Government activities and fossil fuel consumption in Ghana

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ABSTRACT
The purpose of the study is to investigate the relationship between government activities (proxied by government expenditures) and fossil fuel for the period 1971-2011 for Ghana, using annual time series data obtained from World Bank database. The empirical estimates was done by employing the Autoregressive distributed lag model (ARDL), after the Augmented Dickey Fuller (ADF) and Kwiatkowski-Philips-Schmidt-Shin (KPSS) tests have been used to analyse the unit root properties of the variables. The unit root test results indicate the variables are unit root in levels and not in first difference. The cointegration test result shows stable cointegration link between the variables. However, the long run estimate indicates insignificant positive effect of government activities on fossil fuel consumption, whereas, the short run estimate results of the study shows there is stable short run link between government activities and fossil fuel consumption. The policy implication of the findings is that government activities is not a policy tool in the management of fossil fuel consumption.

KEYWORDS: Government expenditures, fossil fuel, cointegration, long run
JEL CODES: E62, G18, O13, P28, Q42

INTRODUCTION
Fossil fuel consumption globally and locally has been increasing over the years and this has been among the most important concerns in relation to environmental pollution (Onwioduokit & Adenuga, 2001; Amegashie, 2006; Central Bank of Nigeria, 2006; Nwafor et al., 2006; Stern 2006; Baig et al., 2007; Gan et al., 2007; IPCC 2007; Ogbuanu, 2008; Carley, 2009; IEA, 2010; Johnstone et al., 2010; Marques & Fuinhas, 2012).

These concerns have led to both theoretical and empirical studies in the area of fossil fuel consumption and its determinants. The main factors that influence fossil fuel consumption theoretically are institutional variables (corruption, nature of law, regulatory quality and government effectiveness, and political stability); macro level variables (human capital, financial development, investment, economic growth, industrialization); and socio-economic factors (carbon dioxide emissions, energy prices, energy needs, and renewables potential).

The theoretical findings on institutional variables are found in the works of Leff (1964); Huntington (1968); Samouilidis and Mitropoulos (1984); Liu (1985); Beck and Maher (1986); Lien (1986); Jones (1991); Murphy, Shleifer and Vishny (1993); Romer (1994); Boycko, Shleifer and Vishny (1995); Parikh and Shukla (1995); Lopez and Mitra, (2000); Mielnik and Goldemberg (2002); Frondel et al. (2004);; Minogue (2005); Awerbuch and Sauter (2006); Jalilian et al. (2006); Carley (2009); Chang et al. (2009); Sadorsky (2009); Van Ruijven and Van Vuuren (2009); Johnstone et al. (2010); Marques et al. (2010); Sadorsky (2010); Belke et al. (2011); Sadorsky (2011); World Bank (2012); Al-mulali et al. (2013); Ocal & Aslan (2013); Sadorsky (2013).

There has been a lot of empirical studies to investigate the determinants of fossil fuel consumption and the findings are reported in the various works (Asafu-Adjaye, 2000; León-González & Montolio, 2004; Oh & Lee, 2004; Sala-i-Martin et al., 2004; Lee, 2005; Soytas & Sari, 2006; Crespo-Cuaresma & Doppelhofer, 2007; Masanjala & Papageorgiou, 2007; Mehrara, 2007; Masanjala & Papageorgiou, 2008; Prüfer & Tondl, 2008; Sadorsky, 2009; Apergis & Payne, 2010; Rafiq & Alam, 2010; Sadorsky, 2010; Pao & Tsai, 2010 & 2011;

Mudakkar & et al., 2013; Aguirr & Ibikunle, 2014; Omri & Nguyen, 2014; Mehrara, Rezaei , Raz, 2015) in the energy literature.

The study adopts different approach from the previous studies reviewed and improves on the existing literature on fossil fuel consumption by considering the effect of fiscal variable (proxied by government expenditures) which have been neglected in the energy literature as one of the main explanatory variables in managing fossil fuel consumption. Very few empirical studies (Glasure, 2002; Bukhari, Sillah, & Al-Sheikh, 2012; Eze, 2017; Yeboah, 2017 & 2018) have considered the role of government activities in both aggregate and disaggregate energy consumption modelling.

However, there are other studies (Isfahani,1996; Adenikinju & Falobi, 2006; Aigbedion & Iyayi, 2007; Amegashie, 2006; Bacon & Kojima, 2006; Nwafor et al., 2006; Baig et al., 2007; Ukah, 2007; Adebimpe & Ibraheen, 2008; Abutu, 2012; Onyisi et al., 2012; Salisu & Uduak, 2012; Umeanozie, Nduka, & Chukwu, 2014) that examined the effect of subsidy on fossil fuel consumption and reported mixed findings on the effect of government subsidies on fossil fuel consumption. The current study deviates from these studies by using total government expenditures and not only government subsidies.

The purpose of the present paper is to investigate the effect of government activities (proxied by government expenditures) on fossil fuel consumption to contribute to the body of knowledge that exists in the energy literature. The study is based on the assumption that government activities statistically and significantly influence fossil fuel consumption positively. The research paper is based on the research question such as what is the effect of government activities on fossil fuel consumption in the short term, and long term?

The study is not without challenges though these challenges do not invalidate the conclusions and recommendations of the study. The findings are limited by the criticisms of the ARDL model, the KPSS and the ADF tests used in examining the cointegration link, and the unit root properties of the variables. Other issues that are not considered are causality, structural breaks, seasonality, and multivariate analyses.
The rest of the sections of the paper looks at the model specification, data, the empirical results, and the conclusions.

2. MODEL SPECIFICATION AND DATA

2.1 Data

The present study is based on annual time series data for the period 1970-2011, for Ghana, with a sample size of 54. The source of the data is World Bank database (World Development Indicator). The data were validated by cross checking with other databases and publications (IEA, Bank of Ghana). Table 1 reports on the data description, proxies, and sources.

Table 1 Data Description, Proxies and Sources

Data Description	Source
Government Activities (GOV) is proxied by Government Expenditure	World Bank World Development Indicator (WDI)
Fossil Fuel Consumption (EC)	World Bank World Development Indicator (WDI)

2.2 Estimation Method

The unit root properties of the data was investigated by employing the Augmented Dickey-Fuller (ADF) stationarity test first followed by the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationarity test. The null assumption of ADF test is that the variables in the model are not unit root in their levels, and the alternative assumption is that the variables in the model are unit root in their levels. The assumption of the KPSS test is that there is non-unit root around a deterministic trend in the variables in their level, whereas, the alternative assumption is that the variables in the estimated model are characterised by unit root around a deterministic trend in their levels. The need for the KPSS test is that it is performed after the ADF test as a confirmatory

test to ensure that the findings are robust. Since there are many literature on ADF and KPSS they are not reviewed in detail in the current paper (see Dickey, & Fuller, 1979; Kwiatkowski, Phillips, Schmidt, & Shin, 1992).

The long run effect of government activities on fossil fuel consumption was analysed by employing the ARDL method of cointegration upon the assessment of the unit root properties. Among the many advantages of the ARDL method of cointegration is that it is applicable whether the unit root features of the variables are known or not if and only if they are not integrated of order two and in the face of small sample size (Pesaran, & Shin, 1999).

2.3 Conceptual Framework and the Empirical Model

The empirical model for the assessment of the effect of government activities on fossil fuel consumption is indicated in equation (1). The model is a bivariate model (simple regression), with fossil fuel consumption (FF) as the regressand, and government activities (proxied by government expenditure) as the regressor. There is no control variable in the model.

$$\ln FF_t = a + \beta \ln GOV_t + \varepsilon_t \text{.....(1)}$$

3. EMPIRICAL RESULTS

3.1 Descriptive Statistics

3.1.1. Results of Central tendencies and Dispersion

Table 2 shows the results of the statistics.. The value of the mean indicate a well fitted model. The results indicate that fossil fuel consumption falls as low as 11.529GWh and rise as high as 31.205GWh, whereas government activities falls as low as 5.861 dollars and rise as high as 15.308 dollars. Fossil fuel consumption (0.195) variable is more volatile than government expenditure (0.177) variable. The coefficient value of the kurtosis of FF (0.097) is more than zero (0) which indicates less flat-topped distribution. The coefficient value of the kurtosis of GOV (0.495) is less than unity (1) which shows more flat-topped distribution. Fossil fuel consumption is positively skewed; whereas government expenditure variable is negatively skewed.

Table 2 Summary Statistics, using the Observations 1970-2011

Var	Mean	Min.	Max.	S.D	CV.	SK.	KUR.
FF	21.797	11.529	31.205	4.257	0.195	0.097	-0.199
GOV	10.967	5.861	15.308	1.945	0.177	-0.439	0.495

Source: Author's computation, 2013. SK=Skewness; KUR. =Kurtosis; CV=Coefficient of Variation; Min. Minimum; Max. =Maximum; S.D=Standard Deviation

3.1.2. Correlation Analysis

Correlation matrix is used to investigate multicollinearity effect between the variables in the model. Table 3 shows the results. The results indicate there is positive relationship between government activities and fossil fuel consumption, which indicate that multicollinearity is not a problem.

Table 3 Correlation Matrix for Test's Variables

Var	EC	GOV
FF	1.000	
GOV	0.208	1.000

Source: Author's computation, 2013

3.2 The ADF and KPSS Unit Root Tests results

3.2.1 The ADF Test

Table 4 indicates the results of the ADF test for the unit root test in levels and in their first differences. The results in levels show that the variables are non-stationary in intercept and with trend. The null assumption of unit root was not rejected for both variables.

Table 4 ADF stationarity test results with a constant and trend

Variables	t-statistics	ADF/P-Value	Results	Lag length
GOV	-2.4671	0.3419	Not stationary	1
GOV-1st dif.	-5.8498	0.0001***	Stationary	1
FF	-2.7613	0.2191	Not stationary	1
FF-1st dif.	-6.9492	0.0000***	Stationary	

Source: Author's computation, 2013: Note: *** and *** denote significance at 1%, and 5% level of significance

3.2.2 The KPSS Test

Table 6 and Table7 show the test results of the KPSS. The variables are analysed in levels, and in first difference. The variables are not unit root in levels, and in first difference, indicating that they are integrated both of order zero, I(0), and order, one, I(1). The levels of significance are 1%; 5% and 10%.

Table 5 KPSS stationarity test results with a constant and a time trend

Variables	t-statistics	Results	Lag length
GOV	0.1073	Stationary	3
GOV-1st dif.	0.0725	Stationary	3
FF	0.2307	Stationary	3
FF-1st dif.	0.0993	Stationary	3

(Source: Author's computation, 2013): Critical values at 10%, 5% and 1% significant levels are 0.122 0.149 0.212 respectively

3.3 The Cointegration, Long Run, and Short Run Tests Results

3.3.1. Results of Autoregressive Distributed Lag (ARDL) model/Bound Approach to Cointegration for Fossil Fuel Consumption and Government expenditure (GOV)

The long term link between fossil fuel consumption and government activities (proxied by government expenditure) was examined using the ARDL method of cointegration. The results as reported in Table 6 indicate significant cointegration between fossil fuel consumption and government activities since the calculated F-statistics of 5.7155 is greater than the critical values of the upper bounds at the 90% and 95% levels of significance for model 1 with fossil fuel consumption as the dependent variable. The null assumption of no cointegration is rejected in model 1. The results indicate that government expenditure is a long-run equilibrium variable that explains fossil fuel consumption during the period under discussion.

Table 5: Test for cointegration relationship

Critical bounds of the F -statistic: intercept and trend						
	90% level		95% level		99% level	
	$I(0)$	$I(1)$	$I(0)$	$I(1)$	$I(0)$	$I(1)$
	2.915	3.695	3.538	4.428	5.155	6.265
Models	**Computed F -Stats**		**Decision**			
1. F_{FF}(FF/GOV)	5.7155**		Cointegrated			
2. F_{GOV}(GOV/FF)	3.5660		Not Cointegrated			

Source: Author's computation, 2013: Note: critical values are obtained from Pesaran et al., (2001) and Narayan, (2004): NB **denotes significance at 5% level

3.3.2. Results of Long-Run Elasticities of ARDL Model

The long-run determinant of fossil fuel consumption was estimated using the model in which fuel consumption is the dependent variable after establishing the cointegration link. Table 6 reports the results. The results indicate that government activities do not statistically significantly determine fossil fuel consumption in the long run since the coefficient value of 0.8144 is insignificant. The coefficient of government activities however, has expected a priori theoretical sign of positive. The results shows that 1% increase in government activities leads to about 81.44 % increase in fossil fuel consumption, though insignificant.

Table 6: Estimated long-run coefficients. Dependent variable is LNFF

Variable	Coefficient	Std. Error	T-ratio	P-value
Constant	0.8898	1.3989	0.6361	0.5290
Trend	0.0113	0.0075	1.5022	0.1430
lnGOV	0.8144	0.5840	1.3945	0.1720

Author's computation, 2013: ARDL (3) selected based on Akaike Information Criterion

3.3.3: Results of Short-Run Elasticities of ARDL Model

Table 7 reports the results of short-run dynamic equilibrium relationship coefficients estimated with trend, intercept and error correction term (ecm). The results of the nature of the short run coefficients (0.2208) are different from that of the long-run coefficients. Government activities are significant determinant of fossil fuel consumption in the short run at 10% level. One percent increase in government activities leads to about 22.1% increase in fossil fuel consumption. The error correction mechanism serves as a means of reconciling short-run behaviour of an economic variable with its long-run behaviour. The error correction term is statistically significant at 10% level of significance and has the theoretical expected sign of negative. The coefficient of -0.2712 indicates that, after 1 percent deviation or shock to the system, the long-run equilibrium relationship of fossil fuel consumption is quickly re-established at the rate of about 27.12% percent per annum. The value does not indicate stronger adjustment rate.

Table 7: Short-run representation of ARDL model. ARDL (1) selected based on Akaike Information Criterion. Dependent variable: ΔlnFF

Variable	Coefficient	Standard error	T-statistic	P-value
Constant	0.24132	0.47512	0.50792	0.615
Trend	0.0030666	0.0022806	1.3447	0.188
ΔlnFF-1	-0.34912	0.16994	-2.0543	0.0480**
ΔlnFF-2	-0.32216	0.15550	-2.0718	0.0460**
ΔlnGOV	0.22088	0.11697	1.8884	0.0680*
ecm (-1)	-0.27122	0.14170	-1.9141	0.0640*
ecm = LNFF -0.8898C -0.01137T -0.8144LNGO……(2)				
R-Squared 0.6282 R-Bar-Squared 0.57185				
S.E. of Regression 0.1379 F-stat. F(5, 33) 11.1507[0.000]				
Mean of Dependent Variable 3.0602 S.D. of Dependent Variable 0.2108				
Residual Sum of Squares 0.6276 Equation Log-likelihood 25.1866				
Akaike Info. Criterion 19.1866 Schwarz Bayesian Criterion 14.1959				
DW-statistic 2.1977				

Source: Author's computation, 2013. Note: * and ** denotes statistical significance at the 10% and 5% levels respectively

3.3.4. Results of Diagnostic Tests

Table 8 depicts the diagnostic tests results of the short-run estimation to examine the reliability of the results of the error correction model. The null hypothesis of no serial correlation could not be rejected using the Lagrange multiplier test and the F-statistics. The RESET test showed evidence of incorrect functional specification of the model through a rejection of the null hypothesis. The estimated model did not pass the normality test. The model passed Heteroscadasticity test indicating the variances are constant over time. The R^2 (0.6282) and the adjusted R^2 (0.5719) in Table 7 are not an indication of a very well behaved model. The

coefficient indicate approximately 62.82% of the variations in fossil fuel consumption are attributed to the government activities.

Table 5.36: Short-Run Diagnostic Tests of ARDL Model

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(1)= 2.7200[0.099]	F(1, 32)= 2.3991[0.131]
B:Functional Form	CHSQ(1)= 0.1988[0.656]	F(1, 32)= 0.1640[0.688
C:Normality	CHSQ(2)= 12.3502[0.002]	Not applicable
D:Heteroscedasticity	CHSQ(1)= 1.0024[0.317]	F(1, 37)= 0.9761[0.330]
A:Lagrange multiplier test of residual serial correlation B:Ramsey's RESET test using the square of the fitted values C:Based on a test of skewness and kurtosis of residuals D:Based on the regression of squared residuals on squared fitted values		

Source: Author's computation, 2013.

The stability of the long-run estimates was determined by employing the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) procedures. This was determined using the residuals of the error-correction model indicated by equation (2). The CUSUM test of stability determines the methodological arrangements of the estimates and its null hypothesis states the coefficients are stable. The null assumption is rejected when the CUSUM surpasses the given critical boundaries, which demonstrate unstable nature of the estimates. The CUSUMSQ determines the stability of the variance. Both tests as shown Figure 1 and 2 revealed that the estimates and the variance were stable as the residuals and the squared residuals fall within the various 5% critical boundaries. The null assumptions are not accepted in both tests.

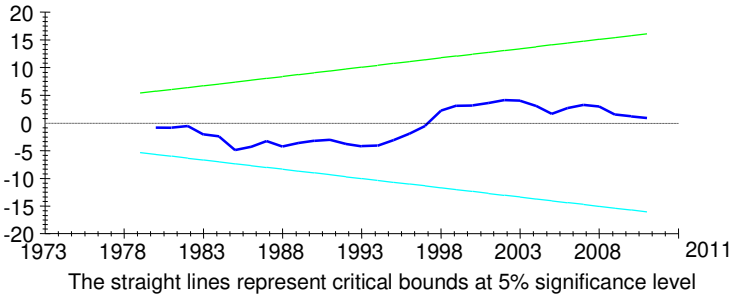

Figure 1: Plot of Cumulative sum of recursive residuals

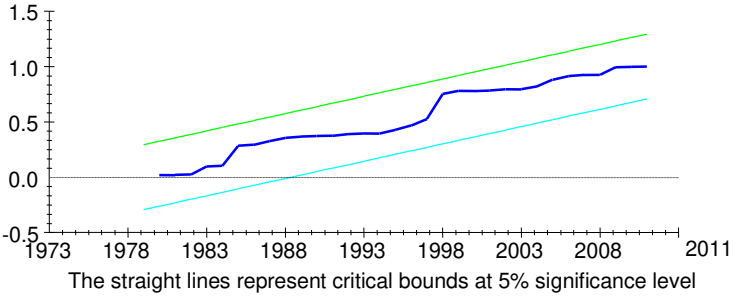

Figure 2: Plot of Cumulative sum of squares of recursive residuals

5. CONCLUSIONS

The objective of the study, which is to examine the effect of government activities on fossil fuel consumption for the period 1971 to 2011, for Ghana, have been achieved. There is cointegration relationship between government activities and fossil fuel consumption. However, there is insignificant positive long run link between government activities and fossil fuel consumption and a significant positive short run nexus between government activities and fossil fuel consumption.

The finding of cointegration is in line with previous studies (Yeboah, 2017 & 2018) on the effect of government activities on aggregate energy consumption and electricity consumption. The insignificant long run effect of government activities on fossil fuel consumption is inconsistent with area studies (Glasure, 2002; Bukhari, Sillah, & Al-Sheikh, 2012; Eze, 2017; Yeboah, 2017 & 2018) that analysed the effect of government activities on aggregate energy consumption and electricity consumption and reported significant positive effect.

The finding of significant positive short run nexus between government activities and fossil fuel consumption are in support of results of earlier studies (Glasure, 2002; Bukhari, Sillah, & Al-Sheikh, 2012; Eze, 2017; Yeboah, 2017 & 2018) that reported of significant effect of government activities on aggregate energy and disaggregate consumption. The empirical estimates of the study provide an important policy implication for Ghana in the area of energy management. The findings suggest that government activities could not be relied on as a policy tool in managing fossil fuel consumption in Ghana in the face of increasing fossil fuel consumption.

Future studies should consider multivariate modelling of government activities on fossil fuel consumption in the presence of structural breaks, as well as analysis of predictive causality among the variables, to determine if the current findings will be replicated.

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