The Impact of Energy Consumption and Financial Development on Economic Growth in Sri Lanka: An ARDL Bounds Testing Approach

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INTRODUCTION

Economic growth is the symbol of progress; it refers to the increase in the productive capacity of a country. Energy is fundamental to human survival and economic growth. It is the basis of life, for millions of years, animals in the form of food and meat are using for survival of human lives. Energy means anything that has an ability to modify and transform. The prime force of all the economic activities and industrial production is energy [9]. It is considered sustenance and helping hand of an economy. It is also important for socio-economic development. Most countries especially the less developed countries have benefited from transfer of technology in the process of exploration, production and marketing.

Financial development consists of approaching financial activities in a country, such as foreign direct investment and promoting banking activity, stock market activity, and domestic credit to the private sector, which influence on economic efficiency and energy demand [5,6].The reason to put the financial development in the production is that it lets people easy to get loan (cheaper cost) in some items, for example household appliances, mobiles, house, et al. Therefore, it may have a positive effect on economic growth (3).

Although many studies have investigated the energy consumption- economic growth nexus and the financial development-economic growth nexus, very few studies have examined the relationship among energy consumption, financial development, and economic growth with production function. Therefore, this study performed an in-depth analysis of the impact (both in short run and long run impact) of energy consumption and financial development on economic growth with production function and an advanced methodology-ARDL bound testing procedure for the empirical study of Sri Lanka.

AIM/OBJECTIVE

The objective of the study was to find out the impact of the energy consumption and financial development on economic growth with production function for the empirical study of Sri Lanka.

METHODS

This study uses annual data covering the period from 1977-2016 and data were extracted from annual report of Central Bank of Sri Lanka and the World Bank. A time series econometric method is employed for the study.

$$lnY_t = \beta_0 + \beta_1 lnk_t + \beta_2 lnl_t + \beta_3 lnec_t + \beta_4 lnfd_t + u_t \qquad (1)$$

where Y is GDP per capita at constant price (a proxy for economic growth), k is capital per capita (Gross fixed capital formation), L is Labor force participation rate, which ec is energy consumption in kg of oil equivalent per capita, fd is financial development proxies by real domestic credit to private sector per capita (using Domestic credit to private sector (% of GDP)),$u_t$is a stationary error term. All variables are taking logarithm.

In this paper the test of cointegration is carried out using the autoregressive distributive lag model (ARDL) approach due to Pesaran et al. (2001). A two-step procedure is used in estimating the long-run relationship. In the first step, we investigate the existence of a long-run relationship predicted by theory among the variables in question. The short and long-run parameters are estimated in the second stage, when if the long-run relationship is established in the first step. Following Pesaran*et al.*(1997, 2001),an ARDL representation of equation (2) can be written as:

$$\ln Y_t = \alpha_0 + \sum_{i=0}^{p} \alpha_1 \Delta lny_{t-1} + \sum_{i=0}^{q} \alpha_2 \Delta\, lnk_{t-1} + \sum_{i=0}^{r} \alpha_3 \Delta lnL_{t-1} + \sum_{i=0}^{r} \alpha_4 \Delta lnec_{t-1} + \sum_{i=0}^{s} \alpha_5 \Delta lnfd_{t-1} + \beta_1 lny_{t-1} + \beta_2 lnk_{t-1} + \beta_3 lnl_{t-1} + \beta_4 lnec_{t-1} + \beta_5 lnfd_{t-1} + \varepsilon_t \qquad (2)$$

Where, Δ is the first difference operator, $\beta_0$the drift component, andε_t the usual white noise residuals. The coefficients (β_1- β_5) represent the long-run relationship whereas the remaining expressions with summation sign (α_1-α_5) represent the short-run dynamics of the model.The unrestricted error correction model based on the assumption made by Pesaran *et al.* (2001) was also employed for the short-run dynamics of the model. Thus, the error correction version of the ARDL model pertaining to the equation (3) can be expressed as:

$$\Delta \ln y_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta lny_{t-i} + \sum_{i=1}^{q} \beta_{2i} \Delta lnK_{t-i} + \sum_{i=0}^{r} \alpha_3 \Delta lnL_{t-1} + \sum_{i=0}^{r} \beta_{4i} \Delta lnec_{t-i} + \sum_{i=0}^{s} \beta_{5i} \Delta lnfd_{t-i} + \gamma ETC_{t-1} + \vartheta_t \qquad (3)$$

where γ is speed of adjustment which should be statistically significant and should have a negative sign. ϑ_t is pure random error term. The coefficients of the lagged variables provide the short run dynamics of the model covering the equilibrium path. The error correction coefficient (γ) is expected to be less than zero and implies the cointegration relation.

RESULTS

Table 1 shows the unit root tests results. All variables in the levels are not stationary but all variables in integrated of order 1 or I(1), first difference, are stationary.

Table 1: ***Unit Root Tests***

	ADF test		**PP test**	
	(t-Statistic)			
	Level			
	Constant Without Trend	Constant With Trend	Constant Without Trend	Constant With Trend
Variable				
Lny	0.9994 (-1.63)	0.9268(-1.04)	0.9988(-1.44)	0.8944(-1.21)
Lnk	0.4825(-1.58)	0.2468(-2.68)	0.5254(-1.49)	0.0537(-3.49)
Lnl	0.9624(0.107)	0.9485(-0.88)	0.9701(0.21)	0.9315(-1.01)
Lnec	0.9442(-0.085)	0.3525(-2.44)	0.9730(0.26)	0.4254(-2.29)
Lnfd	0.9748(0.29)	0.3730(-2.40)	0.9739(0.27)	0.3361(-2.48)
	First Difference			
Lny	0.0014(-4.35)*	0.0043(-4.54)*	0.0014(-4.33)*	0.0044(-4.53)*
Lnk	0.0000(-5.59)*	0.0004(-5.42)*	0.0000(-9.49)*	0.0000(-12.70)*
Lnl	0.0000(-6.09)*	0.0053(-4.48)*	0.0000(-6.09)*	0.0000(-6.44)*
Lnec	0.0000(-6.99)*	0.0000(-6.17)*	0.0000(-7.19)*	0.0000(-7.41)*
Lnfd	0.0000(-6.32)*	0.0000(-6.26)*	0.0000(-6.32)*	0.0000(-6.25)*

Notes: * denotes significance at the 5% level.

The bound test was used to evaluate cointegration. And the result of bound test is shown in Table 2. The F-statistics is 20.7 and higher than upper critical bound 4.66which indicates a long term relationship among economic growth, energy consumption, financial development, and capital during 1977-2016 in Sri Lanka.

Table 2: ***Results of Bounds Test***

F-statistics	K	**Significance Level**	**Bound Critical values**	
			I(0)	I(1)
20.7	4	1%	3.65	4.66
		5%	2.79	3.67
		10%	2.37	3.2

Table 3: ***Statistical output for long run, short runs model and diagnostic tests***

	Long run model coefficients	
Regressor	Coefficient	p-value
constant		
Lnk	0.569107	0.0000*
Lnl	0.231017	0.0456**
Lnec	0.177652	0.2014
Lnfd	0.065801	0.0648***
	Short run model coefficients	
Regressor	coefficient	p-value
Dlnk	0.284004	0.0042*
Dlnl	0.212731	0.0437**
Dlnec	0.206477	0.0346*
Dlnfd	0.060593	0.0689***
ecm	-0.920849	0.0000*
Diagnostic tests	***(p-value)***	
Serial Correlation LM	0.5257	
Normality Test	0.6664	
ARCH Test	0.7406	
Heteroscedisticity Test	0.6125	
Ramsey RESET Test	0.1204	

Table 3 demonstrates that the estimated long run coefficients and the short run coefficients.The long run coefficient of energy consumption is 0.206 and is not significant, all else being constant. The coefficient of financial development is significant in the long run. This indicates that financial development has impact on long term economic growth.

The result suggests that the energy consumption has short run impact on economic growth because the coefficient of lag one is positive and significant. The coefficient of financial development also has the expected positive sign and significance at 10%. The coefficient of *ECM* (-0.92) is negative and very significant, which suggests that nearly 9% of any deviation from the long-run equilibrium is corrected within one year.

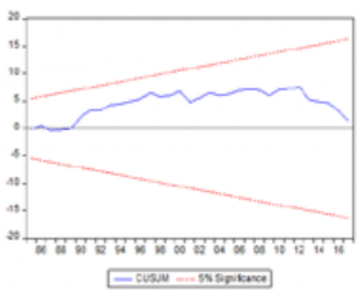

Figure 1: *CUSUM Plots for Stability Tests*
Plot of Cumulative Sum of Recursive Residuals

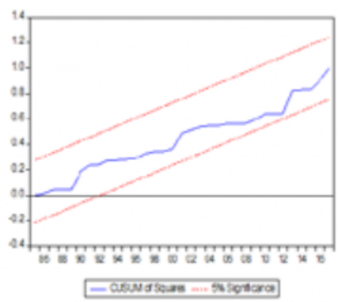

Figure 2: *CUSUMSQ Plots for Stability Test*
Plot of Cumulative Sum of Squares of Recursive Residuals

IMPLICATIONS

This study examined the impact of energy consumption, financial development, and capital on Sri Lanka economic growth during 1977-2016. The ARDL bounds testing model was used in neoclassical production function to identify short-term and longterm relationships among these variables. The analysis revealed a cointegration relationship among energy consumption, financial development, capital, labour and economic growth. The test suggests that there is a positive impact of energy consumption on economic growth only in short run but not in the long run.

The Sri Lanka may continue to develop the energy efficiency technologies to maintain the economic growth of Sri Lanka in the long run. Financial development positively affects economic growth in the long term as well as short run. Therefore, the Sri Lankan government should encourage the financial sector to develop a new financial policy or system to boost up the process of capitalization and to produce a sound energy infrastructure. Capital and labour have positively affected the economic growth and are very important inputs of economic growth both in short run and in long run. The capital and labour have respected result and follows the production theory. This implies that the Sri Lankan government should encourage people to invest more in the capital to maintain the Sri Lanka economic growth.

Further studies are needed to compare cross sectional data. Time series data are also needed for policy analyses of a single country. This study has used time series data (annual data) for analysis of Sri Lanka. policy. However, because of the degree of freedom, time series data cannot include all important variables (for example, export, government spending, and tourism and so on) which may affect the economic development (Smyth & Narayan, 2014). To increase the number of important variables, future studies may use high frequency data if all the data are available. For example, industrial production index monthly data may be used as an alternative to GDP.

KEY WORDS

ARDL, Energy Consumption, Financial Development, Economic Growth, Sri Lanka.

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