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Energy use and the Nigerian Economy

By Ibrahim, Sikiru Olumuyiwa
University of Ilorin

Abstract- The objective of this study is to investigate the influence of energy use on the level of economic development. The case study is limited to oil and gas sub-sectors because they are regarded as the key sub-sectors in the Nigerian energy sector. The methodology for this study entails the followings; ordinary least square regression, Johansen method of co-integration test and vector error correction model (VECM). The findings show that total investment and aggregate oil consumption are the significant variables to influence the level of economic development in Nigeria. The findings of the co-integration test shows that there exists a long run co-integration among the variables and 15 coefficients of the estimated 44 coefficients are significant to explain the long run co-integration among the variables. Furthermore, oil consumption significantly affects the overall activities of the Nigerian economy. Therefore, it is recommended that the government reconsider the oil subsidy policy once again purposely to achieve a sustainable economy.

Keywords: energy use, oil, gas, poverty.

GJHSS-E Classification: FOR Code: 149999

ENERGYUSEANDTHENIGERIANECONOMY

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Keywords: energy use, oil, gas, poverty.

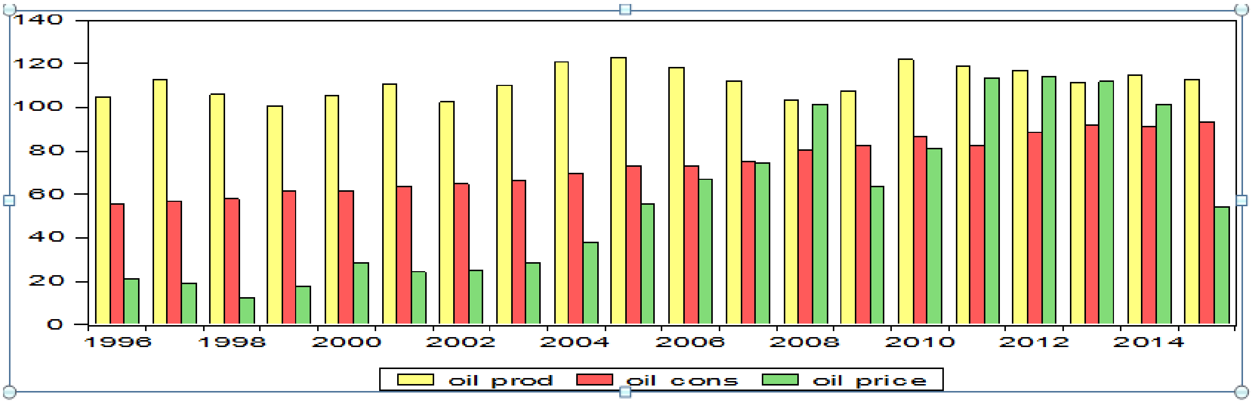
I. The Overview

A severe shortage of essential energy infrastructure is undermining Nigeria's efforts to achieve significant social and economic development. It is deduced that a sustainable economy is built on modern energy system, but the Nigerian energy sector has not yet gotten to the developed status. This research attempts to investigate energy use in Nigeria, and thereby its significant effect on Nigerian economy. Nigeria is possessed with the features of LDC such as; shortages of foreign exchange and resources for development, higher levels of market distortion, relative paucity of energy. Nigeria experience with industrialization has not been sustainable over the years. Consequently, a call for sound industrialization in Nigeria may be the broad requirement for a sustainable economy. Industrialization implies vast social and economic changes. For instance, replacement of labor-intensive technique with capital-intensive technique, hand tools by machine tools, a general tendency towards urbanization. Energy supply is therefore suggested as the core factor that is required to enhance industrialization policy.

The energy sector plays a vital role in overall economic activities, as it serves as a prerequisite for sustainable development of an economy. Therefore, energy planning requires link between energy sector and the rest of the economy, and also interaction between different subsectors within the energy sector. According to Bhattacharyya (2011), energy is classified into primary and secondary energy. The primary energy are those energy that have not undergone transformation such as, coal, crude oil, natural gas, solar power and nuclear power. The secondary energy is referred to as transformed energy purposely to make it useful for consumers; such as oil products and electricity. Also primary energy is classified into renewable and non-renewable energy. There has been expanse transition in the primary energy supply system in Nigeria. Formerly, coal was the main source of energy until later when crude oil and natural gas were introduced. To measure the primary energy utilization in Nigeria, it is accurate to focus on at least any of the followings; oil, gas and nuclear power; this is because they generate a significant amount of primary energy use in Nigeria. However, the research background of this study is restricted to oil and gas sector.

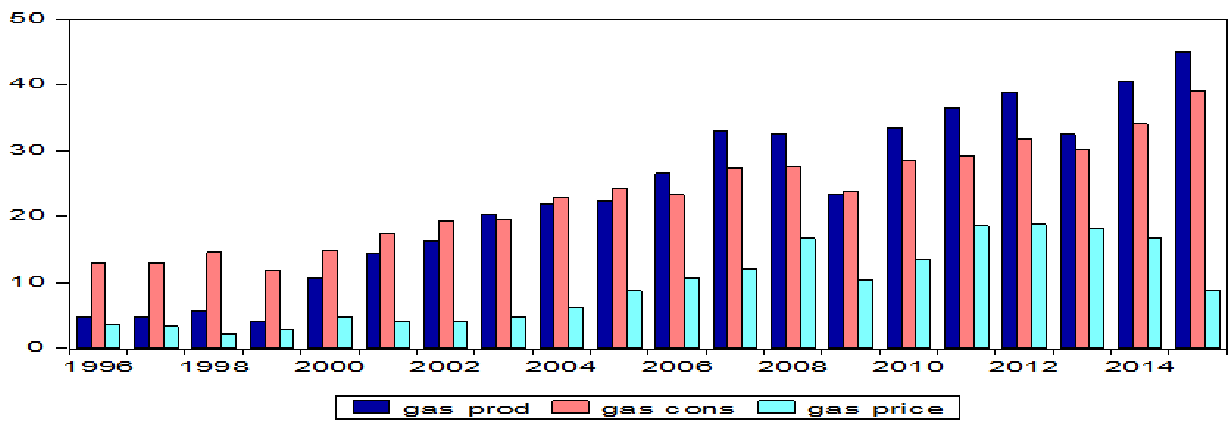
Figure 1 and 2 show the production, consumption and price of oil and gas over the years. The evidences show that there has been under utilization of energy over the years. Increasing prices of oil and gas theoretically supports the excess oil production over its consumption over the years. The reason for the disequilibrium in the oil production and consumption identified in Figure 1 is that, Nigeria has one of the richest energy resource centres, but regulatory uncertainty, militant activity and oil theft in the Niger Delta are deterring investment and production. Figure 2 shows a slight disequilibrium in the production and consumption of gas over the specified years.

Author: University of Ilorin, Ilorin, Nigeria.
e-mail: sikiru.ibrahim@ymail.com



Source: Computed using data obtained from Statistical Review of World Energy (2016)

Figure 1: Production, Consumption and Price of Oil from 1996 to 2015



Source: Computed using data obtained from Statistical Review of World Energy (2016)

Figure 2: Production, Consumption and Price of Gas from 1996 to 2015

II. Objectives

This work attempts to look at oil and gas consumption in Nigeria. The purpose of this exercise is to investigate the effect of energy use in the oil and gas sector in stimulating the activities in the economy to be sustainable. The following objectives are designed to aid the execution of the aforementioned research topic;

1. To investigate if the energy consumption in the oil and gas sector generate any significant effect on the activities of the Nigerian economy.
2. To examine the energy use in the oil and gas sector as a factor required towards transitioning Nigeria from their developing status to a developed nation.

III. Relevance

A sustainable energy provides services such as lighting, heating, transport, communication and mechanical power that support education, better health, higher incomes and general improvements in the quality of life. Economic roles of the energy industry maybe vital to reviving an economy at a time when issues when issues of unemployment, inflation and low investment are so critical, in other words, a period of economic recession. Energy is regarded as the lifeblood of the global economy; a crucial input to nearly all of the goods and services of the modern world, (Voser, 2012). The energy industry is undoubtedly an engine of growth as its products serve as inputs for production, (NTWGS, 2009).

This research work attempts to explore the inevitable contributions of energy sector on other sectors of the economy. Bhattacharyya (2011) categorized the economic areas linked with energy sector as a supplier of factor input; these are industry, agriculture, residential, commercial and transport.

Evidence from NIRP(2014) shows that the Nigerian manufacturing sector's share of GDP has remained less than 4 percent, contributions to foreign exchange earnings have been minimal and the share of government revenue and employment generated have been very low. This is due to the sector's failure to undergo the critical structural transformation necessary for it to play a leading role in economic growth and development. Also, they identified that there are systematic issues affecting competitiveness in the sector such as energy supply, local freight costs. The implication of this is that low energy supply is a core problem in manufacturing sector.

The broad objective of the agricultural sector has been to be a modern technologically enabled sector that fully exploits the vast agricultural resources of the country in order to ensure national food security and contributes to foreign exchange earnings. A sustainable energy supply is relevant to enhance agricultural production; such as the area of transportation of agricultural products, bitumen for manufacturing of pesticide especially for agriculture etc.

Energy use is relevant in residential as it adds to physiological needs of people. Energy use in residential are as follows; maintaining inside temperature, heating water, and cooking, electrical appliances. The form of energy here is final demand, since consumers are interested in transformed energy in order to meet their utility.

ECA (2014), supports prioritizing of power supply for industrial use, because it may generate the following benefits in the country; reduce borrowing costs and mobilize funding for the real sector, facilitate youth training in industrial skills, improve our investment climate, raise our product standard, link innovation to industry and thereby promoting domestic patronage.

IV. Methodology

The methodology shows the model specification, data features and estimation procedure purposely to establish the functional relationship between energy use and the Nigerian economy.

V. Model Specification

Solow growth model is adopted for this study in order to investigate the degree of energy use in the oil and gas sector that affects the Nigerian economy (see Equation 1). For the purpose of deriving an accurate model specification, it may be necessary to exercise some modifications on the adopted growth model. The model to be estimated is developed on the derivative of Equation 1 (Equation 2), by inserting 'Energy use' derives Equation 3. Re-writing Equation 3 derives Equation 4. Transformation of Equation 4 from its functional form to an estimable form derives Equation 5. Decomposition of the Energy use (ϵ) into "OilCons" and "GasCons" derives Equation 6. It is justifiable to assume that percentage change of GDP is suitable to proxy the degree of economic growth. Furthermore, total investment is used to proxy capital per unit of effective labor. And finally, oil and gas consumption for the amount of energy use in the oil and gas sector. It should be noted that GDP is logged in order to generate its percentage rate and to make it uniform with the rest of the variables, thus, we have a log-linear model. The mathematical model specification is presented as follows:

$$Y_t = F(K_t, A_tL_t) \tag{1}$$

$$y_t = F(k_t) \tag{2}$$

$$y_t = F(k_t, \epsilon_t) \tag{3}$$

$$GDP_t = F(TOTINV_t, \epsilon_t) \tag{4}$$

$$GDP_t = \varphi_0 + \varphi_1 TOTINV_t + \varphi_2 \epsilon_t + \mu_t \tag{5}$$

$$GDP_t = \varphi_0 + \varphi_1 TOTINV_t + \varphi_2 OILCONS_t + \varphi_3 GASCONS_t + \mu_t \tag{6}$$

Where,

GDP_t - Measures the level of Economic Growth for the specified years.

$TOTINV_t$ - Denotes the Total Investment for the specified years.

$OILCONS_t$ - Denotes Oil Consumption for the specified years.

$GASCONS_t$ - Denotes Gas consumption for the specified years.

$\varphi_0, \varphi_1, \varphi_2, \varphi_3$ are the parameters to be estimated.

μ_t - Stands for the disturbance term.

Table 1: The Data

S/N	Variable	Definition	Source	Year	Unit of Measurement
1.	GDP	Gross Domestic Product	Organization of Petroleum Exporting Countries (OPEC)	1996-2015	Millions
2.	TOTINV	Total Investment	World Economic Outlook (WEO)	1996-2015	Millions
3.	OILCONS	Total Oil Consumption	World Energy Outlook (WEO)	1996-2015	Millions
4.	GASCONS	Total Gas Consumption	World Energy Outlook (WEO)	1996-2015	Millions

VI. Estimation Procedure

Table 2 shows the results of residual diagnosis on estimated models. The linear model specified in equation 6 was estimated, and the result indicates that total investment and oil consumption are significant variables to explain the level of economic development. However, the model is not reliable because it is serially correlated. Consequently, the series was logged in order to correct for serial correlation (see equation 7). Hence, the regression outcome remains persistent rendering total investment and oil consumption as the only significant variables to explain the level of economic development. Interestingly, the log model passed all the residual diagnosis. Thus, the log model is desirable.

Table 2: Results of residual diagnosis (at 5% level of significance)

S/N	Residual diagnosis	Linear model	Log model
1.	Autocorrelation	0.0190	0.1177
2.	Heteroscedasticity	0.1646	0.1453
3.	Normality	0.6381	0.3678

Source: Author's computation

$$LOGGDP_t = \varphi_1 LOGTOTINV_t + \varphi_2 LOGOILCONS_t + \varphi_3 LOGGASCONS_t + \mu_t \quad (7)$$

In time series data estimation, it is routinely to conduct unit root test because of the usual nature of raw data. This is then followed by the appropriate techniques of de-trending raw data such as, differencing and logging. According to Johnston and Dinardo, the presence of non-stationary variables raises the possibility of conintegrating relations. The essence of a structural equation model is an explanation of the movement of the endogenous variables in terms of the exogenous variable. Differencing operation eliminates the long-term movement (trend) in the series. Regression makes sense if a long run relationship exists.

Table 3 shows that all the series estimated in this study were found to be stationary after first difference, which justifies the precondition of applying Johansen method of co-integration. Result of cointegration test indicates two cointegrating equations. Therefore, this was followed by estimating a VEC model in order to determine the significant coefficients that will influence GDP in the long run. About 44 coefficients were estimated in VEC model, but 15 of them were significant to explain the movement of GDP in the long run.

Table 3: Results of unit root test (at 5% level of significance)

S/N	Series	I(0)	I(1)
1	GDP	0.9926	0.0005
2	TOTINV	0.0798	0.0002
3	OILCONS	0.9817	0.0012
4	GASCONS	0.9996	0.0018

Source: Author's computation

VII. Conclusion

Oil consumption plays a vital role in economic development of nigeria. it determines the level of economic growth, overall production of good and services. Empirically, it should be recalled that since the removal of oil subsidy during GEJ regime, the Nigeria economy has been declining significantly. This evidently revealed the relevance of oil use ininfluencing economic activities. Subsidy removal on oil would have been a good policy if revenue generated from it was channeled towards good governance. Due to corruption, political instability, unproductive feature of the economy, oil subsidy removal policy may not be effective in Nigeria. On the contrary, oil subsidy will enhance aggregate production, and hence augment economic development, since oil use is connected with all economic activities. This study has shown that oil use is required for a sustainable economy. Therefore, it is recommended that the Nigerian government should subsidize oil and employ othermeasures to curb the oil exploiting businessmen (known as the cabals).

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Appendices

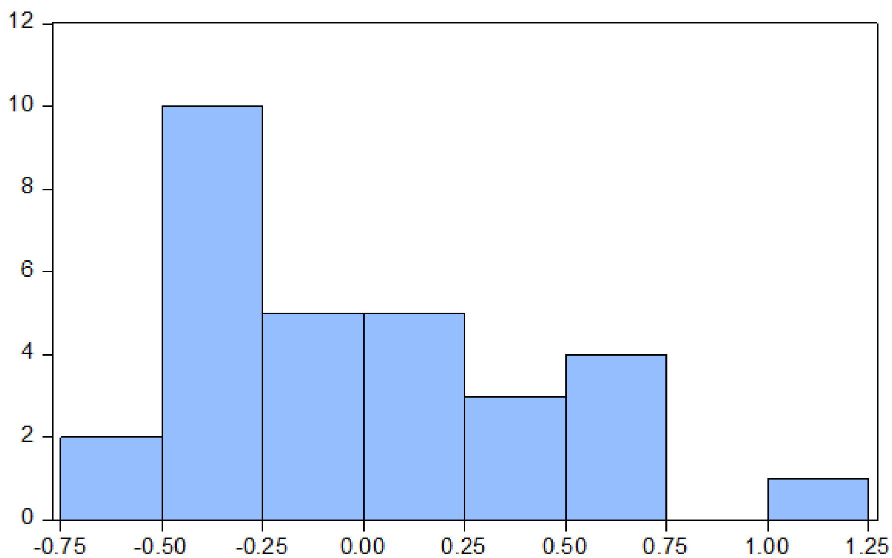
Appendix 1

Appendix 1a

Dependent Variable: LGDP
Method: Least Squares
Date: 01/28/18 Time: 13:34
Sample: 1986 2015
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.380957	3.316574	-0.416381	0.6805
LTOTINV	-2.070958	0.570399	-3.630718	0.0012
LOIL	2.484943	0.617266	4.025727	0.0004
LGAS	0.541917	0.306420	1.768544	0.0887
R-squared	0.855315	Mean dependent var		11.18083
Adjusted R-squared	0.838621	S.D. dependent var		1.162721
S.E. of regression	0.467088	Akaike info criterion		1.438970
Sum squared resid	5.672463	Schwarz criterion		1.625796
Log likelihood	-17.58455	Hannan-Quinn criter.		1.498737
F-statistic	51.23368	Durbin-Watson stat		0.802363
Prob (F-statistic)	0.000000			

Appendix 1b



Series: Residuals
Sample 1986 2015
Observations 30

Mean	4.85e-16
Median	-0.073339
Maximum	1.056341
Minimum	-0.704624
Std. Dev.	0.442269
Skewness	0.567885
Kurtosis	2.442685
Jarque-Bera	2.000715
Probability	0.367748

Appendix 1c

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.898501	Prob. F (3,26)	0.1547
Obs*R-squared	5.390832	Prob. Chi-Square (3)	0.1453
Scaled explained SS	2.920798	Prob. Chi-Square (3)	0.4040

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/28/18 Time: 13:33
Sample: 1986 2015
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.010030	1.568876	0.643793	0.5253
LTOTINV	-0.274057	0.269822	-1.015694	0.3191
LOIL	0.516235	0.291992	1.767978	0.0888
LGAS	-0.324742	0.144949	-2.240386	0.0338
R-squared	0.179694	Mean dependent var		0.189082
Adjusted R-squared	0.085044	S.D. dependent var		0.230992
S.E. of regression	0.220952	Akaike info criterion		-0.058176
Sum squared resid	1.269315	Schwarz criterion		0.128650
Log likelihood	4.872646	Hannan-Quinn criter.		0.001591
F-statistic	1.898501	Durbin-Watson stat		1.828018
Prob (F-statistic)	0.154653			

Appendix 1d

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.681986	Prob. F(8,18)	0.1710
Obs*R-squared	12.83310	Prob. Chi-Square (8)	0.1177

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 01/28/18 Time: 13:30
Sample: 1986 2015
Included observations: 30
Pre sample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.723958	3.733572	-0.461745	0.6498
LTOTINV	0.490558	0.800515	0.612803	0.5477
LOIL	0.022241	0.839188	0.026503	0.9791
LGAS	0.024086	0.327157	0.073623	0.9421
RESID(-1)	0.660899	0.243342	2.715925	0.0142
RESID(-2)	-0.147204	0.292922	-0.502538	0.6214
RESID(-3)	0.228744	0.297189	0.769691	0.4515
RESID(-4)	0.038005	0.331829	0.114532	0.9101
RESID(-5)	-0.158024	0.319598	-0.494446	0.6270
RESID(-6)	-0.189956	0.320205	-0.593231	0.5604
RESID(-7)	0.079491	0.323940	0.245388	0.8089
RESID(-8)	-0.029115	0.289180	-0.100681	0.9209
R-squared	0.427770	Mean dependent var		4.85E-16
Adjusted R-squared	0.078074	S.D. dependent var		0.442269
S.E. of regression	0.424654	Akaike info criterion		1.414089
Sum squared resid	3.245953	Schwarz criterion		1.974568
Log likelihood	-9.211329	Hannan-Quinn criter.		1.593391
F-statistic	1.223263	Durbin-Watson stat		1.840913
Prob (F-statistic)	0.340002			

Appendix 1e

Dependent Variable: GDP
Method: Least Squares
Date: 01/27/18 Time: 06:11
Sample: 1986 2015
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-106345.0	98833.36	-1.076003	0.2918
TOTINV	-15490.81	4125.397	-3.754987	0.0009
OIL_DD	2147.587	313.3359	6.853945	0.0000
GAS_DD	-1.762967	4.825047	-0.365378	0.7178
R-squared	0.899174	Mean dependent var		141377.5
Adjusted R-squared	0.887540	S.D. dependent var		171554.6
S.E. of regression	57530.80	Akaike info criterion		24.88159
Sum squared resid	8.61E+10	Schwarz criterion		25.06842
Log likelihood	-369.2239	Hannan-Quinn criter.		24.94136
F-statistic	77.29018	Durbin-Watson stat		0.983094
Prob (F-statistic)	0.000000			

Appendix 1f

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.775243	Prob. F (3,26)	0.1766
Obs*R-squared	5.100340	Prob. Chi-Square (3)	0.1646
Scaled explained SS	2.212501	Prob. Chi-Square (3)	0.5295

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/27/18 Time: 06:12
Sample: 1986 2015
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.40E+09	5.18E+09	-0.270802	0.7887
TOTINV	15561084	2.16E+08	0.071929	0.9432
OIL_DD	34851578	16431521	2.121020	0.0436
GAS_DD	-562575.1	253028.4	-2.223368	0.0351
R-squared	0.170011	Mean dependent var		2.87E+09
Adjusted R-squared	0.074243	S.D. dependent var		3.14E+09
S.E. of regression	3.02E+09	Akaike info criterion		46.61647
Sum squared resid	2.37E+20	Schwarz criterion		46.80329
Log likelihood	-695.2470	Hannan-Quinn criter.		46.67623
F-statistic	1.775243	Durbin-Watson stat		2.235252
Prob (F-statistic)	0.176605			

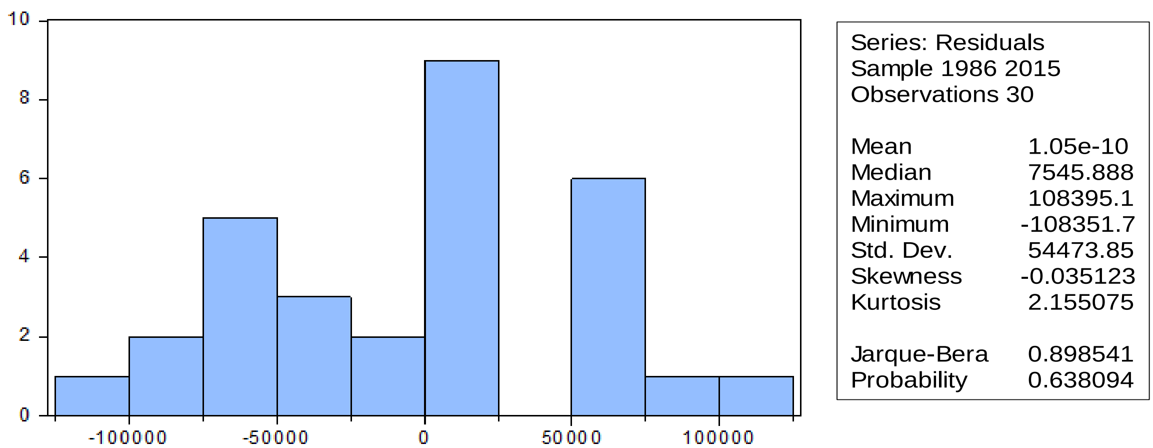
Appendix 1g

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	4.305498	Prob. F (2,24)	0.0252
Obs*R-squared	7.921558	Prob. Chi-Square (2)	0.0190

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 01/27/18 Time: 06:13
Sample: 1986 2015
Included observations: 30
Pre sample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-20634.27	88561.46	-0.232994	0.8177
TOTINV	2727.939	3837.224	0.710915	0.4840
OIL_DD	-181.1364	295.8603	-0.612236	0.5461
GAS_DD	2.304342	4.454585	0.517297	0.6097
RESID (-1)	0.532885	0.208547	2.555231	0.0174
RESID (-2)	0.052205	0.219429	0.237915	0.8140
R-squared	0.264052	Mean dependent var		1.05E-10
Adjusted R-squared	0.110729	S.D. dependent var		54473.85
S.E. of regression	51369.47	Akaike info criterion		24.70833
Sum squared resid	6.33E+10	Schwarz criterion		24.98857
Log likelihood	-364.6250	Hannan-Quinn criter.		24.79798
F-statistic	1.722199	Durbin-Watson stat		1.831747
Prob (F-statistic)	0.167847			

Appendix 1h



Appendix 2: unit root test
Null Hypothesis: GDP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			0.818848	0.9926
Test critical values:	1% level		-3.679322	
	5% level		-2.967767	
	10% level		-2.622989	

**MacKinnon (1996) one-sided p-values.*

Augmented Dickey-Fuller Test Equation
Dependent Variable: D (GDP)
Method: Least Squares
Date: 01/20/18 Time: 08:42
Sample (adjusted): 1987 2015
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP (-1)	0.039988	0.048835	0.818848	0.4200
C	10822.40	10009.14	1.081251	0.2891
R-squared	0.024232	Mean dependent var		16002.49
Adjusted R-squared	-0.011908	S.D. dependent var		41523.69
S.E. of regression	41770.18	Akaike info criterion		24.18423
Sum squared resid	4.71E+10	Schwarz criterion		24.27852
Log likelihood	-348.6713	Hannan-Quinn criter.		24.21376
F-statistic	0.670513	Durbin-Watson stat		2.041336
Prob (F-statistic)	0.420042			

Null Hypothesis: D (GDP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.897349	0.0005
Test critical values:	1% level		-3.689194	
	5% level		-2.971853	
	10% level		-2.625121	

**MacKinnon (1996) one-sided p-values*

Augmented Dickey-Fuller Test Equation
Dependent Variable: D (GDP, 2)
Method: Least Squares
Date: 01/20/18 Time: 08:43
Sample (adjusted): 1988 2015
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-1.001222	0.204442	-4.897349	0.0000
C	16548.12	8939.377	1.851149	0.0755
R-squared	0.479834	Mean dependent var		-1711.832
Adjusted R-squared	0.459827	S.D. dependent var		58495.05
S.E. of regression	42991.78	Akaike info criterion		24.24415
Sum squared resid	4.81E+10	Schwarz criterion		24.33931
Log likelihood	-337.4182	Hannan-Quinn criter.		24.27325
F-statistic	23.98403	Durbin-Watson stat		1.921396
Prob(F-statistic)	0.000044			

TOTINV

Null Hypothesis: TOTINV has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-2.738978	0.0798
Test critical values:	1% level		-3.679322	
	5% level		-2.967767	
	10% level		-2.622989	

**MacKinnon (1996) one-sided p-values.*

Augmented Dickey-Fuller Test Equation
Dependent Variable: D (TOTINV)
Method: Least Squares
Date: 01/20/18 Time: 08:43
Sample (adjusted): 1987 2015
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TOTINV (-1)	-0.437288	0.159654	-2.738978	0.0108
C	7.086482	2.717829	2.607406	0.0147
R-squared	0.217437	Mean dependent var		-0.245310
Adjusted R-squared	0.188453	S.D. dependent var		2.811146
S.E. of regression	2.532446	Akaike info criterion		4.762721
Sum squared resid	173.1587	Schwarz criterion		4.857017
Log likelihood	-67.05945	Hannan-Quinn criter.		4.792253
F-statistic	7.502003	Durbin-Watson stat		1.949075
Prob (F-statistic)	0.010782			

Null Hypothesis: D (TOTINV) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.356213	0.0002
Test critical values:	1% level		-3.699871	
	5% level		-2.976263	
	10% level		-2.627420	

**MacKinnon (1996) one-sided p-values*

Augmented Dickey-Fuller Test Equation
Dependent Variable: D (TOTINV, 2)
Method: Least Squares
Date: 01/20/18 Time: 08:44
Sample (adjusted): 1989 2015
Included observations: 27 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TOTINV(-1))	-1.555743	0.290456	-5.356213	0.0000
D(TOTINV(-1),2)	0.321033	0.188345	1.704493	0.1012
C	-0.311476	0.535470	-0.581687	0.5662
R-squared	0.642195	Mean dependent var		0.125519
Adjusted R-squared	0.612378	S.D. dependent var		4.419267
S.E. of regression	2.751406	Akaike info criterion		4.966540
Sum squared resid	181.6856	Schwarz criterion		5.110522
Log likelihood	-64.04829	Hannan-Quinn criter.		5.009354
F-statistic	21.53779	Durbin-Watson stat		2.197604
Prob(F-statistic)	0.000004			

OILCONS

Null Hypothesis: OIL_DD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			0.450473	0.9817
Test critical values:	1% level		-3.679322	
	5% level		-2.967767	
	10% level		-2.622989	

**MacKinnon (1996) one-sided p-values*

Augmented Dickey-Fuller Test Equation
Dependent Variable: D (OIL_DD)
Method: Least Squares
Date: 01/20/18 Time: 08:45
Sample (adjusted): 1987 2015
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OIL_DD(-1)	0.036682	0.081430	0.450473	0.6560
C	-0.798392	19.79228	-0.040339	0.9681
R-squared	0.007460	Mean dependent var		7.862179
Adjusted R-squared	-0.029301	S.D. dependent var		24.96098
S.E. of regression	25.32403	Akaike info criterion		9.367857
Sum squared resid	17315.28	Schwarz criterion		9.462153
Log likelihood	-133.8339	Hannan-Quinn criter.		9.397389
F-statistic	0.202926	Durbin-Watson stat		1.834902
Prob(F-statistic)	0.655966			

Null Hypothesis: D (OIL_DD) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.552592	0.0012
Test critical values:	1% level		-3.689194	
	5% level		-2.971853	
	10% level		-2.625121	

MacKinnon (1996) one-sided p-values

MacKinnon (1996) one-sided p-values
Augmented Dickey-Fuller Test Equation
Dependent Variable: D (OIL_DD, 2)
Method: Least Squares
Date: 01/20/18 Time: 08:46
Sample (adjusted): 1988 2015
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OIL_DD (-1))	-0.882710	0.193892	-4.552592	0.0001
C	7.413132	5.063911	1.463914	0.1552
R-squared	0.443566	Mean dependent var		0.596885
Adjusted R-squared	0.422164	S.D. dependent var		33.67432
S.E. of regression	25.59770	Akaike info criterion		9.391632
Sum squared resid	17036.30	Schwarz criterion		9.486789
Log likelihood	-129.4828	Hannan-Quinn criter.		9.420722
F-statistic	20.72609	Durbin-Watson stat		1.895917
Prob (F-statistic)	0.000110			

GASCONS
Null Hypothesis: GAS_DD has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic - based on SIC, maxlag=7)

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			1.929967	0.9996
Test critical values:	1% level		-3.769597	
	5% level		-3.004861	
	10% level		-2.642242	

MacKinnon (1996) one-sided p-values

Augmented Dickey-Fuller Test Equation
Dependent Variable: D (GAS_DD)
Method: Least Squares
Date: 01/20/18 Time: 08:46
Sample (adjusted): 1994 2015
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GAS_DD(-1)	0.413939	0.214480	1.929967	0.0757
D(GAS_DD(-1))	-0.781293	0.360536	-2.167030	0.0494
D(GAS_DD(-2))	-1.045153	0.305846	-3.417253	0.0046
D(GAS_DD(-3))	-1.239672	0.374774	-3.307782	0.0057
D(GAS_DD(-4))	-0.773563	0.417456	-1.853041	0.0867
D(GAS_DD(-5))	-1.624423	0.418256	-3.883798	0.0019
D(GAS_DD(-6))	-1.540116	0.696857	-2.210088	0.0456
D(GAS_DD(-7))	-2.163973	0.740146	-2.923711	0.0119
C	95.72147	1370.070	0.069866	0.9454
R-squared	0.677073	Mean dependent var		608.8118
Adjusted R-squared	0.478348	S.D. dependent var		2396.668
S.E. of regression	1731.004	Akaike info criterion		18.04288
Sum squared resid	38952888	Schwarz criterion		18.48922
Log likelihood	-189.4717	Hannan-Quinn criter.		18.14802
F-statistic	3.407095	Durbin-Watson stat		2.623737
Prob(F-statistic)	0.024496			

Null Hypothesis: D (GAS_DD) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.391163	0.0018
Test critical values:	1% level		-3.689194	
	5% level		-2.971853	
	10% level		-2.625121	

**MacKinnon (1996) one-sided p-values*

Augmented Dickey-Fuller Test Equation
Dependent Variable: D (GAS_DD, 2)
Method: Least Squares
Date: 01/20/18 Time: 08:47
Sample (adjusted): 1988 2015
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GAS_DD(-1))	-0.852442	0.194127	-4.391163	0.0002
C	447.0405	421.3979	1.060851	0.2985
R-squared	0.425824	Mean dependent var		-12.22008
Adjusted R-squared	0.403741	S.D. dependent var		2797.358
S.E. of regression	2160.059	Akaike info criterion		18.26241
Sum squared resid	1.21E+08	Schwarz criterion		18.35757
Log likelihood	-253.6737	Hannan-Quinn criter.		18.29150
F-statistic	19.28231	Durbin-Watson stat		1.915502
Prob (F-statistic)	0.000168			

JOHANSEN

Date: 01/20/18 Time: 09:15
Sample (adjusted): 1988 2015
Included observations: 28 after adjustments
Trend assumption: Linear deterministic trend
Series: GDP TOTINV OIL_DD GAS_DD
Lags interval (in first differences): 1 to 1
Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigen Value	Statistic	Critical Value	Prob.**
None *	0.508674	50.27528	47.85613	0.0291
At most 1 *	0.429025	30.37713	29.79707	0.0428
At most 2	0.362895	14.68567	15.49471	0.0659
At most 3	0.071019	2.062668	3.841466	0.1509

** denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values*
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigen Value)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigen Value	Statistic	Critical Value	Prob.**
None	0.508674	19.89815	27.58434	0.3483
At most 1	0.429025	15.69147	21.13162	0.2434
At most 2	0.362895	12.62300	14.26460	0.0894
At most 3	0.071019	2.062668	3.841466	0.1509

** denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values*
Max-Eigen Value test indicates no cointegration at the 0.05 level

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):				
GDP	TOTINV	OIL_DD	GAS_DD	
9.13E-06	0.301478	0.014346	-0.000389	
-1.06E-06	-0.486046	0.014412	-0.000344	
-2.12E-05	-0.238610	0.057174	-0.000152	
-1.09E-07	0.041772	-0.011966	-0.000156	

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Unrestricted Adjustment Coefficients (alpha):				
D(GDP)	1008.960	7473.891	-7776.774	-9684.481
D(TOTINV)	-1.173364	1.305825	0.312721	0.144807
D(OIL_DD)	-2.485692	9.255466	-11.24279	0.398760
D(GAS_DD)	1036.588	746.7815	240.1517	139.0173
1 Cointegrating Equation(s): Log likelihood -768.9769				
Normalized cointegrating coefficients (standard error in parentheses)				
GDP	TOTINV	OIL_DD	GAS_DD	
1.000000	33009.98	1570.841	-42.57900	
	(11608.3)	(912.006)	(12.9114)	
Adjustment coefficients (standard error in parentheses)				
D(GDP)	0.009215			
	(0.07833)			
D(TOTINV)	-1.07E-05			
	(4.7E-06)			
D(OIL_DD)	-2.27E-05			
	(4.6E-05)			
D(GAS_DD)	0.009467			
	(0.00324)			
2 Cointegrating Equation(s): Log likelihood -761.1312				
Normalized cointegrating coefficients (standard error in parentheses)				
GDP	TOTINV	OIL_DD	GAS_DD	
1.000000	0.000000	2748.366	-71.07198	
		(1215.96)	(16.5422)	
0.000000	1.000000	-0.035672	0.000863	
		(0.02179)	(0.00030)	
Adjustment coefficients (standard error in parentheses)				
D(GDP)	0.001258	-3328.476		
	(0.07749)	(4820.29)		
D(TOTINV)	-1.21E-05	-0.988434		
	(4.0E-06)	(0.24883)		
D(OIL_DD)	-3.26E-05	-5.247964		
	(4.3E-05)	(2.64509)		
D(GAS_DD)	0.008672	-50.46182		
	(0.00291)	(181.324)		
3 Cointegrating Equation(s): Log likelihood -754.8197				
Normalized cointegrating coefficients (standard error in parentheses)				
GDP	TOTINV	OIL_DD	GAS_DD	
1.000000	0.000000	0.000000	-33.74560	
			(5.72584)	
0.000000	1.000000	0.000000	0.000379	
			(0.00016)	
0.000000	0.000000	1.000000	-0.013581	
			(0.00190)	
Adjustment coefficients (standard error in parentheses)				
D (GDP)	0.166064	-1472.856	-322.4416	
	(0.19088)	(5120.87)	(501.428)	
D (TOTINV)	-1.87E-05	-1.063053	0.019866	
	(9.9E-06)	(0.26643)	(0.02609)	
D (OIL_DD)	0.000206	-2.565317	-0.545068	
	(9.1E-05)	(2.45103)	(0.24000)	
D (GAS_DD)	0.003583	-107.7645	39.36449	
	(0.00723)	(193.891)	(18.9855)	

VECM

Vector Error Correction Estimates
Date: 01/26/18 Time: 15:50
Sample (adjusted): 1989 2015
Included observations: 27 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	CointEq2
GDP(-1)	1.000000	0.000000
OIL_DD(-1)	0.000000	1.000000
GAS_DD(-1)	-12.66540	-0.014058
	(11.0433)	(0.00286)
	[-1.14688]	[-4.91425]
TOTINV(-1)	-73623.74	-19.35941
	(15436.4)	(3.99858)
	[-4.76949]	[-4.84158]
C	1175437.	188.2398

Error Correction:	D(GDP)	D(OIL_DD)	D(GAS_DD)	D(TOTINV)
CointEq1	0.105641	3.94E-05	-0.015170	-2.17E-06
	(0.11049)	(4.7E-05)	(0.00208)	(5.3E-06)
	[0.95607]	[0.83299]	[-7.29917]	[-0.41221]
CointEq2	-368.5201	0.240679	65.30062	0.057766
	(534.763)	(0.22898)	(10.0584)	(0.02547)
	[-0.68913]	[1.05110]	[6.49218]	[2.26820]
D(GDP(-1))	-0.209098	-0.000108	0.033906	-3.28E-05
	(0.35483)	(0.00015)	(0.00667)	(1.7E-05)
	[-0.58929]	[-0.71278]	[5.08029]	[-1.94137]
D(GDP(-2))	0.117240	-3.18E-05	0.051971	-2.40E-05
	(0.34710)	(0.00015)	(0.00653)	(1.7E-05)
	[0.33777]	[-0.21421]	[7.96053]	[-1.45282]
D(OIL_DD(-1))	110.1778	-0.272626	-47.81626	-0.018495
	(624.058)	(0.26721)	(11.7379)	(0.02972)
	[0.17655]	[-1.02025]	[-4.07366]	[-0.62229]
D(OIL_DD(-2))	393.9240	-0.796114	-35.31005	-0.082686
	(569.088)	(0.24368)	(10.7040)	(0.02710)
	[0.69220]	[-3.26708]	[-3.29878]	[-3.05089]
D(GAS_DD(-1))	-7.890356	0.001208	0.408069	0.000253
	(5.50518)	(0.00236)	(0.10355)	(0.00026)
	[-1.43326]	[0.51229]	[3.94091]	[0.96506]
D(GAS_DD(-2))	-1.819969	-0.000828	0.310338	9.02E-06
	(5.70244)	(0.00244)	(0.10726)	(0.00027)
	[-0.31916]	[-0.33928]	[2.89340]	[0.03320]
D(TOTINV(-1))	-1674.429	5.051368	52.50290	0.363987
	(5463.27)	(2.33931)	(102.759)	(0.26018)
	[-0.30649]	[2.15934]	[0.51093]	[1.39896]
D(TOTINV(-2))	-1201.425	3.838556	39.67175	0.196625
	(4517.92)	(1.93452)	(84.9775)	(0.21516)
	[-0.26592]	[1.98424]	[0.46685]	[0.91384]
C	19280.81	21.26373	-727.1465	1.692110
	(16955.7)	(7.26024)	(318.919)	(0.80750)
	[1.13713]	[2.92879]	[-2.28003]	[2.09549]
R-squared	0.207654	0.597316	0.891650	0.591295
Adj. R-squared	-0.287562	0.345639	0.823932	0.335855
Sum sq. resids	3.79E+10	6951.145	13412695	85.98871
S.E. equation	48677.98	20.84338	915.5837	2.318252
F-statistic	0.419320	2.373343	13.16703	2.314807
Log likelihood	-322.6580	-113.2475	-215.3757	-53.94946
Akaike AIC	24.71541	9.203517	16.76857	4.811071
Schwarz SC	25.24334	9.731450	17.29650	5.339005
Mean dependent	17049.04	8.182618	543.4805	-0.160111
S.D. dependent	42899.13	25.76674	2182.016	2.844653
Determinant resid covariance (dof adj.)		1.99E+18		
Determinant resid covariance		2.45E+17		
Log likelihood		-693.7816		
Akaike information criterion		55.24308		
Schwarz criterion		57.73876		

System: UNTITLED
Estimation Method: Least Squares
Date: 01/26/18 Time: 16:00
Sample: 1989 2015
Included observations: 27
Total system (balanced) observations 108

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.105641	0.110495	0.956073	0.3426
C(2)	-368.5201	534.7630	-0.689128	0.4932
C(3)	-0.209098	0.354830	-0.589292	0.5577
C(4)	0.117240	0.347096	0.337773	0.7366
C(5)	110.1778	624.0581	0.176551	0.8604
C(6)	393.9240	569.0882	0.692202	0.4913
C(7)	-7.890356	5.505176	-1.433261	0.1567
C(8)	-1.819969	5.702444	-0.319156	0.7506
C(9)	-1674.429	5463.269	-0.306488	0.7602
C(10)	-1201.425	4517.920	-0.265924	0.7912
C(11)	19280.81	16955.68	1.137130	0.2597
C(12)	3.94E-05	4.73E-05	0.832994	0.4079
C(13)	0.240679	0.228980	1.051095	0.2972
C(14)	-0.000108	0.000152	-0.712782	0.4786
C(15)	-3.18E-05	0.000149	-0.214206	0.8311
C(16)	-0.272626	0.267215	-1.020251	0.3115
C(17)	-0.796114	0.243677	-3.267083	0.0017
C(18)	0.001208	0.002357	0.512293	0.6102
C(19)	-0.000828	0.002442	-0.339278	0.7355
C(20)	5.051368	2.339312	2.159339	0.0346
C(21)	3.838556	1.934524	1.984238	0.0515
C(22)	21.26373	7.260237	2.928793	0.0047
C(23)	-0.015170	0.002078	-7.299172	0.0000
C(24)	65.30062	10.05835	6.492179	0.0000
C(25)	0.033906	0.006674	5.080294	0.0000
C(26)	0.051971	0.006529	7.960528	0.0000
C(27)	-47.81626	11.73790	-4.073663	0.0001
C(28)	-35.31005	10.70397	-3.298780	0.0016
C(29)	0.408069	0.103547	3.940915	0.0002
C(30)	0.310338	0.107257	2.893396	0.0052
C(31)	52.50290	102.7586	0.510935	0.6112
C(32)	39.67175	84.97751	0.466850	0.6422
C(33)	-727.1465	318.9192	-2.280034	0.0259
C(34)	-2.17E-06	5.26E-06	-0.412206	0.6816
C(35)	0.057766	0.025468	2.268200	0.0267
C(36)	-3.28E-05	1.69E-05	-1.941369	0.0566
C(37)	-2.40E-05	1.65E-05	-1.452820	0.1512
C(38)	-0.018495	0.029720	-0.622287	0.5360
C(39)	-0.082686	0.027102	-3.050889	0.0033
C(40)	0.000253	0.000262	0.965064	0.3381
C(41)	9.02E-06	0.000272	0.033199	0.9736
C(42)	0.363987	0.260184	1.398958	0.1667
C(43)	0.196625	0.215163	0.913844	0.3642
C(44)	1.692110	0.807501	2.095488	0.0401
Determinant residual covariance		2.45E+17		

Equation: D(GDP) = C(1)* (GDP(-1) - 12.6654042887*GAS_DD(-1) -
73623.7390221*TOTINV(-1) + 1175436.62628) + C(2)*(OIL_DD(-1) -
0.0140577575163*GAS_DD(-1) - 19.3594109553*TOTINV(-1) +
188.239825109) + C(3)*D(GDP(-1)) + C(4)*D(GDP(-2)) + C(5)
*D(OIL_DD(-1)) + C(6)*D(OIL_DD(-2)) + C(7)*D(GAS_DD(-1)) + C(8)
*D(GAS_DD(-2)) + C(9)*D(TOTINV(-1)) + C(10)*D(TOTINV(-2)) + C(11)

Observations: 27			
R-squared	0.207654	Mean dependent var	17049.04
Adjusted R-squared	-0.287562	S.D. dependent var	42899.13
S.E. of regression	48677.98	Sum squared resid	3.79E+10
Durbin-Watson stat	1.917069		
Equation: D(OIL_DD) = C(12)*(GDP(-1) - 12.6654042887*GAS_DD(-1) -			
73623.7390221*TOTINV(-1) + 1175436.62628) + C(13)*(OIL_DD(-1) -			
0.0140577575163*GAS_DD(-1) - 19.3594109553*TOTINV(-1) +			
188.239825109) + C(14)*D(GDP(-1)) + C(15)*D(GDP(-2)) + C(16)			
*D(OIL_DD(-1)) + C(17)*D(OIL_DD(-2)) + C(18)*D(GAS_DD(-1)) +			
C(19)*D(GAS_DD(-2)) + C(20)*D(TOTINV(-1)) + C(21)*D(TOTINV(-2)) +			
C(22)			
Observations: 27			
R-squared	0.597316	Mean dependent var	8.182618
Adjusted R-squared	0.345639	S.D. dependent var	25.76674
S.E. of regression	20.84338	Sum squared resid	6951.145
Durbin-Watson stat	1.983234		
Equation: D(GAS_DD) = C(23)*(GDP(-1) - 12.6654042887*GAS_DD(-1) -			
73623.7390221*TOTINV(-1) + 1175436.62628) + C(24)*(OIL_DD(-1) -			
0.0140577575163*GAS_DD(-1) - 19.3594109553*TOTINV(-1) +			
188.239825109) + C(25)*D(GDP(-1)) + C(26)*D(GDP(-2)) + C(27)			
*D(OIL_DD(-1)) + C(28)*D(OIL_DD(-2)) + C(29)*D(GAS_DD(-1)) +			
C(30)*D(GAS_DD(-2)) + C(31)*D(TOTINV(-1)) + C(32)*D(TOTINV(-2)) +			
C(33)			
Observations: 27			
R-squared	0.891650	Mean dependent var	543.4805
Adjusted R-squared	0.823932	S.D. dependent var	2182.016
S.E. of regression	915.5837	Sum squared resid	13412695
Durbin-Watson stat	2.235936		
Equation: D(TOTINV) = C(34)*(GDP(-1) - 12.6654042887*GAS_DD(-1) -			
73623.7390221*TOTINV(-1) + 1175436.62628) + C(35)*(OIL_DD(-1) -			
0.0140577575163*GAS_DD(-1) - 19.3594109553*TOTINV(-1) +			
188.239825109) + C(36)*D(GDP(-1)) + C(37)*D(GDP(-2)) + C(38)			
*D(OIL_DD(-1)) + C(39)*D(OIL_DD(-2)) + C(40)*D(GAS_DD(-1)) +			
C(41)*D(GAS_DD(-2)) + C(42)*D(TOTINV(-1)) + C(43)*D(TOTINV(-2)) +			
C(44)			
Observations: 27			
R-squared	0.591295	Mean dependent var	-0.160111
Adjusted R-squared	0.335855	S.D. dependent var	2.844653
S.E. of regression	2.318253	Sum squared resid	85.98872
Durbin-Watson stat	2.287702		