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Oil Production and Economic Growth in Angola

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ABSTRACT

This study examines the relationship between oil production and economic growth in Angola for the period of 1985-2015. Relying upon the estimation of autoregressive distributed lag model, the study finds that oil production and economic growth are cointegrated. Furthermore, there is positive unidirectional causality from oil production to economic growth in the long run which supports policies about investing in energy infrastructure. However, the absence of reverse causality from economic growth to oil production underscores Angola's heavy reliance on external demand for its oil to drive economic growth. Thus, policymakers should also consider diversifying the economy to other growing sectors to mitigate the impact of adverse global economic shocks associated with sharp decline in global oil demand.

Keywords: Oil Production, Economic Growth, Granger Causality
JEL Classifications: Q40, Q43, C01

1. INTRODUCTION

Oil prospecting in Angola began in 1915 (Koning, 2012). The first commercial oil discovery was made in 1955 in the onshore Kwanza basin. Offshore production followed shortly afterwards in the coastal enclave of Cabinda. Since then, Angola's oil industry has grown substantially, despite the civil war that lasted from 1975 to 2002 (International Energy Agency, 2006; Energy Information Administration, 2016). In 1970, Angola produced 150,000 barrels per day (*bpd*) of crude oil. By 1985, oil production increased to 242,000 *bpd*. Between 1985 and 2015, Angola's oil production fluctuated around 1 million *bpd* peaking at 2.016 million *bpd* in 2008.

Like its oil production, Angola's economic growth has fluctuated quite substantially, averaging about 5% per year between 1985 and 2015. The country's growth reached its highest (22.6%) in 2007 when oil price hit an all-time record high of $123 per barrel. From 2006 to 2015, the oil sector accounted for about 97% of the nation's exports and 45% of its gross domestic product (GDP) (World Bank, 2016). With the post-2008 slowdown in global economic activity combined with the subsequent glut of oil on the global market and falling oil price, continual reliance on oil exports to drive economic growth in Angola remains a source of concern to policymakers.

A large volume of studies in the energy-growth nexus literature have examine the relationship between energy consumption and economic growth (see, for example, Glasure and Lee, 1998; Stern and Cleveland, 2004; Aziz, 2011; Toman and Jamelkova, 2003; Ozturk et al., 2010; Lee and Lee, 2010; Narayan and Smyth, 2008; Soytas and Sari, 2003; Apergis and Danuletiu, 2012; Kalyoncu et al., 2013; Bekle et al., 2010; Oh and Lee, 2004). However, the relationship between oil production and economic growth have received less attention. Some of the studies which examined this relationship are Reynolds and Kolodziej (2008) on former soviet union (FSU) countries, Brunnschweiler (2009) on transition economies of the FSU and Central and Eastern Europe, Akinlo (2012) on Nigeria, Alkhathlan (2013) on Saudi Arabia, Bildirici and Kayikci (2013) on major oil exporting Eurasian countries. Generally, the findings show that oil production affects economic growth positively, and there is a unidirectional or bidirectional causal relationship between the two variables. However, to our knowledge, no study has examined the causal relationship between oil production and economic growth for Angola.

This study investigates the short run and long run relationship between oil production and economic growth in Angola for the period 1985-2015. The study also attempts to establish Granger causality between these variables. In particular, whether there is unidirectional or bidirectional relationship between oil production and economic growth using the autoregressive distributed lag (ARDL) approach to cointegration.

The rest of the paper proceeds as follows. Section 2 describes the data and lays out the empirical methodology. Results are presented and discussed in Section 3. Section 4 includes the conclusions and policy implications.

2. DATA AND EMPIRICAL METHODOLOGY

2.1. Data

Annual data on Angola's oil production and real GDP from 1985 to 2015 were collected respectively from the International Energy Agency (2017), World Energy Statistics and the World Bank World Development Indicators (World Bank, 2017). The annual oil production data, in thousand tons of oil equivalent (*ktoe*), is converted to million barrels (*mb*)of oil based on Brent crude conversion factor of 1 ton of oil equivalent equals 7.57 barrels. The real GDP is in constant 2010 US dollars. Graphical representation of the data is shown in Figures 1 and 2. Summary statistics is provided in Table 1.

2.2. Empirical Methodology

2.2.1. Bounds testing approach to cointegration

The paper utilizes ARDL bounds testing approach to cointegration to examine the relationship between the variables: Oil production and economic growth. An ARDL model is a general dynamic specification which uses the lags of the dependent variable and the lagged and contemporaneous values of the explanatory variable through which the short-run effects can be directly estimated, and the long-run equilibrium relationship can be indirectly estimated (Altinay, 2007; Gosh, 2009). The ARDL technique involves estimating the following unrestricted error correction model:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{m} \beta \Delta Y_{t-i} + \sum_{i=1}^{n} \psi \Delta OP_{t-i} + \phi_1 Y_{t-1} + \phi_2 P_{t-1} + \varepsilon_{1t} \quad (1)$$

$$\Delta OP_t = \alpha_0 + \sum_{i=1}^{m} \beta \Delta OP_{t-i} + \sum_{i=1}^{n} \psi \Delta Y_{t-i} + \theta_1 OP_{t-1} + \theta_2 Y_{t-1} + \varepsilon_{2t} \quad (2)$$

Where Y and OP represent the logarithmic transformation of real GDP and volume of oil production, respectively, and Δ denotes the first difference operator.

An added advantage of the ARDL model is that it can be applied irrespective of whether the underlying variables in the model are purely I(0) or purely I(1) or partially integrated (Pesaran et al.,2001; Altinay, 2007; Gosh, 2009; von Arnim and Prabheesh, 2013). F-test is used to examine whether a cointegrating relationship exists among the variables.

The null hypothesis of no cointegration among the variables in Eq. (1) is H_0: $\varphi_1 = \varphi_2 = 0$ is tested against an alternative H_0: $\phi_1 \neq \phi_2 \neq 0$ denoted as F_Y (Y, OP). Similarly, for Eq. (2), H_0: $\theta_1 = \theta_2 = 0$ is tested against an alternative H_1: $\theta_1 \neq \theta_2 \neq 0$ and denoted as F_{OP} (OP,Y). Two sets of critical F-values have been provided by Pesaran et al. (1999) and Pesaran et al. (2001) with one set assuming all variables in ARDL model are I(0) (lower bound) and another assuming all variables are I(1) (upper bound). If the computed F-statistic falls outside the band, a conclusive decision can be taken without having to know whether the underlying variables are I(0) or I(1). Conversely, if the computed F-statistics falls within the critical band, inference remains inconclusive. Under such circumstances, the order of integration of the variables of interest should be checked using Johansen and Juselius (1990) procedures to detect cointegration (Gosh, 2009; Onafowora and Owoye, 2014).

In addition to the general advantages of the ARDL model over other cointegration procedures, this study particularly prefers the ARDL model for two principal reasons. One, the bounds test procedure produces robust results in sample size that is small (Pesaran et al., 1999) as is the case in this study. Two, several empirical

Figure 1: Oil production (million barrels)

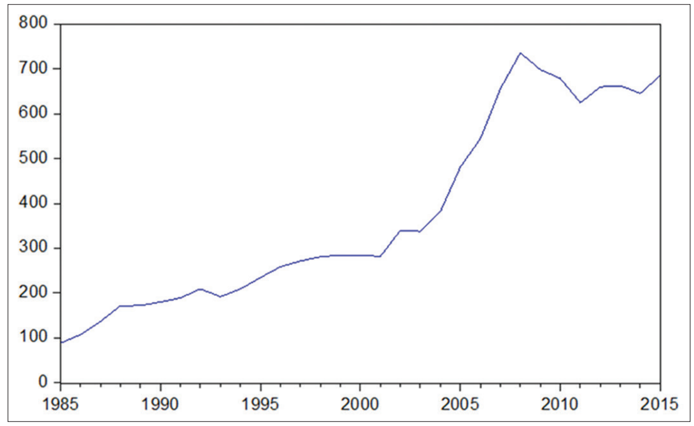


Figure 2: Real gross domestic product (million US dollars)

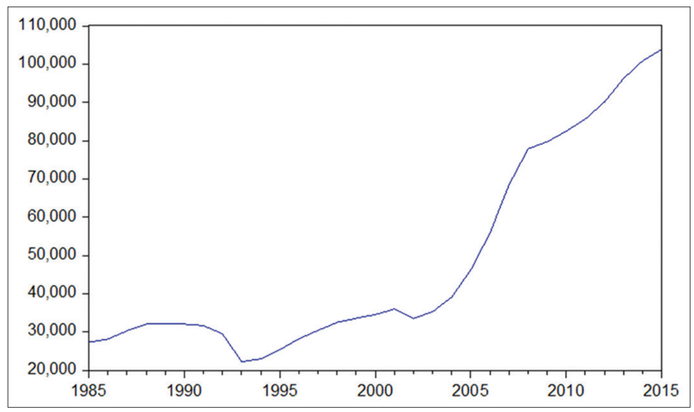


Table 1: Summary statistics of variables

Descriptive statistics	Oil production (million barrels)	Real GDP (million US dollars)
Mean	377.2527	48507.77
Median	284.6178	33525.54
Maximum	736.5824	103920
Minimum	88.3417	22176.97
SD	214.3287	26623.52
Skewness	0.4502	0.9335
Kurtosis	1.62515	2.2567

GDP: Gross domestic product, SD: Standard deviation studies have established that energy-growth variables tend to be either I(1) or I(0) and rarely is one confronted with I(2) series (Apergis and Payne, 2009; Esso, 2010; Bildirici and Kaykci, 2013; Shahateet, 2014; Streimikiene and Kasperowicz, 2016), justifying the application of ARDL model in energy-growth nexus analysis.

2.2.2. Granger causality test

Granger causality test is widely used to examine the causal relationship among variables. Engle and Granger (1987) showed that if series X and Y, for example, are individually I(1) and cointegrated, then there would be a causal relationship at least going in one direction. The direction of causality can be detected through the vector error correction model of long-run cointegrating vectors. Following Gosh (2009), the study tests for Granger causality by estimating the following equations:

$$\Delta Y_t = \beta_{10} + \sum_{i=1}^{p} \beta_{11i} \Delta Y_{t-i} + \sum_{i=1}^{p} \beta_{12i} \Delta OP_{t-1} + \beta_{13} ECT_{t-1} + \varepsilon_{1t} \quad (3)$$

$$\Delta OP_t = \beta_{20} + \sum_{i=1}^{p} \beta_{21i} \Delta OP_{t-i} + \sum_{i=1}^{p} \beta_{22i} \Delta Y_{t-1} + \beta_{23} ECT_{t-1} + \varepsilon_{2t} \quad (4)$$

Where the β_s are parameters to be estimated, ECTs are the error correction terms resulting from the long run equilibrium relationship, and the ε_s are the serially uncorrelated error terms. The F-statistics on the lagged explanatory variables of the ECM indicates the significance of the causal effects in the short-run. The t-statistics on the coefficients of the lagged ECT indicates the significance of the causal effect in the long-run.

3. EMPIRICAL RESULTS

3.1. Bounds Testing Approach to Cointegration

Table 2 summarizes the results of the bounds tests for cointegration. The results indicate that cointegration is present when Y or OP is used as the dependent variable. The computed F-statistic F_Y (Y,OP) and F_{OP}(OP,Y) falls outside the band implying the existence of long-run relationship between the two variables.

Having established the long-run relationship, a further two-step procedure is conducted. In the first step, the optimum order of lags in the models are determined based on Akaike information criterion (AIC), Hannan-Quinn criterion (HQ), and Schwarz criterion (SC). In the second step, the selected model is estimated using the ARDL specification in Eq. (1) and Eq. (2). Based on AIC and HQ criteria, we found an optimum lag of 2 for Eq. (1) and 1 for Eq. (2). SC selected an optimum lag of 1 for both Eq. (1) and Eq. (2). The estimated long-run coefficients together with standard errors and acceptance probabilities based on ARDL (2,0) for Eq. (1) and ARDL (1,1) for Eq. (2) are shown in Table 3. Long-run growth elasticity to oil production is 1.02 and statistically significant suggesting that a 1% increase in oil production is associated with a 1.02% increase in real GDP. The long-run oil production elasticity to real GDP growth is 0.48 and not statistically significant at the 5% level. A series of post-estimation diagnostic tests suggest absence of major diagnostic problems like serial correlation, heteroskedasticity, and non-normality (Tables A1-A3 in the Appendix).

3.2. Granger Causality Test

The cointegration and ARDL results determine the existence or absence of a long run relationship between variables (here, oil production and real GDP) but these methods do not indicate the direction of causality. Consequently, Granger causality test is used to examine the causal relationships. Table 4 shows the results of Granger causality relationships based on Eq. (3) and Eq. (4). The F-statistics on the lagged explanatory variables of the ECM are not statistically significant at the 5% level indicating no causality in any direction in the short-run. The coefficient of the lagged ECT in the ΔY_t equation is statically significant suggesting that the series is non-explosive and long-run equilibrium is attainable between economic growth and oil production. Thus, in the long-run there is unidirectional Granger causality running from oil production to real GDP growth. Because the lagged ECT measures the speed at which the endogenous variable adjusts to changes in the explanatory variables before converging to its equilibrium level, the coefficient of −0.661 suggests that convergence to equilibrium after an oil production shock in Angola takes about a year and half.

Finally, the study examines the stability of the coefficients of the estimated model using the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) stability tests. The plots of CUSUM and CUSUMSQ statistics presented in Figure 3

Table 2: Bounds tests for cointegration

F-statistics	5% critical value bounds	
	I (0) 3.02	I (1) 3.51
F_Y (Y, OP) = 1.575		
F_{OP} (OP, Y) = 10.194		

Table 3: Estimated long-run coefficients with standard errors and acceptance probabilities

Dependent variable: Y			
Regressor	**Coefficient**	**Standard error**	**P**
OP	1.0152	0.2115	0.000
Constant	4.9009	1.1897	0.000
Dependent variable: OP			
Regressor	**Coefficient**	**Standard error**	**Probability**
Y	0.4782	0.2798	0.099
Constant	0.9332	3.0503	0.7621

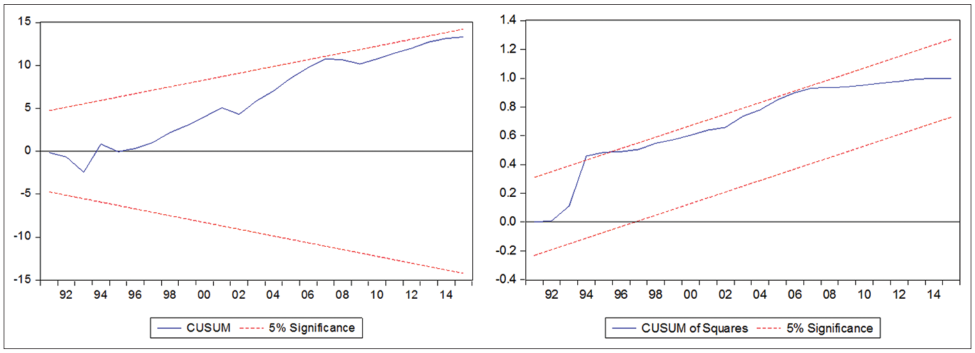
Estimated long-run coefficients for Y based on ARDL (2,0) model and for OP based on ARDL (1,1) model

Table 4: Results of Granger causality tests

a. Short run		
Dependent variable →	**ΔY**	**ΔOP**
ΔY	-	0.7227 (0.7339)
ΔOP	3.6282 (0.156)	-
Results based on F-statistics on the lagged explanatory variables of the ECM. Probability values in parenthesis		
b. Long run		
Dependent variable →	**ΔY**	**ΔOP**
ΔY	-	0.0109 (0.991)
ΔOP	3.0901 (0.005)	-

Results based on t-statistics on the coefficients of the lagged ECT. Probability values in parenthesis

Figure 3: Plots of CUSUM and CUSUMSQ for the estimated ECM model



indicate that the statistics are within the 95% critical bounds, hence, it can be concluded that all coefficients in the estimated ECM model are stable over the sample period.

4. CONCLUSION

The study investigated the cointegration and causality relationship between oil production and economic growth in Angola using the ARDL model. Bounds testing results indicate that oil production and economic growth are cointegrated. Granger causality tests inferred from the error correction model reveal that there is positive uni-directional causality from oil production to economic growth in the long run. Thus, policymakers in Angola should consider improving energy infrastructure and increasing oil production to achieve higher economic growth.

While the empirical results points to the necessity of increasing oil production to spur economic growth in Angola, the absence of reverse causality from economic growth to oil production underscores Angola's heavy reliance on external demand for its oil to drive economic growth. Consequently, adverse global economic shocks associated with sharp decline in world oil prices could severely weaken Angola's ability to achieve higher economic growth through increased oil production. Indeed, Angola had its first a major economic shock in 2009 following the post-2008 slowdown in global economic activity and the subsequent glut of oil on the global market that caused oil to prices to plummet. Thus, in addition to improving energy infrastructure, policymakers should also consider diversifying the economy to other growing sectors to mitigate the impact of adverse global economic shocks associated with sharp decline in global oil demand.

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APPENDIX

Table A1: Breusch-Godfrey serial correlation LM test null hypothesis: No serial correlation

Breusch-Godfrey serial correlation LM Test: Eq. (1)			
F-statistic	**0.151471**	**P F (2,23)**	**0.8603**
Obs*R^2	0.377005	P Chi-square (2)	0.8282
Breusch-Godfrey serial correlation LM Test: Eq. (2)			
F-statistic	**0.037612**	**P F (2,24)**	**0.9631**
Obs*R^2	0.093736	P Chi-square (2)	0.9542

Table A2: Breusch-Pagan-Godfrey heteroskedasticity test null hypothesis: Homoscedasticity

Heteroskedasticity test: Breusch-Pagan-Godfrey: Eq. (1)			
F-statistic	1.301199	P F (3,25)	0.2960
Obs*R^2	3.916617	P Chi-square (3)	0.2706
Scaled explained SS	10.23443	P Chi-square (3)	0.0167
Heteroskedasticity Test: Breusch-Pagan-Godfrey: Eq. (2)			
F-statistic	0.394691	P F (3,26)	0.7579
Obs*R^2	1.306727	P Chi-square (3)	0.7275
Scaled explained SS	1.554867	P Chi-square (3)	0.6697

Table A3: Jarque-Bera normality test null hypothesis: Normal distribution

	Test-statistic	P
Eq. (1)	46.70249	0.000
Eq. (2)	6.210322	0.045