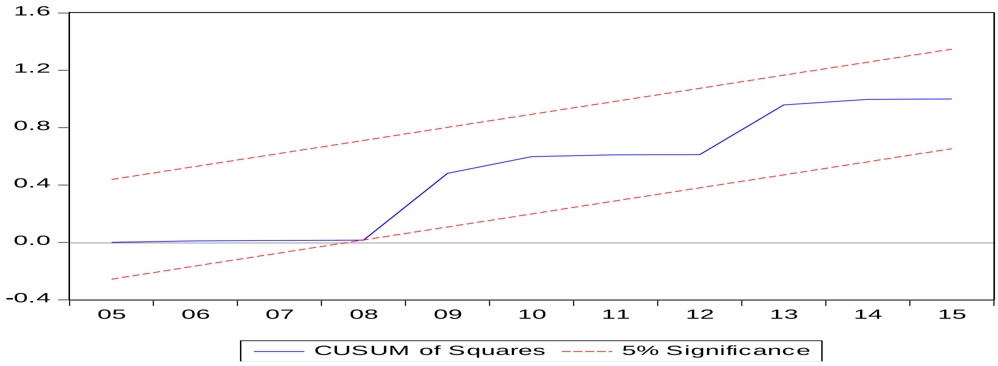


Figure 2: CUSUM of square Test



The table 4, depicts the results of co-integration analysis by using Bound's test. This test is basically used to confirm the existence of long-run association among the variables. The null hypothesis is that the variables are not associated in the long run. The study rejects the null hypothesis by looking the value of F-statistic which shows that the value is 1.493, which is lower than critical and upper critical value i.e., 3.792, which conform the existence of long association among variables in the model.

Table 4: ***Co-integration Analysis: Bound's Test***

TestStatistic	**Values**	**K**
F-statistic	1.493	5
Critical Bounds values		
Significance	**Lower Bound**	**Upper Bound**
10 %	2.262	3.354
5 %	2.623	3.792
2.5 %	2.962	4.184
1 %	3.414	4.681

Note: Author'scalculation

4.Conclusion

The current study analyzes the determinants of energy supply by IPPs in Pakistan. The findings confirm a significant and positive relationship of all variables with energy supply both in the short run as well as in the long run except oil prices. A significant number of IPPs are hydal and they utilize furnace oil for energy generation. The IPPs directly provide electricity to WAPDA, while most of the time unable to pay them on due time and the debt amass on yearly basis. Resultantly they are unable to pay Pakistan State Oil as well as oil supply agencies timely, which leads to piling up of circular debt. Moreover, most of the IPPs are generating below their full potential and contribute less, which does not fulfil the expected results, as was signed between IPPs and NEPRA in various power generation agreement.

4.1 Policy recommendations

The timely supply of energy by IPPs has a vital contribution in the economic productivity and development of Pakistan's economy. By raising the electricity price, demand for IPPs also increases. Therefore, the government should reconsider price policy to enhance economic growth and development. Moreover, the participation of labor in IPPs is too limited partly due to low wages. The low wages result in lower productivity and ultimately result in lower economic growth and development. It is dire need of the day that the policy makers should concentrate on the issue on priority basis to encourage labor force participation rate in the IPPs sector. This can only be done, on making timely payment to IPPs and formulating electricity pricing policy for IPPs properly. The IPPs policy of the government should be consistent and long term, that will cast a significant positive effect on the domestic producers as well as encourage the international investors to invest in uplifting the important sector of energy.

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