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Impact of Electricity Consumption and Transport Infrastructure on the Economic Growth of Pakistan

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Abstract
This study investigates the influence of electricity consumption and transport infrastructure on the economic growth of Pakistan by using Johansen co-integration test. This study uses secondary time series data from 1971 to 2015 and construct an index of transport infrastructure with the help of principle component analysis. The result shows that there is a long run association among electricity consumption, transport infrastructure and economic growth of Pakistan. This result is very important for the government of Pakistan to make policies regarding energy and transportation; and its implication for the development of country.

Keywords: Electricity consumption (EC), Transport infrastructure (TI) and Gross domestic product (GDP), economic growth (EG)

1- Introduction:

Pakistan is considered a paradise on earth because of its fabulous resources. Electricity can be produced by these resources to fulfill the basic needs of life. Electricity plays an important role in the modern economy. Without electricity new innovations and technological advancement are impossible. Electricity consumption has great effect on the growth of the country like Pakistan. Kraft and Kraft (1978) introduced the idea that economic growth (EG) is linked with energy consumption (EC). Electricity Consumption and Economics Growth have shown four possibilities of causal relationships: growth, conservation, neutrality and feedback hypothesis and each theory has their own policy implication (Payne, 2010). The following

table shows that with the increase in EC, the GDP growth rate of the country increases. This depicts that EC is an important element for growth of the economy.

Table 1:
Year wise Electricity Consumption and GDP

Year	Electricity Consumption (kWh per capital)	GDP (Growth rate %)
1971	91.78	0.46
2001	364.65	1.98
2014	488.74	5.4

Source: WDI, 2015

Electricity consumption has great importance for the progress of a state (Abbas & Choudhury, 2013). Accessibility of electricity can increase the human development of the country as it has become a basic need of life in the modern economy. On contrary, Pakistan railway has been turned down in the past few years but now in 2015 this institution again getting the ladders of growth and development. They start business train to facilitate people to reached at time towards destination with low cost package and overcome the problem of oil shortage. The pervious data shows that in 2008 the gross earning of railway sector was maximum and in 2013 it was minimum (Economic Survey of Pakistan, 2014-15).

The World Bank has recognized poor infrastructure as a major growth limitation for the country than the stark power crisis. Pakistan is needed to improve infrastructure to reveal growth. According to the World Bank report (2013), Pakistan is turning from agriculture based economy to a services-based economy like other South Asian countries. The annual cost of an inefficient transport sector of Pakistan is 4.6 % of its GDP. Development of transport infrastructure maintenances economic growth. Road transport shows significant role in the economic development. A good system of road network is considered a key of progress for a country. A bad infrastructure facility in a country is hazardous to maintain economic growth. Infrastructure growth is a dynamic constituent in enhancing the growth of country. A good infrastructure expands productivity of country. Infrastructure gives spurs to community and isolated sector; promotes production, transportation, and communication. The openness and quality of infrastructure in a county make desirability to foreign investors. Foreign Direct Investment inflows are also conditioned with Infrastructure (Sahoo, 2006).

Technological equipment and improvement in transport have increased the energy demand for achieved sustainable development (Belaid & Abderrahmani, 2013). Hypothetically, energy and transport are sticking together. Electricity causes transport and transport causes energy and they both have association with economic growth (Pradhan, 2010). So, there is a need to identify the role of EC and infrastructure in the Pakistan's economic growth.

The aims of this study is to explore the association among electricity consumption, transport infrastructure and GDP of Pakistan from 1971 to 2015 by applying Johansen co-integration test. Substantial work has been done where the researchers explained the relationship between EC and EG. But very few study found where the relationship was developed between EC, TI and GDP. A very few studies focused on the association of electricity consumption, transport infrastructure with the economic growth of different countries. [Oladipo & Olomola (2015); Aslan (2014); Omri & Kahouli (2014); Pradhan (2010); Pradhan & Bagchi (2013) and Phiri & Bothwell (2015)]. But no study can be found which explored the relationship of electricity consumption along with transport infrastructure with the economic growth in

context of Pakistan Therefore, the present research depicts a model in which transport infrastructure and electricity consumption affect the economic growth of Pakistan. It tests the hypotheses whether these two different variables affect the economic growth of Pakistan in a positive or in a negative way. This study utilizes the time series techniques for the empirical evidence.

1.1 Research Questions

This study has following research question:

1. Is electricity consumption effect the economic growth?
2. Is transport infrastructure effect the economic growth?
3. Is electricity consumption and transport infrastructure affect the economic growth of Pakistan in a positive or in a negative way?

1.2 Objective of this study

This study has following objectives:

- To explore the association between EC and GDP of Pakistan
- To explore the association between TI and GDP of Pakistan

1.3 Significance of study

This study will help to understand the association between EC, TI and EG of Pakistan. There is a need of this study due to the electricity situation in Pakistan. Firstly, Pakistan is a developing country and to become a developed country it is needed a stabilize economy. In this regard to understand the consumption pattern of electricity matters a lot. Second, Pakistan has fabulous resources. If consumption of energy is consumed on increasing GDP of country and gives attention to transport development, then the economy will grow rapidly. Thirdly, this research uses latest data to check the relationship among variables. This study will help the policy makers in the implementation of new projects and economic growth strategies in Pakistan.

2- Literature Review

Fedderke & Garlick (2008) examined the association between road & railway with growth of the economy of some South African countries and concluded that the infrastructure impacts on output both directly and indirectly. MorgenRoth et.al (1999) observed the role of transportation in trade and EG from the period of 1970 to 1990 and results indicates the positive relationship between infrastructure and trade and these two variables increase the EG indirectly. Song et al. (2008) observed the influence of transport infrastructure on EG. Granger-test used in the study and results suggested that investment on roads can become a major cause of economic growth.

Song & Geenhuizen (2014) assessed the influence of port infrastructure on economy of China by applying co-integration and utilize data from 1999 to 2010. The results concluded that port infrastructure investment effected positively on the economic growth of china. Omri & Kahouli (2014), examined interrelationships between EC and EG using data of panel 65 countries by taking data from 1990 to 2011 and found mixed results related to interrelationship between EC and EG. Pradhan & Bagchi (2013), observed the influence of road and railway infrastructure on EG of India from 1970 to 2010. This study used Vector Error Correction Model as statistical tool and results indicate that road infrastructure cause EG and

EG causes road and railway infrastructure. Abbas & Choudhury (2013), studied the causal relationship between EC and EG in Pakistan and India. This study focus on agriculture sector and utilize the amount of electricity use in agriculture sector. And results indicate that due to increase the electricity consumption the production in agriculture sector increase and the EG of country increase in India and vice versa. In Pakistan the GDP of agriculture sector causes agricultural EC. Zeshan & Talat (2012), investigates the relationship between EC and EG in Pakistan by applying Cobb-Douglas production function and results indicate long run association among EC and EG. EC can increase the EG of country. So the policy makers do some attention towards energy sector of country. Pradhan (2010), investigated the association among TI, EC and growth of economy in India for the period of 1970-2007. co-integration and Granger causality test are used to find out the relationship and results indicate that roads and railways causes EG and EG cases EC and roads and railway causes EC. So these variables are related to each other and play important role in the economic growth. Chandran et al. (2010) examined association between EC and GDP of Malaysia form the era of 1971 to 2003 by using autoregressive distributed lag (ARDL) model. Statistical result of long-run indicate that EC effects on GDP like one unit change in EC will increase GDP by 0.7. In the short-run, the results indicate that EC causes GDP but not GDP causes EC in Malaysia.

Oladipo & Olomola (2015) examined the causal relationship among TI development and EG in Nigeria from 1980 to 2012 and suggests that TI development especially road network effects EG of Nigeria. Road transport helps to grow economy development.

Phiri & Bothwell (2015) examined multivariate co-integration and causality relationships between EC and EG in South African cover the time of 1994-2014. The results concluded into two categories. Firstly, this study found significant multivariate long-run co-integration relationships between EG and EC. Secondly, empirical analysis supported the neutrality hypothesis existing between EC and EG in the long-run.

Dogan (2014), examine the causality between EC and EG in four countries of Sub-Saharan Africa by applying Granger causality test. Results shows that EC cause EG so the causality runs from EC to EG in Kenya and no causal association between EC and GDP in Benin, Congo and Zimbabwe.

Aslan (2014), explore the connection between EG and EC in Turkey and found long run association between EC and EG when EC is dependent variable. Lean & Smyth (2014), examines the relationship between EC and EG in Bhutan. Time series data utilize for this study in between 1980 to 2013 and results shown that EC and EG are associated in long run as one unit change in EC will increase EG from 0.03%–0.05%.

2.2 Conceptual Framework

This research is being conducted to observe the relationship among EC, transport infrastructure and GDP of Pakistan.

Dependent variable:

Economic growth is dependent variable and it is measure by GDP.

Independent variable:

EC (kWh per Capita) and transport infrastructure (length of roads and Railway) are independent variable in this study.

- Economic growth = f (electricity consumption and transport infrastructure)
- Y = F (EC, TI)
- $Eg = \beta o + \beta 1\ Ec + \beta 2\ TI + \mu o$

3- Methodology

In this study the secondary data was used from 1970 to 2015 which was taken from the World Development Indicators and Economic Survey of Pakistan report 2014-15. Electricity consumption in Kwh per capita, Economic growth by GDP per capita and transport infrastructure measure by the index of length of roads and railway in kilometer by kilometer square. Index is constructed with the help of principle component analysis (PCA). Length of lag selection is chosen by Akaike information criterion. To observe the association among gross domestic product, EC and transport infrastructure by using the Johansen co- integration test. This test helps to estimate long and short run relationship and also it can apply on small size of observation. So this technique is best for this research.

Stationery of time series data was checked by Augmented. Dickey. Fuller Test (ADF) and Philip Peron (PP) test. After checking the stationary of time series data, lag length was selected by AIC then apply Johansen co-integration test to check the impact of EC and transport infrastructure on GDP of Pakistan. Johansen Test applied, when all data stationary at first difference. This test is divided into two test one is trace test and other is maximum eigenvalue test. For one co integration equation maximum eigenvalue test is reliable but more than one co integration equation trace test is more liable. These are the following Johansen equation of trace and maximum eigenvalue test.

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{n}\ln\left(1-\hat{\lambda}_i\right)$$

and

$$\lambda_{\max}(r, r+1) = -T\ln\left(1-\hat{\lambda}_{r+1}\right)$$

To find out short run relationship among EC, transport infrastructure and economic growth of Pakistan vector error correction model (VEC) model is used.

4- Data Analysis and Interpretation

This section represents the results of the data. Initially the stationary of the data has been checked by applying different tests.

Table 2:
Results of ADF & PP Test

Variables	A.D.F. Test .Statistics		P.P.-. test .Statistics	
	At .level	At. 1st difference	At. level	At .1st difference
EC	-0.519455	-5.397244*	0.519455	-5.364043*
	(0.8771)	(0.0001)	(0.8771)	(0.0001)
TI	-0.404490	6.146146*	-0.411996	-6.146146*
	(0.8991)	(0.0000)	(0.8977)	(0.0000)
GDP	2.256136	-3.499020*	4.166652	-3.463770*
	(0.9999)	(0.00528)	(1.0000)	(0.00570)

(*shows the rejection of the presence of unit root at significance level of 5%).

The above tables show that electricity consumption, transport infrastructure and GDP are stationary at 1st difference at p-value 0.05. So, null hypothesis is rejected. Lag length is selected 5 by following AIC.

Table 3:
Results of trace & maximum eigenvalue test

No. of. co.-.integration	Trace. test				Maximum. Eigenvalue. Test			
	Eigenvalue	Trace Statistic	0.05. Critical .Value	Prob.	Eigenvalue	Trace .Statistic	0.05 .Critical .Value	Prob.
None *	0.608136	50.89638	29.79707	0.0001	0.608136	34.66308	21.13162	0.0004
At most 1 *	0.355150	16.23330	15.49471	0.0387	0.355150	16.23329	14.26460	0.0241
At most 2	1.45E-07	5.35E-06	3.841466	0.9994	1.45E-07	5.35E-06	3.841466	0.9994
Trace test shows 2 co-integrating equations at the 5% level					Max-eigenvalue test shows 2 co-integrating equations at the 5% level.			

The trace and maximum eigenvalue of Johansen test shows that there is maximum two co-integrating equation at 0.05 level. So it can be proceeding for investigating long run relationship among EC, transport infrastructure and GDP of Pakistan.

Table 4:
Results of long run estimation

GDP	EC	TI
1.000000	-0.560076	-0.617562
	(0.07370)	(0.12204)

* Normalized co-integrating coefficients (standard error in parentheses)

In the above table, the coefficient of electricity consumption (EC) is 0.560076 in model which mean one unit change in EC will increases the GDP by 0.560076 units and demonstrate the significant positive long-run effect of EC on GDP in case of Pakistan such results are consistent with many previous studies such as Phiri & Bothell 2015; Abbas & Choudhury 2012; Payne, J. E. 2010; Aslan 2014 and Lean & Smyth 2014, hypothesis of electricity consumption is rejected at 5% confidence interval.
The coefficient of transport infrastructure (TI) is 0.617562 in model which mean one unit change in TI will increase GDP by 0. 617562 units and demonstrate the significant and positive long-run effect of transport infrastructure on GDP in case of Pakistan such results are consistent with many previous studies such as Oladipo & Olomola, 2015, Pradhan & Bagchi, 2013; Faridi et.al 2011; Pradhan, R. P. 2010 and Song et. al 2008 hypothesis of foreign direct investment is rejected at 5% confidence interval. These result shows that EC and TI has positive and significant relationship with the Economic Growth of Pakistan.

Table 5:
Results of Short run estimation

Regressors	Coefficient	Std. .Error	t-Statistic	Prob.
C (1)	-0.065568	0.019541	3.355400	0.0033
C (2)	-0.031874	0.012567	-2.536278	0.0201
C (3)	-0.420849	0.286204	-1.470450	0.1578
C (4)	-0.648627	0.259984	-2.494871	0.0220
C (5)	-0.416250	0.234065	-1.778356	0.0914
C (6)	-0.406117	0.211442	-1.920697	0.0699
C (7)	-0.244516	0.220452	-1.109157	0.2812
C (8)	0.076720	0.029469	2.603439	0.0175
C (9)	0.115178	0.036154	3.185788	0.0049
C (10)	0.090105	0.039628	2.273752	0.0348
C (11)	0.121582	0.035450	3.429644	0.0028
C (12)	0.013128	0.035288	0.372032	0.7140
C (13)	0.015438	0.012026	1.283720	0.2147
C (14)	0.043626	0.010913	3.997606	0.0008
C (15)	0.037151	0.014665	2.533329	0.0203
C (16)	0.042088	0.014336	2.935726	0.0085
C (17)	0.016038	0.014753	1.087139	0.2906
C (18)	10.83008	2.278235	4.753713	0.0001
R-squared	0.837621	Mean dependent var		4.624257
Adjusted R-squared	0.692335	S.D dependent var		2.378706
S.E. of regression	1.319410	AIC		3.698741
Sum squared resid	33.07602	S.C		4.482431
Log likelihood	-50.42670	HQC		3.975028
F-statistic	5.765316	DW		2.185476
Prob (F-statistic)	0.000216			

The above table shows the estimated coefficients of short-run model revealed that EC and transport infrastructure have significant short-run effect on GDP. The coefficient of error correction term is -0.065568, quite significant at 5% confidence interval and have negative sign, which implies moderate significant high adjustment speed after shock to long-term equilibrium. The short run model is good because the R-squared is 0.837621 which is greater than 60% and F-statistic & Prob (F-statistic) is significant at 5% level.

Table 6:
Results of Diagnostic tests

Diagnostic tests	P-value
Serial correlation (LM)	0.2152
Normality (LM)	0.1157
Heteroscedasticity (LM)	0.3446

Results in the above table revealed that estimated p- value is greater than tabulated p-value which means there is no autocorrelation and heteroscedasticity among the error term of

variable, null hypothesis is accepted as p-value of serial correlation test is more than 0.05 or 5%.

5- Conclusion and Recommendation

This study investigates the effect of EC and TI on the GDP of Pakistan. Secondary data is used of 1971 to 2015 which was taken from WDI and Economic Survey of Pakistan. Johansen co-integration approach is applied because stationarity test shows the all variables at (1) which shows the co-integrating relation among variables. Then, diagnostics tests are applied which confirm that the model is free from autocorrelation and hetroskadasticity. The long run coefficients are estimated which shows the significant relationship among electricity consumption, transport infrastructure and GDP in the long run. For the short run relation, the ECM is applied which also shows the strong linkage among variables. The results show that there is long run co integration among EC, transport infrastructure and GDP of Pakistan. And the short run model depicts that model is converging back toward long-run equilibrium. So, policy maker should pay special attention to develop and implement good policy related to electricity and transport sector.

The findings of this study confirm the significant relation between EC, transport infrastructure and EG of Pakistan. Some exclusive recommendations are stated below:

Electricity consumption has positive effect on economic growth. So, to face and remove the problem of electricity crisis, policies should be adopted to increase the production of electricity. Electricity supply should be according to demand. So, Government of Pakistan should develop some policy related to energy and produce electricity by solar energy, water energy and coal to meet the demand of electricity.

Transport Infrastructure has positive effect on the growth of economy. Road and railway transport provide facilities to people and if the infrastructure of country seems develop then it attracts other countries to invest and foreign inflow will increase. So Government should make policies to promote infrastructure like China Pakistan Economic Corridor (CPEC), orange line, metro train and business train. Owing to these developments of infrastructure, the country will grow rapidly.

5.1 Limitations of this Study

This study use time series data of electricity consumption, transport infrastructure and GDP. So, Penal data can be used for this model. Model can be tested with combination of other variables like poverty, human development index, inflation, trade, import, export and income etc.

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