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NATURAL RESOURCES, INDUSTRIAL OUTPUT GROWTH AND ENVIRONMENTAL SUSTAINABILITY

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Abstract

Industrial growth to every economy is an undisputed pre-requisite for economic development. However, growing economic activity (production and consumption) requires larger inputs of natural resources and material, and generates larger quantities of waste by-products. Increased extraction of natural resources, accumulation of waste and concentration of pollutants will therefore overwhelm the carrying capacity of the biosphere and result in the degradation of environmental quality and a decline in human welfare, despite rising incomes. At the other extreme, are those who argue that the fastest road to environmental improvement is along the path of economic growth: with higher incomes comes increased demand for goods and services that are less material intensive, as well as demand for improved environmental quality that leads to the adoption of environmental protection measures. Therefore, will the world be able to sustain industrial output growth indefinitely without running into resource

[redacted]

KEYWORDS:
Industrial Growth, Inputs, Natural Resources, Production and Consumption, Increased Demand, Goods and Services and Products.

constraints or despoiling the environment beyond repair? What is the relationship between a steady increase in industrial output and environmental quality? Are there trade-offs between the goals of achieving high and sustainable rates of industrial growth and attaining high standards of environmental quality? This study is aimed at solving the above mentioned questions using annual time series data. The study employed the bound testing (ARDL) approach to co-integration to examine the long run relationships between natural resource, industrial output and environmental sustainability. The result reveals that industrial development improves on the environmental quality in Nigeria while natural resource utilization causes environmental degradation. Therefore, we recommend that to achieve environmental sustainability in Nigeria, government should promote industrial development that will reduce the level of carbon emission given it method of production.

Introduction

Industrial growth to every economy is an undisputed pre-requisite for economic development. For achievement of rapid economic transformation and poverty reduction in an economy, rapid industrialization should be the paramount and key agenda in the economic policy. Several studies have discovered a strong relationship between economic development and industrialization (Lall, 2005; Rodrik, 2007; Hasse, 2008; Szirmai, 2009). High, rapid and sustained economic growth and development is strongly related to industrialization. Industrialization is such a crucial and critical key to economic growth that it calls for improvement in systems, technologies and processes that will utilize natural resources more efficiently. Interestingly, about a fifth of global income is generated directly from the manufacturing industry, and nearly half of household consumption relies on goods from industrial processes. Nigeria is blessed with abundant natural resources, mainly mineral and agricultural resources, and huge human potentials. However, Nigeria is characterized by excessive dependence on export of primary commodities and natural resources. These types of exports can make for high but not long term economic growth. Nigeria is unable to derive maximum benefits from its abundant resources without adding value (UNIDO, 2011). This has made the nation to be behind in terms of industrialization. Indeed, Nigeria and most other developing nations are rich in natural resources, but this has not always been a blessing. Despite strong theoretical evidence indicating that natural resource abundance has a positive impact on economic growth, the reality is often to the contrary in the Nigerian context. This calls for the study of the relationship between natural resource and industrialization.

However, growing economic activity (production and consumption) requires larger inputs of natural resource and material, and generates larger quantities of waste by-products and carbon emission to the atmosphere. As a result, global environmental issues are getting more attention especially the increasing threat of global warming and climate change. Higher global average air and ocean temperatures, and rising global average sea level are some evidence of warming of the climate system. According to the intergovernmental panel on climate change (IPCC) report, there is an increase of about 1.2 to 6.4 °C of the global temperatures and a rise in the sea level of about 16.5 to 53.8 cm by 2100 (IPCC, 2007). This would have tremendous negative impact on half of the world's population which lives in coastal zones (Saboori et al 2012). Increased extraction of natural resources, accumulation of waste and concentration of pollutants will therefore overwhelm the carrying capacity of the biosphere and result in the degradation of environmental quality and a decline in human welfare, despite rising incomes.

At the other extreme, are those who argue that the fastest road to environmental improvement is along the path of industrial growth: with higher incomes comes increased demand for goods and services that are less natural resource intensive, as well as demand for improved environmental quality that leads to the adoption of environmental protection measures. The intergovernmental Panel on climate change (IPCC) reported that the most important environmental problem of our ages is global warming, which is caused by greenhouse gas emissions, especially carbon dioxide (CO_2) emissions produced mainly from the consumption of fossil fuels. The observed and huge improvements in the living standard in the past decades have not come without a cost. Air pollution (smoke and noise), municipal waste problems, loss of forest areas, habitat destruction, threats to biodiversity, resource depletion, and the global green house problem are not unconnected with economic growth. As the process of growth continues, a critical collapse of the world economy due to environmental problems becomes evident. This constitutes a situation in which the success of growth leads to its own demise and generates adverse effects on an economy (Alege, & Ogundipe 2013). According to the High Emission Scenario (HES), it is suggested that by 2025 Nigeria will emit 54 million tons of carbon. This would amount to six folds increase over present emissions. However, emissions can be reduced by 25 percent only if proactive measures to conserve carbon are initiated as recommended by the Low Emission Scenario (LES) (Omojolaibi, 2010). According to Alege, & Ogundipe (2013) Carbon emission tends to be falling at the higher level of income in the developed world while carbon emissions seem to be rising with income in the emerging economies.

From these scenario and thoughts, will the world be able to sustain industrial output growth indefinitely without running into resource constraints or despoiling the environment beyond repair? What is the relationship between a steady increase in industrial output and environmental quality? Are there trade-offs between the goals of achieving high and sustainable rates of industrial output growth and attaining high standards of environmental quality? This study is aimed at solving the above mentioned questions to help reduce the environmental problems faced by Nigeria and the world at large.

LITERATURE REVIEW

In principle, natural resource use can be seen as the level of natural resource input (gas, petroleum, coal, etc) involved in the production of output in different sectors of the economy. The relationship between

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natural resource, industrial output growth and the environment can be demonstrated using the Environmental Kuznets Curve (EKC). This is due to the fact that economic production, distribution and consumption makes use of natural resource inputs that can exert anthropogenic pressures on the environment, ranging from carbon emissions to climate change, water, soil and air pollution as well as deforestation (Chuku and Akpan 2010). The environmental impact of natural resource utilization is encompassing, affecting both the bio and ecosystem at every level of human existence. However, these impacts vary depending on the method of natural resource extraction and consumption, the conversion technologies adopted and regulatory framework. Dealing with sustainability involves three broad dimensions of natural resource-environment linkages. These are regarded as the indicators of environmental sustainability (Vera & Langlois, 2007). These indicators are aimed at addressing three dimensions of the natural resource-related impacts on the environment as; land resource; the atmosphere; and the water resources.

In specific terms, examining the effect of natural resource on the atmosphere entails an assessment of greenhouse gas emissions, climate change trends and pollutants that adversely affects the quality of air. For that of land resources, issues like deforestation, soil quality as well as waste generation and disposal are addressed, while the water resource dimension uses the level of contaminants discharged in to the water as yardstick for measuring of quality of water resource. When modern theories of economic growth first began to be developed in the 1950s and 1960s, natural resources and the environment essentially were absent. Economic output flows and rates of output growth were assumed to depend on the applications of services provided by capital and labour. Capital could be augmented by net investment as a result of domestic savings and external capital flows. But the role of natural resources and the environment as valuable inputs to the growth process remained outside of growth theory at that time, as did possible constraints from the natural world that could lead to more rapid slowing or even a decline in output per capita over time.

Over time, as a result of efforts by specialists of both types, theories of growth with various kinds of natural resource inputs and environmental implications became fairly well developed. Therefore, the theoretical explanation of the relationship between natural resources, growth and environment lies on the environmental Kuznets curve (EKC) initially originated from the inverted U-shaped income distribution curve of Simon Kuznets, known as the Kuznets Curve. The Kuznets Curve hypothesis posits that at lower levels of per capita income, income distribution is skewed toward higher income levels implying that inequality is high but as income rises, skewness is reduced. (Yandle et al., 2004). In 1991, Kuznets hypothesis took a new dimension. It became a tool for describing the income-pollution relationship. That is, how environmental quality (such as concentration of sulphur dioxide emissions) relates with per capita income. Kuznets suggests an evidence of similar inverted U-shaped relationship between level of environmental degradation for some pollutants and per capita income. Lakshmi and Sahn (2012) comments that "The EKC statistical relationship suggests that as development and industrialization progress, environmental damage increases due to greater use of natural resources, more emission of pollutants, the operation of less efficient and relatively dirty technologies, high priority to raise material output and less regard for environmental consequences of growth"

Moreover, for the natural resource-industrial output growth nexus, the theoretical underpinning could be linked to the Cobb-Douglas production function. In economics, the Cobb– Douglas production function is a particular functional form of the production function, widely used to represent the technological relationship between the amounts of two or more inputs, particularly physical capital and labour, and the amount of output that can be produced by those inputs.

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Methodology and Data

Based on EKC hypothesis, it is possible to form a linear quadratic relationship between natural resource utilization, industrial output growth and environmental degradation. However to eliminate the omitted variable bias, some control variables are added to the model. Dina (2004) proposes other variables such as trade openness, demography, technological progress and energy consumption as the determinants of environmental pollution. Based on this development, we take into account the effects of energy consumption, using both mineral, forest and energy depletion as proxy for energy consumption, and trade openness, as well as population density on CO2 emissions. Following Ang (2008), Iwata et al. (2010) and Saboori et al (2012) we form the longrun relationship between environment (measured by CO2 emissions), industrial output growth and natural resource utilization (measured by energy consumption, mineral resource depletion and forest depletion) and control variable, K (which are trade openness and population density) with a view of testing the validity of the EKC hypothesis in logarithm version as follows:

$$\ln E_t = \alpha_0 + \alpha_1 \ln Q_t + \alpha_2 (\ln Q_t)^2 + \alpha_3 \ln NU_t + \alpha_4 \ln K_t + \varepsilon_t \quad (1)$$

Where

E = CO2 emissions,

Q = industrial output growth,

NU = natural

resource

utilization K =

control

variables ε =

stochastic

error

In the context of this study,

NU = (engydl,

NFDL,

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MINDPE)
Where
engydl = energy depletion
NFDL = net forest depletion
MINDPE = net mineral depletion
Similarly, K = (OPN, POPDEN)
Where
OPN = trade openness
POPDEN = population density

A priori expectation

Based on EKC hypothesis the sign of α_1 is expected to be positive whereas a negative sign is expected for α_2. Since higher level of natural resource utilization leading to greater economic activity and stimulates CO_2 emissions, α_3 is expected to be positive. The expected sign of α_4 is mixed depending on the level of a country in economic development stages. It is expected to be negative for developed countries as they specialize in clean and service intensive production and instead import the pollution-intensive products from other countries with less restrictive environmental protection laws. On the other hand it may be positive in the case of developing countries as they are likely to be net exporters of pollution-intensive goods (Grossman and Krueger, 1995). There are various methods of conducting the co-integration analysis. These include the residual-based approach proposed by Engle and Granger (1987), the maximum likelihood-based approach proposed by Johansen and Juselius (1990), the fully modified OLS procedures of Phillips and Hansen's (1990) and the recently developed approach, Autoregressive Distributed Lag (ARDL) suggested by Pesaran et al. (2001). ARDL for co-integration analysis has a number of attractive features over the other alternatives (Pesaran & Shin, 1999). First the approach avoids endogeneity problems and inability to test hypotheses on the estimated

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coefficients in the long-run associated with the Engle-Granger (1987). Second the short-run as well as the long-run effects of the independent variables on the dependent variable are assessed at the same time. Third all variables are assumed to be endogenous. Forth the econometric methodology does not require establishing the order of integration of the variables (unit-root test). The approach is applicable regardless of whether the underlying regressors are I(0), I(1) or fractionally integrated and finally the methodology is popular in small samples as the case of the present study.

In this study ARDL bounds testing approach is employed to examine the long-run relationship among environment, industrial output growth and natural resource utilization. The ARDL framework of Eq. (1) of the model is as follows:

$$\ln E_t = \alpha_0 + \alpha_1 \ln Q_t + \alpha_2(\ln Q_t)^2 + \alpha_3 \ln EngydL_t + \alpha_4 \ln NfdpL + \alpha_4 \ln Opn + \alpha_5 \ln popden_t + \varepsilon_t \quad (2)$$

Data for this study covers the period 1970 to 2015. Data used for analysis are carbon dioxide (CO2) emissions, GDP, population density, trade openness, net energy depletion. Others are gross fixed capital formation (GFCF), industrial output and net forest depletion. All data were collected from World Bank's World Development Indicators (WDI). CO2 emissions (E) is measured in metric tonnes, the real GDP (Y) is in constant 2000 local currency unit, energy depletion (Engydl) is measured as kg and trade openness ratio (Opn) is the total value of real import and real export as a percentage of real GDP.

Empirical Analysis and Results

When the variables are non-stationary there is tendency to generate spurious regression results.

To avoid this, before carrying out the ARDL bounds test, stationary status of all the variables were examined by conducting test for the order of integration of the individual variables. This helps to authenticate that the variables are not 1(2) stationary. The bound test is based on the assumption that the variables are 1(0) or 1(1) series. The presence of 1(2) series renders the calculated F-statistic invalid thereby crashing the ARDL procedure. All the variables are integrated at first difference using the Augmented Dickey-Fuller (ADF) test except gross domestic product (GDP) and net forest depletion (NFDPL) who are integrated at level, while the Phillips-Perron technique also shows that there is no variable that is integrated at second difference.

TABLE 1: AUGMENTED DICKEY-FULLER UNIT ROOT TEST

Variable	ADF LEVEL	ADF 1 diff	1% LEVEL	5% LEVEL	10% LEVEL	INTEGRAT. ORDER
GFCF	-1.409247	-5.303938	-3.646342	-2.954021	-2.615817	I(I)
Gdp	4.356644	7.508618	-3.646342	-2.954021	-2.615817	I(0)
INDOUT	-1.456743	-6.509306	-3.646342	-2.954021	-2.615817	I(I)
OPEN	-1.991737	-8.380789	-3.646342	-2.954021	-2.615817	I(I)
ENGYDL	-1.869873	-5.002216	-3.646342	-2.954021	-2.615817	I(I)
NFDPL	4.559934	-4.873730	-3.646342	-2.954021	-2.615817	I(0)
ENV	-2.116822	-7.490916	-3.646342	-2.954021	-2.615817	I(I)
POPDEN	1.889617	2.805996*	-3.646342	-2.954021	-2.615817	I(I)

Note: * stationary at 5% level, ** stationary at 10% level

Source: computed by the authors

TABLE 2: PHILLIPS-PERRON UNIT ROOT TESTS

Variable	PP LEVEL	PP 1diff	1% LEVEL	5% LEVEL	10% LEVEL	INTEGRATION ORDER
GFCF	-1.588962	-5.251345	-3.592462	-2.931404	-2.603944	I(I)
Gdppc	6.694103	-5.019202	-3.592462	-2.931404	-2.603944	I(0)
OPEN	-1.918406	-8.350245	-3.592462	-2.931404	-2.603944	I(I)
INDOUT	-2.723689**	-7.276473	-3.592462	-2.931404	-2.603944	I(0)
ENGYDL	-1.966508	-5.002216	-3.592462	-2.931404	-2.603944	I(I)
NFDPL	8.276466	-4.908140	-3.592462	-2.931404	-2.603944	I(0)
ENV	-2.116822	-7.483310	-3.592462	-2.931404	-2.603944	I(I)
POPDEN	23.77248	1.189349	-3.592462	-2.931404	-2.603944	I(0)

Source: computed by the authors

Tables 1 and 2 show the results of the unit root test. The result shows that none of the variables are integrated in order two, I(II), showing that capital (GFCF), trade openness (opn), energy depletion (ENGYDL) and environment (ENV) are integrated at first difference, I(I) while the rest of the variables are stationary at levels with the PP test. In the ADF test, only economic growth (GDP) and net forest depletion (NFDPL) are integrated at level I(0) while the rest of the variables are integrated at first difference. Based on this result, the ARDL analysis can be conducted since the assumption of no I(II) level is met. Therefore we moved on to estimate equation 2, which is the first step of the ARDL analysis, to determine whether there is a long run relationship between the variables in the model.

TABLE 3: ARDL BOUND TEST FOR CO-INTEGRATION

VARIABLE	**F-STATISTIC**	**CO-INTEGRATION**
	6.655926	CO-INTEGRATED
CRITICAL VALUE	LOWER BOUND	UPPER BOUND
1%	5.15	6.36
5%	3.79	4.85
10%	3.17	4.14

Source: computed by the authors

Table 3 presents the result of the co-integration. From the result, given that the F-statistic value is greater than the upper bound of the critical value, we conclude that there is a long run relationship existing between natural resources utilization, industrial output growth and the environment in the estimated model, hence the empirical findings lead to the conclusion that a long run relationship between natural resources utilization, industrial output growth and the environment exist. Therefore, the long run coefficient of the ARDL model (equation 2) is estimated.

As shown in the appendix, according to the result, the coefficients of the long run relationship show that the industrial output negatively affects the level of carbon emission into the environment. This means that an increase in industrial output in Nigeria will cause a decrease in the level of carbon emission by 0.51 per cent thereby promoting the quality of environment in Nigeria. While natural resource utilization has a positive impact on the level of carbon emission meaning that an increase in the use of natural resource will increase the level of carbon emission release into the atmosphere by 0.49 per cent. This will cause environmental degradation in Nigeria. Population density in the model shows that there is a positive impact of population density on the level of carbon emission. Therefore, an increase in the Nigerian population will exerts pressure on the environment causing environmental degradation in the country. Statistically, the explanatory variables in the model are not significant given their t values and probability. But the entire model is statistically significant using the F-statistical ratio and the Durbin-Watson result showing that there is no existence of autocorrelation in the model while the coefficient of determination is very high and has a high goodness of fit.

SUMMARY AND CONCLUSION

This paper investigated the relationship between natural resources, industrial output growth and environmental sustainability through; review of empirical studies; theoretical issues; and centred on empirical findings using econometric method. Annual time series data of macroeconomic indicators in Nigeria from 1970 to 2015 was used. The study employed the bound testing (ARDL) approach to co-integration to examine the long run and short run relationships between natural resource, industrial output and environmental sustainability. The bound test suggested that the variables used in the model are bound together in the long run given the Wald coefficient test result. Also, the long run coefficient reveals that industrial development improves on the environmental quality in Nigeria by reducing the level of carbon emission into the atmosphere. However, natural resource utilization indicates that the more natural resource used in the nation will cause environmental degradation. The speed of adjustment to equilibrium is fast, showing that only 64.4 per cent of distortion in the system will be corrected back to equilibrium. From the findings we recommend that to achieve environmental sustainability in Nigeria, government should promote industrial development that will reduce the level of carbon emission given it method of production.

REFERENCES

Ang, J.B., 2008. Economic development, pollutant emissions and energy consumption in Malaysia. Journal of Policy Modelling 30(2), 271-278.

Chuku, C. A., and Akpan, U. F. (2010) Energy Efficiencey, Environmental Sustainability and Economic Growth: A Computable General Equilibrium Framework for Nigeria. Published in the conference proceedings of Nigerian Association of Energy Economists

Dinda, S. (2004). Environmental Kuznets curve hypothesis: a survey. *Ecological Economics*, 49, 431-455. http://dx.doi.org/ 10.1016/j.ecolecon.2004.02.011

Engle, R.F., & Granger, C.W.J. (1987). Co-integration and error-correction: representation, estimation and testing. *Econometrica*, 55, 251-276. http://www.jstor.org/pss/1913236

Hasse H (2008). "Export Diversification and Economic Growth." *Working Paper No. 21, Commission on Growth and Development* Intergovernmental Panel on Climate Change (IPCC). (2007). Climate change Synthesis report 2007. http://www.ipcc.ch/

Iwata, H., Okada, K., & Samreth, S. (2010). Empirical study on environmental Kuznets curve for CO2 in France: the role of nuclear energy. *Energy Policy*, 38, 4057-4063. http://dx.doi.org/10.1016/j.enpol.2010.03.031

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52, 169-210. http://paper.blog.bbiq.jp/Johansen_and_Juselius_1990.pdf

Lall S (2005). "Is Africa Industry Competing?" Working Paper 121, Queen Elizabeth House, London Oxford University

Pesaran, M.H., & Shin, Y. (1999). An autoregressive distributed lag modeling approach to cointegration analysis. In: Strom, S. (Ed.), *Econometrics and Economic Theory in 20th Century:* The Ragnar Frisch Centennial Symposium. Cambridge University Press, Cambridge, (Chapter 11).

Pesaran, M. H., Shin, Y. & Smith, R. J. (2001). Bound testing approaches to the analysis of level relationship. *Journal of Applied Econometrics*, 16, 289-326, http://dx.doi.org/10.1002/jae.616

Phillips, P., & Hansen, B. (1990). Statistical inference in instrumental variables regression with I(1) process. *Reviewof Economic Studies*, 57, 99-125. http://www.jstor.org/pss/2297545

Rodrick D (2007). Industrial Development: Some Stylized Facts and Policy Directions, in United Nations. (Ed). Industrial Development for The 21st Century. New York: United Nations.

Saboori, B., Sulaiman, J. B., and S. Mohd, 2012, An Empirical Analysis of the Environmental

Kuznets Curve for 2 CO Emissions in Indonesia: The Role of Energy Consumption and Foreign Trade, International Journal of Economics and Finance, 4, 2, 243-251, www.ccsenet.org/ijef.

Szirmai A (2009). "Industrialization as an Engine of Growth in Developing Countries." UNUMerit Working Papers 2009-10.

UNIDO (2011). Industrial Development Report, Industrial Energy Efficiency For Sustainable Wealth Creation: Capturing Environmental, Economic And Social Dividends, UNIDOID/442

Ivan Vera and *Lucille Langlois*, (2007), Energy indicators for sustainable development, *Energy*, **32**, (6), 875-882

Yandle, B., M. Bhattarai, and M. Vijayaraghavan. (2004). Environmental Kuznets curves: A review of findings, methods and policy implications. Research study, 02–1, Bozeman, MT: Property and Environmental Research Center.

APPENDIX

ARDL Bounds Test

Date: 07/30/17 Time: 23:22
Sample: 1978 2015
Included observations: 38
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	6.655926	2
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	3.17	4.14
5%	3.79	4.85
2.5%	4.41	5.52
1%	5.15	6.36

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Test Equation:
Dependent Variable: DLOG(CO2)
Method: Least Squares
Date: 07/30/17 Time: 23:22
Sample: 1978 2015
Included observations: 38

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(CO2(-1))	0.257366	0.178947	1.438224	0.1709
DLOG(INDOUT)	-0.070792	0.028458	-2.487634	0.0251
DLOG(INDOUT(-1))	-0.409059	0.124809	-3.277486	0.0051
DLOG(INDOUT(-2))	-0.479272	0.140736	-3.405453	0.0039
DLOG(INDOUT(-3))	-0.632633	0.170247	-3.715972	0.0021
DLOG(INDOUT(-4))	-0.524993	0.133477	-3.933223	0.0013
DLOG(INDOUT(-5))	-0.436005	0.141201	-3.087845	0.0075
DLOG(INDOUT(-6))	-0.322205	0.166667	-1.933224	0.0723
DLOG(ENGYDL)	0.040498	0.108243	0.374142	0.7135
DLOG(ENGYDL(-1))	0.510922	0.155338	3.289106	0.0050
DLOG(ENGYDL(-2))	0.130916	0.126995	1.030876	0.3189
DLOG(ENGYDL(-3))	0.498312	0.137200	3.632000	0.0025
DLOG(ENGYDL(-4))	0.060773	0.100241	0.606270	0.5534
DLOG(ENGYDL(-5))	0.262855	0.102396	2.567050	0.0215
DLOG(ENGYDL(-6))	-0.074521	0.094927	-0.785032	0.4447
DLOG(ENGYDL(-7))	0.124057	0.105312	1.177996	0.2571
OPN	-7.56E-06	3.95E-05	-0.191065	0.8510
POPDEN	-0.013688	0.011989	-1.141734	0.2715
GDP	-3.27E-09	3.18E-09	-1.030214	0.3192
C	13.00509	4.483875	2.900413	0.0110
LOG(INDOUT(-1))	0.331534	0.166497	1.991228	0.0650
LOG(ENGYDL(-1))	-0.314263	0.189871	-1.655139	0.1187
LOG(CO2(-1))	-0.643858	0.167595	-3.841747	0.0016

R-squared	0.866134	Mean dependent var	0.016773
Adjusted R-squared	0.723132	S.D. dependent var	0.187370
S.E. of regression	0.142311	Akaike info criterion	-0.780615
Sum squared resid	0.303786	Schwarz criterion	0.210556

Log likelihood	37.83168	Hannan-Quinn criter.	-0.427964
F-statistic	12.233610	Durbin-Watson stat	2.132786
Prob(F-statistic)	0.056611		

ARDL Cointegrating And Long Run Form

Dependent Variable: LOG(CO2)
Selected Model: ARDL(2, 7, 8)
Date: 07/31/17 Time: 00:40
Sample: 1970 2015
Included observations: 38

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(CO2(-1))	0.257366	0.178947	1.438224	0.1709
DLOG(INDOUT)	-0.070792	0.028458	-2.487634	0.0251
DLOG(INDOUT(-1))	0.070213	0.052113	1.347319	0.1979
DLOG(INDOUT(-2))	0.153362	0.163393	0.938608	0.3628
DLOG(INDOUT(-3))	-0.107640	0.128528	-0.837486	0.4155
DLOG(INDOUT(-4))	-0.088988	0.055209	-1.611825	0.1278
DLOG(INDOUT(-5))	-0.113800	0.145489	-0.782189	0.4463
DLOG(INDOUT(-6))	-0.322205	0.166667	-1.933224	0.0723
DLOG(ENGYDL)	0.040498	0.108243	0.374142	0.7135
DLOG(ENGYDL(-1))	0.380007	0.140131	2.711801	0.0161
DLOG(ENGYDL(-2))	-0.367396	0.137092	-2.679923	0.0171
DLOG(ENGYDL(-3))	0.437539	0.114537	3.820064	0.0017
DLOG(ENGYDL(-4))	-0.202082	0.113555	-1.779596	0.0954
DLOG(ENGYDL(-5))	0.337375	0.102934	3.277598	0.0051
DLOG(ENGYDL(-6))	-0.198578	0.108133	-1.836412	0.0862
DLOG(ENGYDL(-7))	0.124057	0.105312	1.177996	0.2571
D(OPN)	-0.000008	0.000040	-0.191065	0.8510
D(POPDEN)	-0.013688	0.011989	-1.141734	0.2715
D(GDP)	-0.000000	0.000000	-1.030214	0.3192
CointEq(-1)	-0.643858	0.167595	-3.841747	0.0016

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*Cointeq = LOG(CO2) - (0.5149*LOG(INDOUT) -0.4881*LOG(ENGYDL) -0.0000*OPN -0.0213*POPDEN -0.0000*GDP + 20.1987)*

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(INDOUT)	-0.514917	0.254850	-2.020475	0.0616
LOG(ENGYDL)	0.488094	0.323908	1.506891	0.1526
OPN	-0.000012	0.000061	-0.192621	0.8498
POPDEN	0.021259	0.018409	1.154840	0.2662
GDP	0.000000	0.000000	0.965370	0.3497
C	20.198694	7.069720	2.857071	0.0120