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Short and Long Run Equilibrium between Electricity Consumption and Foreign Aid

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Abstract

Nepal is becoming an aid dependent country. It is because of its limited and unmanaged internal resources to invest in socio-economic development. Past trend shows that majority of hydropower projects were built through aid. In this light this study attempts to investigate short and long run equilibrium between the variables-electricity consumption as dependent, foreign aid as explanatory variable included in the system of single equation model during the period 1974-2011. There are two co-integrating equations indicating a long run equilibrium between the variables. The long run elasticity coefficient reveal that the 1% change in foreign aid will change the electricity consumption by 0.48%. The results of ECM indicate that there is both short and long run equilibrium in the system. The coefficient of one period lag residual is negative and significant which represent the long run equilibrium. The coefficient is -0.336 meaning that system corrects its previous period disequilibrium at a speed of 33.6% annually

Keywords: Electricity consumption, foreign aid, co-integration, short run, long run, error correction

Introduction

Nepal is becoming an aid dependent country. It is because of its limited and unmanaged internal resources to invest in socio-economic development. Infrastructure projects require huge investments that the government is incapable of. “Successful development requires public investments, but governments in impoverished countries are often too cash strapped and too indebted to finance the requisite investments. When the government is unable to build the roads, a power grid and other basic infrastructure the private sector languishes the result in a fiscal policy trap in which poverty leads to low public investments and low public investments reinforce poverty.

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This kind of fiscal collapse is one of the most important causes of economic development failures in the poorest countries" (Sachs, 2008 p.223). In Nepal, the private sector is reluctant to invest in infrastructure because of the long gestation period bound by the risk of political instability. In spite of this, private sector has been involving in generating electricity from its immense water resource. But the rate of investment in this sector is not encouraging. Existing hydropower projects keeping constant a few in exception were built either from foreign loan or from grant. In this light, aid played vital role in the development of hydropower projects. Keeping a few cases given and constant, all the hydropower projects small or big have largely been influenced by foreign aid. At the beginning, aid in the form of grants played an important role in construction of hydropower projects. But foreign assistance in the form of grants has been changing over time. Grant at large is being replaced by loans as bilateral donors are gradually changing into multilateral. The role of foreign aid, be it in the form of grant or loan in harnessing hydropower is a hot button issue. In this context this article aims to investigate the short and long run equilibrium between electricity consumption and foreign aid by using standard econometric tools such as error correction model

A Brief Survey of Previous Work

A number of studies have been conducted to investigate the casual relationships between energy consumption and economic growth but with few studies about foreign aid. Aqueel and Butt (2001) studied the causal relationship between energy consumption and economic growth. To investigate the causal relationship among the stated variables, they prefer to use the integration and Granger tests. They found unidirectional causality running from economic growth to petroleum consumption and causality running from economic growth to gas consumption.

Dhungel (2013) has used VECM to investigate the short and long run causality between gross domestic product and foreign aid. He found that foreign aid does not cause GDP in the long run but it caused in the short run. Opposite is true in the case of GDP. GDP cause foreign aid in the long run but not in the short run. Mozumdar and Marathe have applied vector error correction model (VECM) to explore the dynamic Granger causality. They found that per capita gross domestic product Granger causes per capita energy consumption. Dhungel (2008) has found a unidirectional running from coal, oil and commercial energy to per capita real GDP and a unidirectional causality from per capita real GDP to per capita electricity consumption.

Mashih and Mashih (1996) consider six Asian economies to examine the temporal causality between energy consumption and income. They have applied vector error correction model (VECM). Their finding shows that energy consumption is causing income in India, income is causing energy consumption in Indonesia, bi-directional causality exists in Pakistan. However, they use an ordinary vector autoregressive (VAR) model for the rest three countries (Malaysia, Singapore and the Philippines). Their investigation failed to find any causality between energy consumption and income. Dhungel (2009) has investigated, causal relationship between the per capita electricity consumption and GDP during the period 1980-2006 in Nepal using co-integration and vector error correction model.

He found unidirectional causality from per capita real GDP to per capita electricity consumption and but not otherwise. Zaman K et al.(2012) have found that determinants of electricity consumption function are co-integrated and influx of foreign direct investment, income and population growth is positively related to electricity consumption in Pakistan. However, the intensity of these determinants was different on electricity consumption. If there is 1% increase in income, foreign direct investment and population growth; electricity consumption increases by 0.973%; 0.056% and 1.605% respectively. Dhungel (2012) has estimated elasticity coefficient of earning from export, tourism and remittance by using Granger causality test. He found that a 1% change in remittance and export changes GDP by 0.02% and 0.09% respectively.

Variables and Data Sources

Electricity consumption (EC) in million KWh over the period 1974-2011 is the dependent variable. Foreign aid (FA) in million rupees comprising loan and grant over the same period of time is the explanatory variable. The data of these variables are collected from the ministry of i) finance, ii) energy, Central bureau of statistics, Nepal Rastra Bank and other published sources.

Estimation Method

First of all the collected data of all the variable under consideration has been converted into per capita terms to capture the effect of population growth and converting them into natural logarithm.

Generally time series data are non-stationary if used to run regression may produce spurious regression which is not desirable. Saying the same thing again, regression of a non-stationary time series on another non-stationary time series may cause a spurious regression. Running regression on the non-stationary series at their level would generally be produced spurious regression. In such a case Durbin-Watson statistics may be less than the value of R-squared. If R-squared value is found greater than Durbin- Watson statistic, it definitely implies the symptom of the spurious regression. But instead, the residual of the model is found stationary, the model under consideration would not be no longer spurious regression. Therefore, OLS estimation of the given non-stationary time series data is a necessary condition for the estimation of R-squared, Durbin-Watson statistic and residual (error term) which are used to detect spurious regression. If the model is non-spurious then the variables in the model are co-integrated or they have long run relationship or equilibrium relationship between them. Then it is a long run model and estimated coefficients are long run coefficients. The model is given by

$EC = b_0 + b_1FA + U$

Where, EC = Electricity consumption in million KWh,

FA = Foreign aid in million rupees

U = Error term (residual-difference between observed and estimated values)

b_0, (intercept) b_1(slop coefficient) are parameters to be estimated and they represent long run coefficients.

Generally, time series data contains unit root meaning that these series are not stationary. Augmented Dickey Fuller (ADF) test, generally popular method, is being applied to test the unit root. Akaike criterion has been followed to lag selection.

To test the long run relationship between these variables Johansen co-integration test has been conducted. Finally, short and long run equilibrium has been investigated with the help of error correction model (ECM) which is appropriate for single equation model.

Empirical Findings

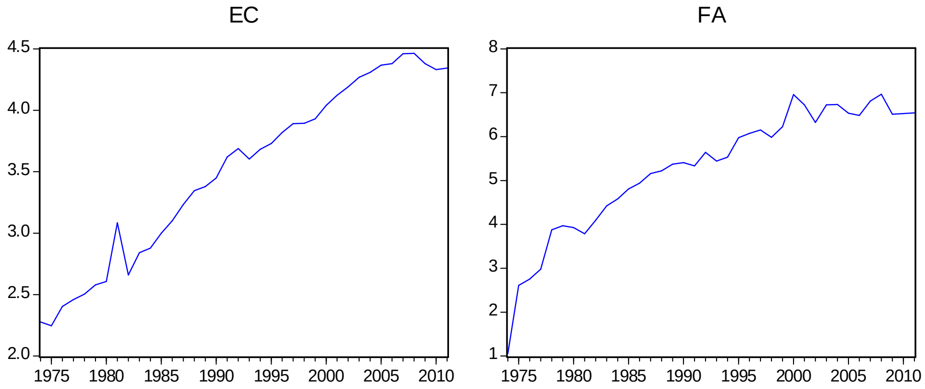
Graphical Representation of Data

Each variable under consideration are non-stationary. First set of graphs represent the non-stationary series. In the similar way, second set of graphs represent the stationary series.

Graphs of Non-Stationary Series

A graphical view of non-stationary series is given in figure 1. The graph of all the three variables indicated by EC and FA are non-stationary.

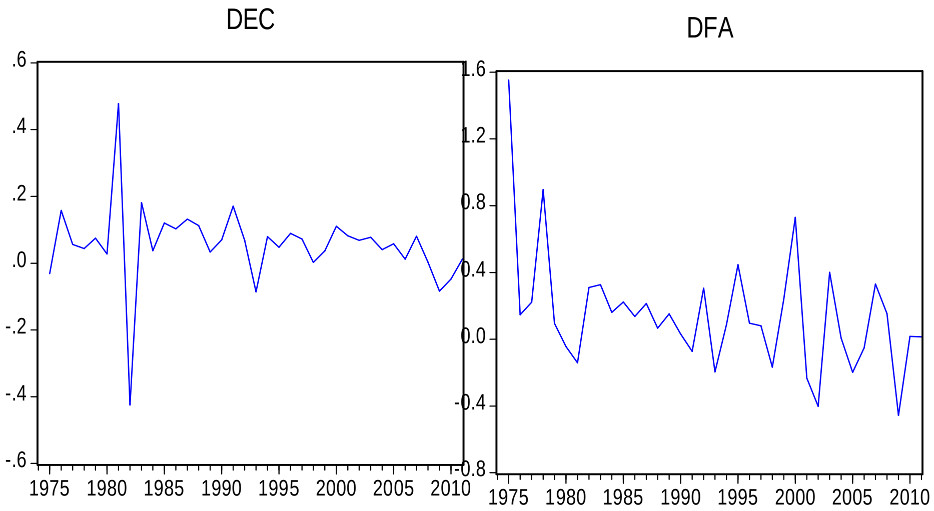
Fig.1 Graph of EC and FA at their Level



Graphs of Stationary Series

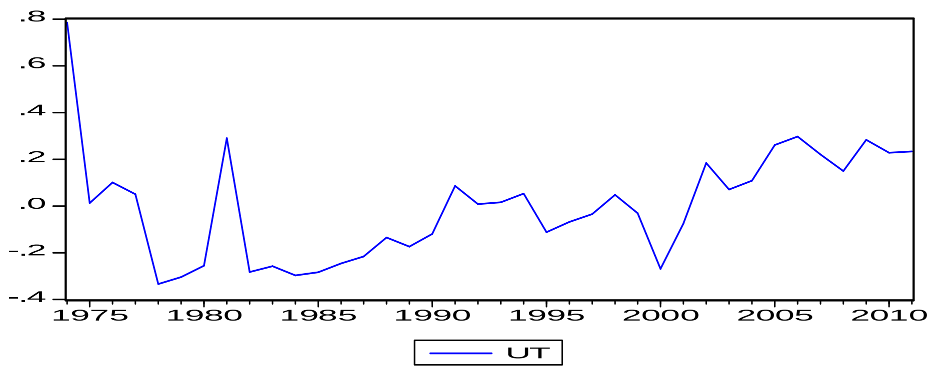
Figure 2 is a graphical view of stationary series. Presented graphs of all the series indicated by DEC and DFA are being drawn after the corresponding data has been converted into first difference.

Fig. 2 Series Become Stationary at First Difference



Spurious Regression

Fig.3 Stationary of Residual at Level



Unit Root Test

1. Observed Variable

The finding of the ADF test exhibits that all the series under consideration are non-stationary in their level. However, stationarity is found after first deference. The appropriate lag order is 3 selected by using Akaike criteria. The ADF test results are given in table 1.

Table 1: ADF Test (Unit Root Test)

Variable	Level		First difference	
	Value	Prob	Value	Prob
EC	-1.3621	0.5901	-9.84636	0
FA	-2.04802	0.266	-5.5766	0

*significant at 1% level

2. Residual

Results show that R-squared value is greater than Durbin-Watson statistic showing a symptom of spurious regression (table 4). However residual of this regression is stationary at level. it can be considered alternative criteria for accepting the model if spurious as proved by R-squared and Durbin-Watson statistic. Table 2 shows the stationarity of residual at level as shown by ADF test.

Table 2: Residual Unit Root Test

Variable	Statistic	Probability
Residual	-4.6892	0.0005

Co-Integration Test

Table 2 represents the Johansen co-integration test results. This table shows whether there is any long run co-movement between the series under consideration. Test results shows that there are two co-integrating equations indicating a long run relationship between variables (EC and FA).

Table 3 Results of co-integration test

Ho	H1	Statistic					
		Tracc	CV(0.05)	Prob	Max eigenevalue	CV(0.05)	Prob
r=0	r=1	20.56656*	15.49471	0.0079	12.46476	14.26460	0.0944
r=1	r=2	8.101803*	3.841466	0.0044	8.101803	3.841466	0.0044

(*) Indicates rejection of hypothesis at 5% level. Trace statistics indicates 2 co-integrating eqn(s) at the 0.05 level but not the Max-eigenvalue statistics.
Series: EC and FA

OLS Estimation Results at Level

The co-integration test suggests that a regression equation can be set up between electricity consumption and explanatory variables in levels. OLS estimation is more important to detect the spurious regression. The results of this estimation are given in table 4.

Table 4 Results of OLS Parameter Estimation at Level

Dependent variable EC					
Variable	Coefficient	Std. Error	t-Statistic		Prob.
Intercept	o.986898*	0.151686	6.506195		0
FA	0.47757*	0.027709	17.23522		0
R-squared					0.891909
Adjusted R-squared					0.970055
F-statistic		297.0529		Probability	0
Durbin-Watson stat					0.844436

(*) Significance at 1% level.

Table 4 represents results from the ordinary least square estimation of the relationship between EC and FA. F-statistic (297.1 with probability 0) shows that over all estimation is significant at 1% level and has a strong explanatory power (R-squared is 0.89). Individual coefficients are also significant at 1% level as indicated by t-statistic. It appears from these results that electricity consumption and foreign aid are positively correlated over the time period of 1974-2011. The growth elasticity of foreign aid in that time period is 0.48. It indicates that the 1% change in foreign aid and GDP will change the electricity consumption by 0.48%. The elasticity coefficient of FA is less than 1 indicating a less proportional change in electricity demand associated with the change in FA.

Another main purpose of OLS estimation in level is to detect the spurious regression. The estimated result shows evidence for this. Durbin-Watson statistics is less than R-squared. This is the fundamental criteria for having spurious regression. But it is found that residual of this model is stationary at level (table2). It is the second criteria to accept the model for further analysis even at a situation in which R-squared is greater than Durbin-Watson statistics.

Error Correction Model (ECM)

Co-integration and non-spurious regression are the fundamental requirements of ECM. Results of co-integration test (table 2) and OLS estimation (table 3) at level have fulfilled these two conditions. EC and FA are co-integrated and non-spurious regression. They provide basis to run the ECM on the proposed variables. Short and long run equilibrium between the variable EC and FA in the system have been investigated with the help of ECM as given below.

$d(EC) = b_3\, d(FA) + b_4\, U_{t-1} + V$
d(EC) = first difference of electricity consumption
d(FA) = first difference of foreign aid
U_{t-1} = One period lag of residual obtained from the OLS estimation at level
b_3 and b_4 are parameters to be estimated
V = Error term

Parameters $b_3$irrespective of its sign but should be individually significant represent short run equilibrium between EC and FA . However, parameter b_4 represents long run equilibrium between the same variable. The sign of b_4 should be negative and significant as well for holding long run equilibrium. Table 5 represents the results of ECM.

Table 5 Results of OLS Parameter Estimation in First Difference

Dependent variable d(EC)				
Variable	Coefficient	Std. Error	t-statistic	Prob.
D(FA)	0.113696*	0.053786	2.11199	0.0419
U_{t-1}	-0.33596*	0.088846	-3.78139	0.0006
R-squared				0.146277
Adjusted R-squared				0.121885
Durbin-Watson stat				2.435028

* indicate significant at 5% level.

The ECM is no spurious regression model as indicated by the R-squared and Durbin-Watson statistics. The coefficient b_3 is positive indicating there is positive relationship between d(EC) and d(FA). b_3 is significant at 5% level. It is known as the short run equilibrium coefficients.

The coefficient b_4 is long run equilibrium coefficient which also is known as the error correction coefficient. It is negative and significant as desired. The values of these parameters are given in Table 6 to show the short and long run equilibrium of the variables under consideration which is the main theme of this investigation.

Table 6: Short and Long Run Equilibrium

	d(FA)	U_{t-1}
Equilibrium	b_3	B_4
Short run	0.114	
Long run	-0.336	

The Short Run Equilibrium

The values of b_3 is 0.114 (table 6) and it is individually significant at 5% level (see table 5).This coefficient represents the short run coefficient and represent the short run equilibrium. It tells about the rate at which the previous period disequilibrium of the system is being corrected. The value of $b_3$is 0.114 meaning that system corrects its previous period disequilibrium at a speed of 11.4% between variables EC and FA.

The Long Run Equilibrium

U_{t-1} is one period lag error correction term or residual. It guides the variables (EC and FA) of the system to restore back to equilibrium or it corrects disequilibrium. To happen this the sign of this should be negative and significant. Parameter b_4 represents its coefficient. It tells about the rate at which it corrects the previous period disequilibrium of the system if it is negative and significant. The coefficient of b_4 is negative (-0.336, table 6) and is significant at 1% level (table 5) meaning that system corrects its previous period disequilibrium at a speed of 33.6% annually. It implies that the model identified the sizable speed of adjustment by 33.6% of disequilibrium correction yearly for reaching long run equilibrium steady state position.

Conclusion

A strong relationship exists between electricity consumption and foreign aid over the period of 1974-2011. The regression model is not spurious as tested. The time series data of these variables contain unit root and they become stationary after conducting ADF test. They have long run relation as indicated by Johansen co-integration test. The statistically significant elasticity coefficient of OLS estimation at level expresses that the 1% change in foreign aid will change the electricity consumption by 0.48%. The results of ECM indicate that there is both short and long run equilibrium in the system. The coefficient of one period lag residual coefficient is negative and significant which represent the long run equilibrium. The coefficient is -0.336 meaning that system corrects its previous period disequilibrium at a speed of 33.6% annually.

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