Vol. II, Issue 4
July 2013

Electricity Consumption and Economic Growth in Nigeria

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The paper seeks to examine the relationship between electricity consumption and economic growth in Nigeria using the Johansen and Juselius Co-integration technique based on the Cobb-Douglas growth model covering the period 1980-2008. The study adopted also conducted the Vector Error Correction Modelling and the Pairwise Granger Causality test in order to empirically ascertain the error correction adjustment and direction of causality between electricity consumption and economic growth. The study found the existence of a unique co-integrating relationship among the variables in the model with the indicator of electricity consumption impacting significantly on growth. Also, the study shows an evidence of bi-directional causal relationship between electricity consumption and economic growth. Prominent among the policy recommendation, is the need to strengthen the effectiveness of energy generating agencies by ensuring periodic replacement of worn-out equipment in order to drastically curtail transmission power losses.

Keywords: *Electricity Consumption, Economic Growth, Co-integration, and Causality test*

Introduction

Poor access to electricity in Nigeria has been a major impediment to Nigeria's economic growth. SMEs have been adjudged as the engine of economic growth but its performance is grossly dismal due to inadequate power supply. Researchers have identified the increase in energy use as a vital component of emerging economies; economic growth of the South Asia Association for Regional Cooperation (SAARC) countries – involving Bangladesh, India, Pakistan and Sri Lanka is closely related to its energy consumption which is an impediment for enhancing export values, increasing remittances receipts from manpower supply, Sheriff (2002). Whether African economies, most especially Nigeria are ready for developmental take-off should be based on its readiness to ensure adequate and regular power supply, which represent a crucial factor that supports economic growth in developing countries, (Morimoto and Hope 2001). As sited in Morimoto and Hope 2001; Ferguson et al (2000) study of the correlation between electricity use and economic growth in Sri Lanka found a very high positive correlation of 0.993, thereby concluding the existence of strong correlation between electricity use and economic development. Increasing incidence of power shortages has been identified as responsible for the dwindling growth of most underdeveloped countries and this is not unconnected with the inabilities to develop new generating capacity as hydropower has been the only source of power, thereby diminishing electricity supply severely during droughts (Ferguson et al 2000). In order to ensure an appropriate recovery of the socio-economic process of Nigeria within the framework of effective economic system, development, enhancing structures, patterns and evolution of production, allocation and utilization of its vast resources, similarly ensuring optimal development and efficient management of available resources, equitable allocation of such resources and effective utilization in order to ultimately achieve economic development; the issue of electricity (power) availability needs to be taken as a vocal point in development planning, that is, the modern technologies needed to drive economic development are strictly tied to the use of energy. This therefore, is a function of adequate supply and distribution of energy, most especially electricity. This study therefore becomes imperative in analyzing the challenges of electricity supply and to examine the level of electricity induced growth in the Nigerian economy. The study is outlined into the following sections; section two focused on the background information/stylized facts on the subject matter in Nigeria; section three, briefly link the incidence of energy consumption and growth in line to the existing literatures; section four provides the theoretical framework and model formation for the study and section five concludes with policy implementation.

Stylized/background facts

Evidences have shown that Nigeria is primarily an energy store house accommodating resources such as coal and lignite, natural gas, crude oil, solar, hydro, nuclear, wood fuel, geothermal, tide, biogas and biomass. In spite of the available vast resources, only four sources (coal, crude oil, natural gas and hydro) are currently utilized in processed forms while two others (wood fuel and solar) are used in their crude forms for heating, cooking and lighting. The responsibility of production and distribution of electricity was saddled with the National Electric Power Authority (NEPA), established by decree no. 24 of 1972 until recently when the sector was deregulated in order to allow private participation. The NEPA was charged with the statutory monopoly power to over-see electricity development throughout the country and produce electricity under a high proportion of in-operational generating plant capacities of 27%, overloaded and overstretched transmission lines; in addition, the problem of hydrological inadequacies in hydro-electric plants especially within the period of dry season. The foregoing challenges coupled with illegal access to transmission lines have culminated into frequent breakdown of electricity equipment (seemingly due to overload) and a large quantum of electricity losses in the transmission system (ranging between 20-30%), NEPA often responded to these anomalies by creating an electricity supply-demand artificial balance such as rationing, shedding and suppressed demand services; all these have resulted in the low quantum of electricity available for consumption. This current status of electricity supply in Nigeria reflects a situation of supply crisis in which industrial growth and socio-economic development paces are kept below the potential of the economy (Ayodele, 2000; FRN 1975; WORLD BANK 1991; Ayodele, 1992 & 1999).

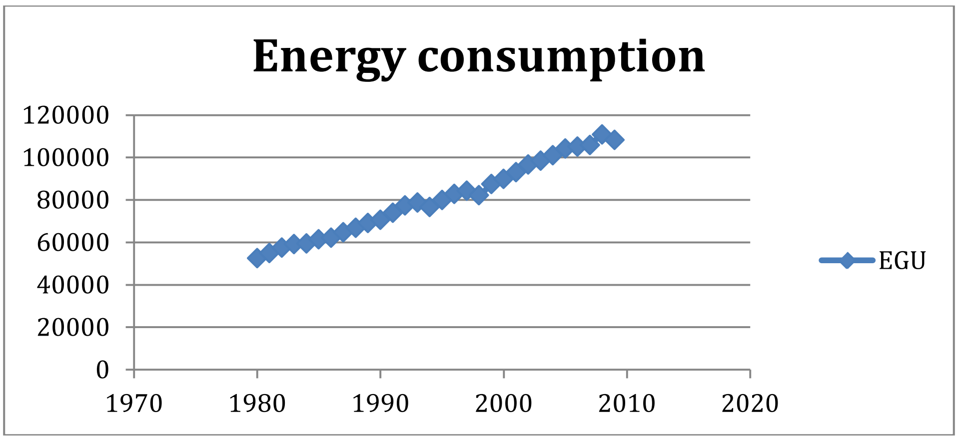

Figure 1: Energy Consumption Trend in Nigeria

Source: computed from World Development Indicator Database

In line with the trend witnessed in most developing countries, Nigeria energy consumption has increasingly experienced an upward trend with over 23% increase in energy use between 2000 and 2008 (see figure 1). Since 1970, Nigeria's energy consumption has consistently maintained an upward trend, likewise the energy use per capita has steadily been rising until 2005 where a decline was witnessed and afterwards has been steadily increasing. The continuous increase in energy consumption is quite consistent with GDP but the energy consumption has been increasing at a faster rate than GDP (see figure 2).

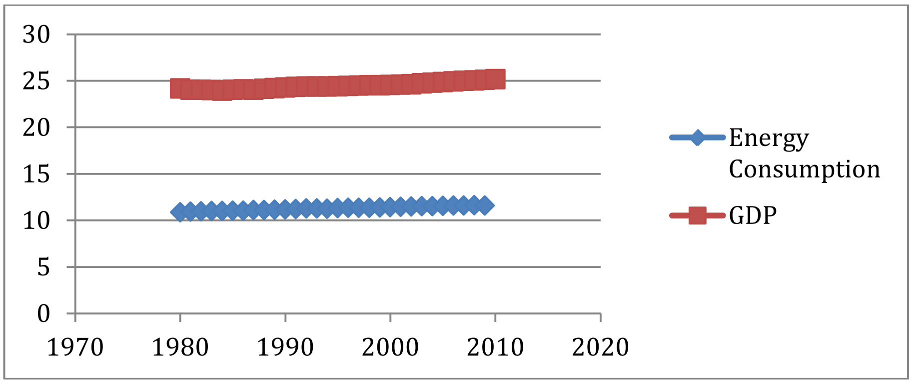

Figure 2: Log Trend Pattern of Energy Consumption and GDP

In the face of the raging need for energy consumption, distribution losses (see table below) and the NEPA devices to allocate available electricity to consumers; it is therefore evident that the quantum of electricity does not meet the actual demand for electricity. The situation but describes an electricity supply crisis has activated wide spread poverty in Nigeria as the businesses of the middle class populace has been eradicated due to increasing energy cost and multi-nationals have sort greener pasture in neighboring countries.

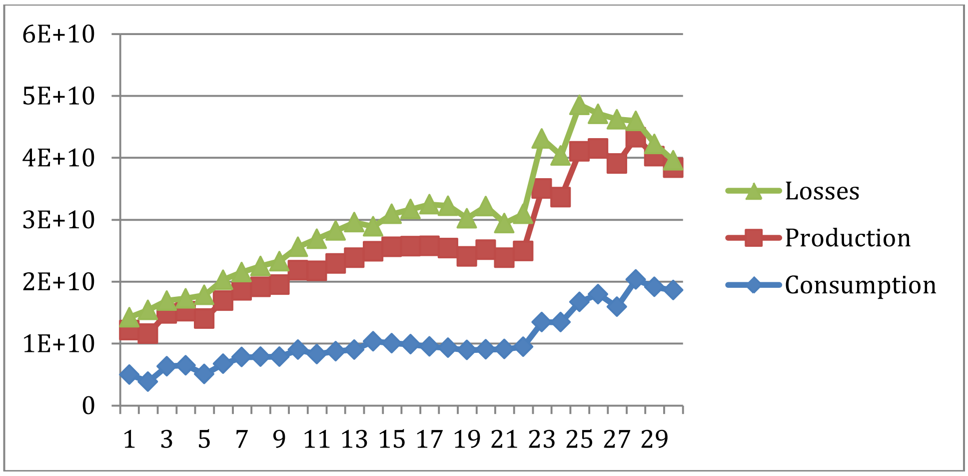

Figure 3: Total Electricity Production, Consumption and Losses (1980-2009)

Source: Computed from World Development Indicators Database

The issue of power losses has been a major challenge for the electricity generating agencies in Nigeria, majority of this problem is due to vandalism and inadequate and worn-out electricity transmission equipments. Over 45% of the electricity generated are unavoidably lost in transmission process, several power plants have been erected in the country from the inception of democratic governance in 1999 but the Nigeria economy is yet to appropriate the benefits of the huge investment, as electricity unavailability still remains an invisible ghost haunting the nation's economy and has successfully wiped off cottage industries due to high cost of generating power independently.

Table 1: Electricity Generation and Consumption

year	installed capacity(mw)	total generation (million kwh)	total consumption (million kwh)	power losses in transmission	Losses (million kwh % of total)
1990	4,548	13,462.9	7,870.5	5,592.4	41.5
1991	4,548	14,166.6	8,292.0	5,874.6	41.5
1992	4,548	14,833.8	8,699.0	6,134.8	41.4
1993	4,586.6	14,504.6	9,998.3	4,506.3	31.1
1994	4,548.6	15,531.6	9,593.9	5,937.1	38.2
1995	4,548.6	15,856.6	9,435.9	6,420.7	40.5
1996	4,548.6	16,242.8	9,051.8	7,191.0	44.3
1997	4,548.6	16,116.8	8,843.2	7,273.7	45.1
1998	5,400.0	15,110.0	8,521.2	6,588.8	43.6
1999	5,876.0	16,088.7	8,576.3	7,512.4	46.7

Source: Compiled by author from CBN, 2002

Brief Review of Literature

Economic debates surrounding the research can't explicitly link the relationship between energy consumption and economic growth to theories, though empirical evidences have stated results for about two decades. The seminal work of Kraft and Kraft (1978) presented the premier study on the causal relationship between economic growth and energy consumption; Also, research evidences have discovered a story correlation between electricity use and wealth creation (Ghosh 2002; Shiu and Lam 2004; Morimoto and Hope 2004; Jumbe 2004; Wolde-Rufael 2004; Narayan and Smyth 2005; Yoo 2005. Altinay and Karagol (2004) discovered a rising energy need for most developing countries; Turkey also facing an ever increasing electricity demand experienced 8.1% per annum in the average growth rates of total electricity consumption between 1980 and 2000; Nigeria also face similar trend experiencing about 23% increase in energy use between 2000 and 2008.

Several studies have attempted the relationship and direction of causality between energy consumption and economic growth, Ahmed N,

Hayat F.M, Hamed N and Inqman M (2012) investigated the relationship between energy consumption and economic growth in Pakistan for the period of 1973-2006 and found a positive relationship with a unidirectional causality from GDP to energy consumption. A similar study of Kouakou A. K (2010) in Cote d'Ivoire covering 1971-2008 found a bi-directional causality between per capita electricity consumption and per capita GDP. A study by Ouadraogo N.S (2012) for fifteen countries of ECOWAS from 1980-2008 using a panel co-integration technique found GDP and energy consumption as well as GDP and electricity to exhibit a long-run co-integrating relationship, likewise found a unidirectional causality running from GDP to energy consumption. Ciarreta A. and Zarraga A (2007) using a standard Granger causality test in a VAR found a unidirectional linear causality running from real GDP to electricity. Also, a premier work from by Morimoto R and Hope C found electricity supply to have a significant impact on variation in GDP in Sri Lanka; the result obtained is similar to Yang (2000). Several studies, most especially in developing economies have found electricity consumption to be a significant determinant of GDP growth

(Soytas and Sari 2003; Asafu-adjaye 2000; Ferguson et al 2000; Altinay G and Karagol E 2005). Contrarily to the forgoing assumptions, Mehrara M. and Musai M (2002) using a panel analysis of 11 selected oil exporting countries found that electricity use does not have any significant effects on GDP.

Methodological Framework

The Model

The study adopts a Cobb-Douglas production function with constant returns to scale similar to Ahmed N et al (2012).

$$Y = AK^{\alpha}L^{\beta}$$

In the model above, Y is the total production (output), L is the labor input, K is capital input and A is the total factor productivity. α and β are the output elasticity's of labor and capital respectively.

$$GDP = \beta_0 KAP^{\beta_1} LAB^{\beta_2} ELEC^{\beta_3}$$

The explicit form of the model stated in a log linearized form can presented as follow:

$$LOGGDP_t = \beta_0 + \beta_1 LOGKAP_t + \beta_2 LOGLAB_t + \beta_3 LOGELEC_t + \varepsilon_t$$

GDP_t represents Gross Domestic product, ELE_t is the electricity consumption (Kilowatt per hour), LAB_t is total labor force, KAP_t is the stock of capital and ε_t is the white noise term. The a priori expectation is such that $\beta_1, \beta_2, \beta_3 > 0$.

The equation for Granger causality test can be specified as follows:

$$LOGGDP = \sum \emptyset\, iLOGEGU_{t-1} + \sum \emptyset\, jLOGGDP_{t-1} + \varepsilon_{t_1}$$

$$LOGEGU = \sum \alpha\, iLOGEGU_{t-1} + \sum d\, jLOGGDP_{t-1} + \varepsilon_{t_1}$$

Data Sources and Measurement

The data used in the study is drawn from the World Development indicators and central bank of Nigeria statistical Bulletin. Data for gross fixed capita formation, labor force and energy use are sourced from the World Development Indicators of World bank, 2012 while gross fixed capita formation is drawn from the central bank of Nigeria statistical Bulletin, 2010.

Variable	Description	Source	measurement
lgdp	Gross Domestic Product	World Development Indicators of World Bank, 2012	Constant 2000 US$
lkap	Gross Fixed Capital Formation	Central Bank of Nigeria Statistical Bulletin, 2010	Constant 2000 US$
llab	Labour force	World Development Indicators of World Bank, 2012	Number
elec	Electricity Consumption	World Development Indicators of World Bank, 2012	KwH

Source: Compiled by author

Econometric Analysis

This aspect attempts an empirical investigation of the effect of energy consumption (proxy for electricity consumption) on gross domestic product. The section starts with examining the time series characteristics of the variables included in the model; that is, testing the time series property of gross domestic product, capital stock, labor and energy consumption in order to avoid the occurrence of a spurious regression. Determining the order of integration of the variables involves subjecting the data series to a unit root testing; here two unit root test procedure shall be adopted-the Augmented Dickey Fuller (ADF) and the Philip

Perron (PP) test. After ascertaining the order of integration, we can then proceed to estimating the Johansen and Joselius co-integration analysis in order to test for the existence of a co-integrating relationship among the variables. Finally, a test of causal relationship between energy consumption and GDP is conducted using a pairwise granger causality test.

Unit Root Testing

The section examines the unit root property of the variables in the model using ADF and PP test with the inclusion of trend and intercepts components in the test equations at both levels and first difference. All the variables appear to be stationary at first difference at 5% significance level.

Variable	**Level**		**First difference**	
	ADF	*PP*	*ADF*	*PP*
lgdp	-3.7157**	-3.4144**	-5.3803*	-5.4849*
lkap	-1.0143	-1.0143	-4.3094**	-4.3307**
llab	-2.6504	-2.7639	-5.5434*	-5.5157*
Lelec	-1.0559	-0.8049	-8.0410*	-8.1822*

Source: Computed by author using e-views 5.0
*significance at 1% **significance at 5% ***significance at 10%

Johansen Co-integration Test

The study proceeds to test for the existence of co-integration among the variables in the model; this is based on the representation of the approach specified by Johansen and Juselius (1990). The Johansen test for co-integration provides an analytical statistical framework for ascertaining the long-run relationship between the economic variable (Agbola, 2004). The table compare unrestricted co-integration rank test available from the trace and maximum eigenvalue test with the corresponding critical values due to Mackinnon-Haug-Michelis (1999). The result indicates that the trace statistic show an evidence of a unique co-integration equation, which implies an existence of long run equilibrium relationship among the observed variables.

		Trace Test		
eigenvalue	Trace Static	critical value at 0.05	Prob	Hypothesized no. of CE(s)
0.975426	97.51483	55.24578	0.0000	None*
0.667875	34.51174	35.01090	0.0565	At most 1
0.469386	15.77360	18.39771	0.1122	At most 2
0.254827	5.000350	3.841466	0.0253	At most 3
		Maximum Eigenvalue		
0.975426	63.00309	30.81507	0.0000	None*
0.667875	18.73815	24.25202	0.2267	At most 1
0.469386	10.77325	17.14769	0.3299	At most 2
0.254827	5.000350	3.841466	0.0253	At most 3
		Co-integration co-efficient normalized on growth		
LGDP	LKAP	LLAB	LELEC	
1.000000	-0.073886	3.324912	-0.125961	
	(0.00235)	(0.11649)	(0.00723)	

Source: Computed by author using e-views 5.0

The normalized energy induced growth equation shows the respective effect of the explanatory variables on the regressand. The explanatory variables all exert an inelastic and significant impact on the explained variable, except labour force which exerts an elastic impact on the log of growth. A proportionate change in capital stock and electricity consumption will bring about a lesser proportionate change in growth while a proportionate change in labour force will bring about a more proportionate change in growth. The result obtained from the estimation was found consistent to that of Wolde-Rufael Y (2004), Akinlo A.E (2009) and Kauakou A.K which also found a positive cointegrated and significant impact of electricity consumption on the level of economic growth.

Vector Error Correction Model

The table below indicates that estimated lagged error correction term of growth. The magnitude of the error correction term is negative (appropriately signed), its absolute value lies between zero and one, and it's statistically significant. This implies a long-run convergence of the model; it hereby implies that if any external shock is introduced into the model, the model would still converge with time. The speed of error adjustment of the model is quite impressive (about 99%), implying 99% of present error in the model would be corrected in the long-run

Variable	**D(LGDP)**	**D(LKAP)**	**D(LLAB)**	**D(LELEC)**
ECT_1	-0.985996	7.746074	-0.004681	-2.311518
	(0.32424)	(8.75592)	(0.16940)	(2.40066)
	[-3.04091]	[0.88467]	[-0.02763]	[-0.96287]

Causality Test

The causality test using the pairwise approach shows the causal relationship between electricity consumption and GDP with f-stat of 3.41182 and probability of 0.05040, due to the significance of the probability; we hereby conclude that electricity consumption does granger cause GDP for the observed period. Also, the result indicates that GDP does granger cause electricity consumption. This implies bi-directional relationship between electricity consumption and GDP for the observed period, implying that as the level of electricity consumption increases; the growth of the Nigerian economy is enhanced and vice versa. The obtained result is similar to the works of Odhiambo N.M (2010), Ouedraogo N.S (2012) and Akinlo A.E (2009) which all concluded that increasing demand for energy is an engine of development for developing countries.

Pairwise Granger Causality Test

Null Hypothesis	F-statistics	Prob
LELEC does not Granger Cause LGDP	3.41182	0.05040
LGDP does not Granger Cause LELEC	4.64951	0.02015

Source: Computed by author using e-views 5.

0

Conclusion

This paper attempts to examine the relationship that exists between electricity consumption and economic growth in Nigeria using the Johansen and Juselius co-integration technique of estimation based on Cobb-Douglas growth model for the period covering 1980-2010. The study used the electricity consumption data readily available from WDI as against that provided by the Central Bank of Nigeria Statistical Bulletin, since the latter exhibited some form of inconsistencies from time to time. The study conducted a unit root testing to ascertain the stationery status of the data series; as theories as proofed the non-stationary of most economic data in level state. The series were found to contain unit root, hereby necessitating the incorporation of the differencing mechanism at first-order integration. The study found the existence of a unique co-integrating relationship among the variables in the model, as well the VECM estimates indicates a possibility of a long run convergence with high speed of error correction. The indicator of electricity consumption was found to exert a very significant impact on growth. In line with the obtained result, there exist a bi-directional causal relationship between electricity consumption and economic growth. The inelastic impact of electricity consumption on growth, as obtained in the analysis; therefore call for the need to strengthen the effectiveness of energy generating agencies by ensuring periodic replacement of worn-out equipment and necessary tools in order to drastically reduce power losses.

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APPENDIX

Date: 01/24/13 Time: 23:31

Sample (adjusted): 1992 2008

Included observations: 17 after adjustments

Trend assumption: Quadratic deterministic trend

Series: LGDP LKAP LLAB LELEC

Lags interval (in first differences): 1 to 1

Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.975426	97.51483	55.24578	0.0000
At most 1	0.667875	34.51174	35.01090	0.0565
At most 2	0.469386	15.77360	18.39771	0.1122
At most 3 *	0.254827	5.000350	3.841466	0.0253

Trace test indicates 1 co-integrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.975426	63.00309	30.81507	0.0000
At most 1	0.667875	18.73815	24.25202	0.2267
At most 2	0.469386	10.77325	17.14769	0.3299

At most 3 *	0.254827	5.000350	3.841466	0.0253

Max-eigenvalue test indicates 1 co-integrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integrating Coefficients (normalized by b'*S11*b=I):

LGDP	LKAP	LLAB	LELEC
-73.57378	5.436044	-244.6264	9.267434
-12.43977	-1.993485	81.79619	11.23605
8.557411	-2.120117	-80.61079	-0.793924
6.085605	-1.551089	74.07431	-5.524506

Unrestricted Adjustment Coefficients (alpha):

D(LGDP)	0.013401	0.010721	0.002844	-0.000303
D(LKAP)	-0.105283	0.142125	0.176942	-0.106376
D(LLAB)	6.36E-05	-0.000900	0.002050	-0.003304
D(LELEC)	0.031418	-0.039546	0.052314	0.024985

1 Co-integrating Equation(s): Log likelihood 146.2102

Normalized co-integrating coefficients (standard error in parentheses)

LGDP	LKAP	LLAB	LELEC
1.000000	-0.073886	3.324912	-0.125961
	(0.00235)	(0.11649)	(0.00723)

Adjustment coefficients (standard error in parentheses)

D(LGDP)	-0.985996
	(0.32424)
D(LKAP)	7.746074
	(8.75592)
D(LLAB)	-0.004681
	(0.16940)
D(LELEC)	-2.311518
	(2.40066)

2 Co-integrating Equation(s): Log likelihood 155.5793

Normalized co-integrating coefficients (standard error in parentheses)

LGDP	LKAP	LLAB	LELEC
1.000000	0.000000	0.200714	-0.371243
		(0.87773)	(0.04686)
0.000000	1.000000	-42.28426	-3.319752
		(11.8478)	(0.63257)

Adjustment coefficients (standard error in parentheses)

D(LGDP)	-1.119364	0.051479
	(0.21010)	(0.01630)
D(LKAP)	5.978075	-0.855647
	(8.22260)	(0.63804)
D(LLAB)	0.006520	0.002141
	(0.17049)	(0.01323)
D(LELEC)	-1.819573	0.249622
	(2.24881)	(0.17450)

3 Co-integrating Equation(s): Log likelihood 160.9659

Normalized co-integrating coefficients (standard error in parentheses)

LGDP	LKAP	LLAB	LELEC
1.000000	0.000000	0.000000	-0.376676
			(0.04603)
0.000000	1.000000	0.000000	-2.175137
			(0.75819)
0.000000	0.000000	1.000000	0.027070
			(0.01633)

Adjustment coefficients (standard error in parentheses)

D(LGDP)	-1.095025	0.045448	-2.630685
	(0.20040)	(0.01645)	(0.72104)
D(LKAP)	7.492240	-1.230785	23.11685
	(7.13014)	(0.58536)	(25.6549)
D(LLAB)	0.024063	-0.002206	-0.254469
	(0.16455)	(0.01351)	(0.59207)

D(LELEC)	-1.371897	0.138710	-15.13742
	(1.89204)	(0.15533)	(6.80773)

Vector Error Correction Estimates

Date: 01/24/13 Time: 23:42

Sample (adjusted): 1992 2008

Included observations: 17 after adjustments

Standard errors in ( ) & t-statistics in [ ]

Co-integrating Eq:	CointEq1
LGDP(-1)	1.000000
LKAP(-1)	-0.073886
	(0.00235)
	[-31.4478]
LLAB(-1)	3.324912
	(0.11649)
	[28.5426]
LELEC(-1)	-0.125961
	(0.00723)
	[-17.4143]
@TREND(80)	-0.123061
C	-75.86021

Error Correction:	D(LGDP)	D(LKAP)	D(LLAB)	D(LELEC)
CointEq1	-0.985996	7.746074	-0.004681	-2.311518
	(0.32424)	(8.75592)	(0.16940)	(2.40066)
	[-3.04091]	[0.88467]	[-0.02763]	[-0.96287]
D(LGDP(-1))	0.367783	-3.952285	0.049494	1.933972
	(0.22320)	(6.02726)	(0.11661)	(1.65253)

	[1.64779]	[-0.65574]	[0.42445]	[1.17031]
D(LKAP(-1))	-0.027700	0.135965	0.001435	-0.118703
	(0.01790)	(0.48344)	(0.00935)	(0.13255)
	[-1.54726]	[0.28125]	[0.15340]	[-0.89556]
D(LLAB(-1))	0.948793	-7.390596	-0.117253	5.185533
	(0.81096)	(21.8993)	(0.42368)	(6.00424)
	[1.16996]	[-0.33748]	[-0.27675]	[0.86365]
D(LELEC(-1))	-0.061404	1.525942	0.025138	-0.607433
	(0.05420)	(1.46366)	(0.02832)	(0.40130)
	[-1.13289]	[1.04255]	[0.88772]	[-1.51366]
C	-0.070296	-0.474103	0.035394	-0.256863
	(0.03591)	(0.96983)	(0.01876)	(0.26590)
	[-1.95734]	[-0.48885]	[1.88635]	[-0.96600]
@TREND(80)	0.003742	0.032546	-0.000507	0.006106
	(0.00121)	(0.03259)	(0.00063)	(0.00893)
	[3.10123]	[0.99878]	[-0.80385]	[0.68339]
R-squared	0.745612	0.272122	0.169489	0.258426
Adj. R-squared	0.592979	-0.164605	-0.328817	-0.186518
Sum sq. resids	0.003302	2.407722	0.000901	0.180994
S.E. equation	0.018171	0.490685	0.009493	0.134534
F-statistic	4.885001	0.623094	0.340131	0.580806
Log likelihood	48.52341	-7.508430	59.56031	14.48936
Akaike AIC	-4.885107	1.706874	-6.183565	-0.881101
Schwarz SC	-4.542020	2.049962	-5.840478	-0.538013
Mean dependent	0.041489	-0.090937	0.025718	0.045978
S.D. dependent	0.028482	0.454688	0.008235	0.123508

Determinant resid covariance (dof adj.)	3.32E-12
Determinant resid covariance	3.98E-13
Log likelihood	146.2102
Akaike information criterion	-13.43650
Schwarz criterion	-11.86810

Vol. II, Issue 4
July 2013

Pairwise Granger Causality Tests
Date: 01/25/13 Time: 00:23
Sample: 1980 2010
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
LKAP does not Granger Cause LGDP	17	1.06842	0.37409
LGDP does not Granger Cause LKAP		0.38695	0.68730
LLAB does not Granger Cause LGDP	19	1.37442	0.28510
LGDP does not Granger Cause LLAB		1.39448	0.28037
LELEC does not Granger Cause LGDP	28	3.41182	0.05040
LGDP does not Granger Cause LELEC		4.64951	0.02015
LLAB does not Granger Cause LKAP	17	0.05402	0.94764
LKAP does not Granger Cause LLAB		0.04386	0.95724
LELEC does not Granger Cause LKAP	17	0.93410	0.41973
LKAP does not Granger Cause LELEC		1.67644	0.22801
LELEC does not Granger Cause LLAB	18	2.57734	0.11408
LLAB does not Granger Cause LELEC		0.72138	0.50455