

Original Research Article

Red parts show the corrections.

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Pink sentences are the referee's notes.

THE IMPACT OF VOLATILITY OF OIL PRICE (OIL PRICE VOLATILITY) ON THE ECONOMIC GROWTH IN SUB-SAHARAN AFRICA

Abstract

This study examines the impact of the **volatility of oil price (oil price volatility)** on economic growth in 20 sub-Saharan **African (Africa)** countries from the period of 1986-2012. These countries were divided into group A and group B. **(The)** Group A consists of 10 oil exporting countries,**(a comma here)** while group B consists of non oil exporting countries in sub-Saharan Africa. Panel data were used for the analysis. Panel Pooled OLS, panel Fixed Effect Model and Generalized Method of Moment model were employed in the estimation for both oil exporting and non-oil exporting countries. The estimation of **(the)** panel A model consisting **of** the oil exporting countries shows that **the volatility of oil price (oil price volatility)** has **a** positive effect on **the** economic growth of **(the)** oil exporting countries; **even though this effect is not significant. (but it is not significant.)** This **may (might)** be as a result of the way the oil exporting countries spent their oil **windfall (wind fall)**. The result of panel B consisting of non-oil producing countries shows that **the volatility of oil price (oil price volatility)** also has **a** positive and insignificant impact on economic growth.

20 Key words: Oil price, volatility, economic growth, panel data, GMM, fixed effect

1.0 INTRODUCTION

The **volatility of oil price (oil price volatility)** and its consequence on economic growth is an important issue confronting a growing number of world economies. The relationship between **the** oil prices and the level of economic activity has been the subject of debate for some time as this issue has been extensively discussed in empirical literature for the past decades.

The earlier studies such as [1] and [2] concluded that most economic recession experienced in the past was preceded by a high increase in the price of oil. **However, this notion weakened over the years (But this notion over the years weakened)** as later empirical studies show that **the volatility of oil price has a (oil price volatility having)** lesser influence on economic output. Despite several interesting lines of research **(that have been done)** to examine the impact oil price on economic growth, **(a comma here) the relationship between the volatility of oil price and economic growth is still controversial. (no consensus has emerged.)****Avoid repetitions. (That is the relationship between oil price volatility and economic growth is a controversial one.)**

???[Some studies have shown that **an increase in oil prices (oil price increase)** has **a** positive impact on **the** economic growth of **(the)** oil exporting countries and **has (have) a** negative impact on oil importing countries e.g. [3]. Some studies also found **a** negative impact of high oil price on both **the** importing and exporting countries e.g. [4] and some studies found **a** positive relationship between oil price volatility on both oil importing and exporting countries e.g. [5], while [5] found negative oil price volatility on oil exporting countries and this is consistence with the argument of [7] that experience has shown that some oil exporting countries have persistently experienced slow and, in some cases, volatile growth even in periods of consistent higher oil prices. [8] found that oil price volatility has negative impact

on US economy. However, most of these studies done to examine the impact of **the volatility of oil price (oil price volatility)** on economic growth were either done on **a** single country, multiple countries **or (and)** developed countries. According to [3] it is believed that the **volatility of oil price (oil price volatility could) can** negatively **impact** (impacting) oil importing countries through high import bills with adverse effects on inflation, production and employment, **(a comma here)** while **the situation may be vice versa for the oil exporting countries. Such countries may benefit from high oil prices since an increase in oil revenues may improve the balance of payments. (for the oil exporting countries in contrast could benefit from high oil prices because an increase in oil revenues which may improves their balance of payments and for both importing and exporting economies oil price volatility could have negative impact as it lowers, for instance, the predictability of marginal costs of production for companies. The uncertainty regarding their cash flows may induce companies to reduce their investments and limit job creation which can consequently harm economic growth.)]**

Even though many studies examining the relationship between the oil prices and economic growth are done, only a few studies have examined this relationship especially in sub-Saharan Africa. (From the existing literatures, a lot of studies has been done to examine the relationship between oil price and economic growth but only few studies has examined the relationship between oil price volatility on economic growth especially in sub-Saharan Africa.) In this regard, we will examine the impact of the volatility of oil price in 20 sub-Saharan, African countries. (That is why in this study we are examining the impact of oil price volatility on 20 sub-African countries.) These 20 countries **are** divided into two groups as group A and group B, the first group with 10 oil exporting countries and the latter with 10 oil importing countries. **(of 10 oil exporting countries and group B as will made up of 10 oil exporting countries and 10 oil importing countries in sub-Saharan Africa.)**

(The organisation of this study is as follows. After this introduction in section 1, we provide the overview of oil in sub-Saharan Africa in section 2, while in section 3 we review the literatures on the oil price and economic growth. In section 4 we discussed the data and methodology adopted for the empirical analysis. In section 5 we report the estimation results and lastly in section 6 we conclude.) Referee's Note: This part is really unnecessary.

2.0 Overview of oil in sub-Saharan Africa

Africa's oil history can **be** linked to several decades ago. Oil production in Africa started in the 1960s and has been increasing gradually **since (from)** that period, except for a slowdown in the early 1980s owing to the collapse in oil prices. **(Presently,)** There are about 500 oil companies that participate in African hydrocarbon exploration **presently**. According to **some** figures, **(a comma here) (from the [9])** Africa's proven oil reserves have grown by nearly 120% in the past 30 years or so, from 57 billion barrels in 1980 to 124 billion barrels in 2012. **[9]** In addition, it is estimated that at least *another* 100 billion barrels are offshore Africa, only waiting to be discovered. In turn, Africa's proven reserves of natural gas have grown from 210 trillion cubic feet (tcf) in 1980 to 509 tcf in 2012, representing **a** growth of over 140%. Furthermore, recent further discoveries of sizeable natural gas reserves in Tanzania and Mozambique point to **a** significant upward potential for these figures. **(In 2010,)** Africa's oil production represented 12.4% of the world's total crude oil *output*, while Africa's crude oil exports grabbed a higher share at nearly 20% of the world's total exports of crude **in 2010**. – as a result of limited refining capacity and still limited oil consumption on the continent – while Africa held 8.8% of the world's proven reserves of oil in the year.

Focusing on the exploration of oil, (Based on oil exploration) sub-Saharan, **(no comma here)** Africa is made up of both **(of) the** oil exporting and importing countries. **(According to [6] over the last decade),** The Atlantic Ocean **(off the)** coast of Western and Southern Africa has become one of the most promising oil exploration areas in the world. A convergence of interests **among (between)** African governments, multinational oil companies, **international financial institutions** and **northern governments** is propelling the rush to exploit Africa's oil reserves. Ten countries in **the** sub-Saharan region,**(no comma here)** namely; Nigeria, Angola, Gabon, Equatorial Guinea, São Tome, Cameroon, Ivory Coast and,**(no comma here)** more recently, Ghana, Chad and Sudan have become **the** key players in the world's energy stake and more are likely to join their ranks in the near future. Africa is a significant player in world oil production. **As it can be seen from Figure 1,** the contribution of Africa to world oil market has been increasing over the years. **While the contribution of Africa was 11 % in 2003 and 2004, it was increased to 12 % between the years 2005-2011. (The percentage contribution of Africa to world oil in 2006 was 12 per cent.)** However, **this contribution was reduced back to 11 % in 2012 due to the civil unrests in Libya and Egypt since these countries are the major oil producers of Africa. (But there was decline in 2012 as the Africa contribution was reduced to 11per cent. This decline was as a result of civil unrest in Libya and Egypt which are major producer of oil in Africa. The percentage contribution of Africa to oil market for the past 10 years is shown in Figure 1 below.)**

Figure 1: The percentage contribution of Africa to oil market (for) in the past 10 years

These two sentences should be above (The percentage contribution of Africa in 2003 and 2004 was 11 percent. The percentage contribution was increased to 12 percent in 2005 and this was maintained till 2011.)

When Africa is compared in terms of oil production to other regions of the world, it is the fourth largest oil producer. (By comparing Africa to other regions of the world in term of oil production, Africa is the fourth largest producer of oil.) The middle east region which contains countries like Iran, Iraq, Kuwait, Saudi Arabia, Oman and others **is (are)** the **world's** largest producer of oil **(in the world) and it is followed (follow)** by Europe **& (and)** Eurasia region. The North America region is the third largest oil producer **(in the world)** while the South **&(and)** North America region is the least producer **(region)**. The oil production by region in 2012 is shown in figure 2 below. **Referee's Note: The author wrote that the North America is the third largest producer and added that the South&North America is the least producer. Here North America is repeated twice. Which North America does the author try to mean? Does it mean Alaska for example when saying North America? This point should be made clear.**

The four largest producers of oil in Africa are Nigeria, Algeria, Libya and Angola **in the period of 1989-2012. (from 1989 to 2012).** These four countries accounted for 77 percent of African continent production to **the** world oil market. **Nigeria which is the biggest oil exporter with 2,5 million bpd is followed by Algeria with 1,88 million bpd and Angola with 1,84 million bpd in 2011. (In 2011 Nigeria is the biggest oil exporter, at 2.5 million bpd, follow by Algeria which exported 1.88 million bpd while Angola a fellow- OPEC member with Nigeria exported an estimated 1.84 million bpd in that year.)** Libya could only manage to export 502 million bpd **in the same year (in 2011)** due to civil war that engulfed the country in 2011 but their export in 2010 was 1.37 million bpd. Smaller producers include Equatorial Guinea (303,000 bpd), Congo (Brazzaville) (298,000 bpd), Gabon (244,000 bpd), Cameroon (62,000 bpd), **(no comma here)** and Ivory Coast (40,600 bpd), **(no comma here)** with all these numbers being estimated **as** average daily oil output for 2011.

The trend of oil production in Africa is shown in figure 3 below.

111 Figure 3: Trend of oil production in Africa from **the period of** 1998-2012

Nigeria is the largest producer of oil in Africa and is the second in oil reserves, with a reserve of over 35 billion barrels and a daily production of over two million barrels. **When** Nigerian oil and gas **are** combined, **it accounts** (accounted) for about 95% of export receipts, around 15% of GDP and over 80% of fiscal revenue [10]. This situation makes Nigerian economy (to) be more vulnerable to oil prices or **to volatility of crude production. (crude production volatility)** **On the other hand,** Algeria has one of the largest oil and gas opportunities in Africa. **(According to the [11])** Algeria had an estimated 12.2 billion barrels of proven oil reserves at the end of 2012 – the third biggest in Africa. **[11]** The Algeria's full hydrocarbon potential still has to be reliably established. The fact that Algeria's stock of reserves has stagnated at close to its current level over the past few years, **(no comma here)** possibly reflects **(the fact)** that tax such as **windfall (wind fall)** tax and investment laws are providing little incentive for **the** oil companies to invest and explore Algeria. **(According to [10])**

Referee's Note: It is better if the part about Libya comes after Algeria because it is the third producer of oil. The part about Angola should follow Libya, not Algeria. Therefore, the paragraphs should be as below.

Libya is exceedingly well endowed with hydrocarbon resources. Libya with its proven crude oil reserves of 47.1 billion barrels, accounts for nearly 38% of the continent's proven oil reserves. This country **(not only)** has substantial reserves **not only** on an African scale, but also on a global basis. The country has 12 oilfields with reserves of over one billion barrels each and two others with reserves of between 0.5 and one billion barrels. The oil and gas industry accounts for almost 70% of GDP, 90% of fiscal revenues,**(no comma here)** and approximately 97% of export earnings. **The oil sector made a quick recovery after the civil war caused the oil production to fall to zero in August 2011. (After the civil war caused oil production to fall to zero in August 2011, the sector made a quick recovery.)** Indeed, figures from OPEC show that Libya produced 1.51 million bpd of crude oil by October 2012,**(no comma here)** which **was (is)** only slightly below the pre-crisis level of 1.55 million - 1.6 million bpd.

Libya is followed by Angola which (Angola) is the fourth largest producer of oil in Sub-Saharan Africa. The hydrocarbon sector remains Angola's main engine of economic growth, accounting for more than 96% of exports, 80% of government revenue,**(no comma here)** and in excess of 60% of GDP. **Although the volatilities in the production of oil and/or global oil prices tend to have a direct influence on the performance of the economy, Angola's hydrocarbon potential is indeed massive. (Accordingly, any volatility in oil production and/or global oil prices tends to have a direct influence on the performance of the economy.) (Fortunately, Angola's hydrocarbon potential is indeed massive.)** While **(the [12] indicated)** Angola's proven oil reserves **are or are around (to be)** 9.5 billion barrels, it is in fact conservatively estimated that remaining oil reserves are around 12 to 15 billion barrels, with the bulk located offshore and in the Cabinda area. **[12]**

However, evidence has shown that mineral-exporting countries have **(being having)** disappointing economic records. Twelve of the world's 25, **a comma here** most mineral dependent states, **(no comma here)** and six of the most oil dependent **countries, (no comma here)** are classified **(by the World Bank)** as Highly Indebted Poor Countries **by the World Bank**. When taken as a group, all "petroleum rich" less developed countries **have (has)** witnessed **a** severe decline in the living standards of their populations and many of them currently rank in the bottom one-third of the United Nations Human Development Index. In addition to poor growth records and entrenched poverty, they are characterized by high level

of corruption and a low prevalence of democratization, all of which act to create high risks of civil war.

3.0 Literature Review

Several (A lot of) studies have investigated the price changes in crude oil (crude oil price changes), fluctuation and uncertainty besides (,and) their impact on economic activity,(no comma here) for about four decades ago. However, most of these studies (however,) focused either on the price movements themselves,(no comma here) or on the influence of price changes in (on) the economies of developed, (a comma here) industrial countries and industries, such as (in) the United States and (or) Japan. [13], [2,14] (e.g. [13] and Hamilton [2, 14].)

Therefore, there is (the) need to review the existing literature on the volatility of oil price (oil price volatility) and economic growth in sub-Saharan Africa. (However,) Due to the fact that only few studies have been done on this topic in sub-Saharan African, we decided to extend (therefore extended) our review to cover the studies done in other countries and regions. The effects of changes in the international oil price and price volatility on the macro-economy of Nigeria, the largest oil exporter of Africa, was analysed in a study [15] where five-variable Structural Vector Auto Regression (SVAR) model was applied to monthly data series from January 1970 to May 2011. Impulse response functions were calculated to see the influences among the crude oil price, Nigeria's exchange rate, money supply (M2), domestic price levels (CPI) and the policy interest rate (Discount Rate). It was found that Nigeria's exchange rate is affected not only by the changes in the international oil price but also by its price volatility. ([15] analysed the effects of changes in the international oil price and price volatility on the macro-economy of an African largest oil exporter, Nigeria.) They applied five-variable Structural Vector Auto Regression (SVAR) model to monthly data series from January 1970 to May 2011, impulse response functions were calculated to see the influences among the crude oil price, Nigeria's exchange rate, money supply (M2), domestic price levels (CPI) and the policy interest rate (Discount Rate). Their findings show that Nigeria's exchange rate is affected not only by the changes in the international oil price but also by its price volatility.) M2 increases as a response to an increase in oil price (oil price increase,) which suggests that an increase in the international price of oil leads to a huge increase in the money supply into the domestic market by both the national and international oil companies that are the largest suppliers of dollars besides the monetary authority. (that as the international oil price rises there is a huge increase in the money supply into the domestic market from the national oil company and international oil companies, which are the largest suppliers of dollars next to the monetary authority itself.) The long run relationship between the oil prices and real GDP in ten sub-Saharan countries was examined in another study [5] which used the Panel data for the period of 1980-2008 and applied unit root tests¹. The author of this study came out with the result that the price movement of oil has a positive impact on the economic growth of all of the eight², selected, African countries in the long run. ([5] examined the long run relationship between oil prices and real GDP in ten sub-Saharan countries by using the Panel data for the period of 1980-2008. This paper applied the unit root test such as Levin, Lin and Chu (LLC) test and Im, Pesaran and Shin (IPS) test, and test of cointegration developed by Johansen (1988) which is the Fisher panel cointegration test and Pedroni, lastly,

¹ These tests are LLC (Levin, Lin and Chu Test), IPS (Im, Pesaran and Shin Test), test of cointegration developed by Johansen, Pedroni and ARDL Test.

² These countries are Democratic Republic of Congo, Cote d'Ivoire, Gabon, South Africa, Sudan, Botswana, Swaziland and Zambia.

ARDL test. In this study the author found that oil price movement have a positive impact on economic growth for 8 selected SSA countries not only for oil exporting countries (Democratic Republic of Congo, Cote d'Ivoire, Gabon, South Africa and Sudan) but also non-oil exporting countries (Botswana, Swaziland and Zambia) in long run through panel co-integration test.) ???However, they also found that the estimated coefficients of oil price have the negative sign with economic growth because Kenya and Senegal as non-oil exporting SSA countries are rich with primary product such as gold, forest product and agricultural product but not oil.- What does that mean?

The fluctuations in oil prices and their effect on the GDP growth of USA and Sweden were also analysed. [17] Bivariate correlation between the fluctuations of oil prices and GDP growth and descriptive statistics were used in this study. The result in Sweden did not show a pattern of negative correlations between the increase of real oil prices and GDP, while the result in the USA showed that GDP was more sensitive to the increases in oil prices. ([17] examined oil price fluctuations and its effect on GDP growth of USA and Sweden. They used bivariate correlation between oil-price fluctuations and GDP growth and descriptive statistics. Their results did not show a pattern of negative correlations between real oil price increase and GDP in Sweden. However, in U.S.A the result shows that GDP is more sensitive to oil price increases.)

The demand for oil, oil prices, economic growth and resource curse were examined in another study [7] by the use of Structural Time Series Modelling (STSM) technique. The co-movements and causality relationship between the oil prices and GDP of non-OECD countries which were grouped depending on whether a country is a net oil exporter or importer was also investigated by using both time-series and panel data models. As a result, a long run cointegrating relationship between the oil prices and GDP was found. The oil prices have a strong influence on the economic output of net oil exporting countries while they have a very small or no influence on the economic output of net oil importing countries.

[7] examined Oil Demand, Oil Prices, Economic Growth and the Resource Curse. The author adopted Structural Time Series Modelling (STSM) technique. The author also investigated the co-movements and causality relationship between oil prices and GDP of non-OECD countries, grouped depending on whether a country is a net oil exporter or net oil importer using both time-series and panel data models. The author found that there is a long run cointegrating relationship between oil prices and GDP and that oil prices Granger-causes GDP for the group of net oil exporting countries but fails to Granger-cause GDP for the net oil importing countries. This implies that oil prices have a strong influence on economic output of net oil exporting countries with little or no influence on the economic output of net oil importing countries. Referee's Note: What does Granger-cause mean?

Moreover, there are also other studies on the same issue. For instance, a study titled "Oil and Growth in Africa: A Comparative Analysis" examined the impact of oil on the economic growth of seven, major Sub-Saharan African oil exporting countries.[6] A balanced data structure was adopted in the period of 1985-2005 and it was found that the investment rate and terms of trade had a significant and positive impact on the growth process while the volatility in the price of crude oil had a negative effect on growth in the sampled countries at an initial level of GDP.

[6] in their study titled "Oil and Growth in Africa: A Comparative Analysis" examined the impact of oil on growth in seven major Sub-Saharan African oil exporting countries. This study adopted a balanced panel data structure over the period 1987 to 2005. The authors found that at initial level of GDP, investment rate and terms of trade have a significant and

positive impact of on the growth process while volatility in crude oil price had a negative effect on growth in the sampled countries.

A similar study was conducted to analyze the effects of the oil price shock on Malaysia's industry by the use of EGARCH³ model to estimate the monthly volatility of oil prices and SVAR model to the monthly data of the period 1986-2009. The researchers of this study suggested that the volatility of oil price negatively affected the industrial production of Malaysia and they came up with the result that the volatility of oil price lowered the price levels in the long term. [18]

[18] on the other hand, employ an Exponential General Auto Regression Conditional Heteroscedasticity (EGARCH) model to estimate monthly oil price volatility, apply the SVAR model to 1986 to 2009 monthly data, and thus analyze the effects of the oil price shock on Malaysia's industry. They suggest that oil price volatility negatively affects Malaysian industrial production. Notably, they point out that oil price volatility lowers price levels over the long term.

Moreover, the relationship between the volatility of oil price and US macroeconomic activity was also analyzed. [8] It was found that the volatility measure constructed by the use of daily crude oil prices had a negative and significant effect on the future growth of gross domestic product (GDP) in the period of 1984-2004 and this effect became more significant after the inclusion of the changes in oil prices in the regression. This evidence provides economic rationales for nonlinear oil shock measure "It captures overall effects, both symmetric and asymmetric, of oil price shocks on output." [19]

[8] examine Oil Price Volatility and U.S. Macroeconomic Activity. The authors found that a volatility measure constructed using daily crude oil futures prices has a negative and significant effect on future gross domestic product (GDP) growth over the period 1984-2004. Moreover, the effect becomes more significant after oil price changes are also included in the regression to control for the symmetric effect. The evidence here provides economic rationales for [19] nonlinear oil shock measure: It captures overall effects, both symmetric and asymmetric, of oil price shocks on output.

4.0 Methodology

After a careful examination of the literature which informs the readers about the relationship between the oil prices and economic growth, (After carefully examined the literature that empirically examined the relationship between oil price and economic growth,) we specify the model of our study. The econometric model of this study is based upon a study undertaken by Lim et al 2011. It is as follows

$$GDP_{it} = \beta_0 + \beta_1 OPV_{it} + \beta_2 INF_{it} + \beta_3 REXC_{it} + \mu_t \quad (1)$$

Where GDP is the real GDP per capita, OPV is the oil price volatility, INF represents inflation, REXC represents real exchange rate and μ_t is the error term.

The logarithmic transformation of estimated model is stated in eq (2)

$$\ln GDP_{it} = \beta_0 + \beta_1 \ln OPV_{it} + \beta_2 \ln INF_{it} + \beta_3 \ln REXC_{it} + \mu_t \quad (2)$$

β_0 is a constant term in the model, β_1 , β_2 and β_3 are the slope of coefficients of the three independent variables.

4.1 Measurement of variables and data source

(In this study) Unbalanced panel data will be adopted for our empirical analysis in this study. Annual data from 20 sub-Saharan Africa countries which will cover the period from (of)

³ EGARCH: Exponential General Auto Regression Conditional Heteroscedasticity

1986 to 2012 will be used for our analysis. These 20 countries will be divided into **two** groups **as** A and **(group)** B and each group is made up of 10 countries. **(The)** Group A **(will)** consists of 10 oil exporting countries in sub-Saharan Africa **which are (These countries include)** Nigeria, Angola, Chad, Sudan, Ivory Coast, Gabon, Libya, Cameroon, Democratic Republic of Congo and Equatorial Guinea. The second group **of (which is)** group B consists of 10 non-oil exporting countries in sub-Saharan Africa, **namely Gambia, Mali, Senegal, Sierra Leone, Botswana, Central Africa Republic, Kenya, Malawi, Rwanda and Lesotho. (These countries include Gambia, Mali, Senegal, Sierra Leone, Botswana, Central Africa Republic, Kenya, Malawi, Rwanda and Lesotho.)** Panel A will represent the oil exporting countries in sub-Saharan Africa while Panel B will **represent (represents)** the oil importing countries in sub-Saharan Africa. These countries are divided into groups **in order to (so as to)** investigate **whether (weather) the volatility of oil price (oil price volatility)** will have the same **effect** or **a** different impact on **these country groups. (oil exporting countries and non-oil exporting countries in sub-Saharan Africa.)**

We used three methods of estimations, namely panel OLS regression, fixed effect and Generalized Method of Moment (GMM) in this study since they were not used to examine the relationship between the volatility of oil price and economic growth in sub-Saharan Africa before. Moreover, four variables⁴ which are GDP (gross domestic product), INF (inflation), REXC (real exchange rate) and OPV (volatility of oil price) were used for the regression. (GDP measured in current US dollars across the sample. INF – Inflation measured at consumer prices (annual %). REXC – Real exchange rate and OPV- this is oil price volatility, this volatility variable is generated using the GARCH methodology. In this study we used three methods of estimations, panel OLS regression, fixed effect and Generalized Method of Moment (GMM) which to our knowledge has not being used to examine the relationship between oil price volatility and economic growth in sub- Saharan Africa.) Data on the variables **were (are)** obtained from United Nations Conference on Trade and Development (UNCTAD) Statistics, a database maintained by the United Nations Conference on Trade and Development, Selected Statistics on African Countries and African Statistical Year book.

5.0 Empirical Results

In order to investigate the impact of **the volatility of oil price (oil price volatility)** on economic growth in sub-Saharan Africa we begin our analysis with descriptive analysis. We first examine the descriptive statistics and the correlation matrix of the oil exporting countries and non-oil exporting countries. The descriptive statistics of data series **provide (provides)** information about sample statistics such as mean, median, minimum value, maximum value and distribution of the sample measured by the skewness, kurtosis and the Jarque-Bera statistic. The descriptive statistics of Panel A consisting of oil exporting countries from 1986-2012 is provided in Table 1 below.

Table 1: Descriptive Statistics of Group A

⁴ GDP is measured in current US dollars, INF is measured at consumer prices and OPV is generated using the Garch Methodology.

	Inf	rexc	gdp	opv
MEAN	2.355959	3.887922	7.894479	-0.870078
MEDIAN	2.071373	4.601480	6.716388	-0.543125
MAXIMUM	10.07631	11.42928	25.25767	0.965506

MINIMUM	-3.305445	-7.600902	1.435085	-5.434137
STD.DEV	1.871271	2.280669	4.597489	1.447087
SKEWNESS	0.903113	-1.609240	3.023444	-1.189022
KURTOSIS	5.193358	6.823493	11.16526	3.847269
JARQUE-BERA	75.68689	234.1661	967.8408	59.74646
PROBABILITY	0.000000	0.000000	0.000000	0.000000
SUM	530.0907	874.7825	1776.258	-195.7675
SUM SQ DEV	784.3711	1165.125	4734.666	469.0699
OBSERVATION	225	225	225	225

There is high level of consistency displayed by **the** series in Table 1 (**above**) as their mean and median fall within the minimum and maximum values of the series. For example, the growth rate of GDP is very low over the period of this study as the mean value stands at 7.89%. The mean value of oil price volatility is -0.870078 which **reveals (reveal)** that **fluctuation in oil price (oil price fluctuation)** is minimal for the study period. The standard deviation which measures the level of variation or **the** degree of dispersion of the variables from their mean is relatively very low for all the series; **indicating (indicate)** that the deviations of actual data from their mean values are very small. The standard deviation of GDP is 4.597489 which shows that the growth rate of GDP is unstable **when compared to (compare to)** other variables. Oil price volatility with the **standard deviation** of 1.447087 is the most stable of all the variables and this shows that **fluctuation in oil price (oil fluctuation)** is relatively stable.

In order to (For us to) examine the degree of **a** possible association **among (between)** the variables, we **(therefore)** obtained the correlation matrix of both **the** dependent and **independent** variables. The correlation matrix usually provides information about the direction of **the** relationship among the variables. The correlation matrix result is presented in table 2 below.

Table 2: Correlation Matrix of Panel A

	INF	REXC	GDP	OPV
INF	1.000000			
REXC	-0.139868	1.000000		
GDP	-0.219469	-0.513576	1.000000	
OPV	-0.235150	0.279774	-0.077059	1.000000

The result of Table 2 of panel A above shows **that** both **the** inflation, real exchange rate and oil price has **a** negative relationship with GDP. The correlation matrix has shown interesting results on **the** relationship between dependent **(variable)** and independent variables. After examining the descriptive statistics and the correlation matrix of the Panel A we now proceed to examine the descriptive and correlation matrix of Panel B. The descriptive statistics of panel B are presented in Table 3 below.

Table 3: Descriptive statistics of Panel B

	Inf	rexc	gdp	opv
MEAN	2.225216	4.417756	6.395111	-0.439279
MEDIAN	2.203836	4.661392	6.053151	-0.412235
MAXIMUM	5.298447	5.819932	8.980025	1.292594
MINIMUM	-2.918607	0.626633	4.787148	-2.290044
STD.DEV	1.201296	1.062054	1.071918	0.744371
SKEWNESS	-0.573608	-2.346336	0.951404	0.184663

KURTOSIS	5.545068	7.572663	2.707565	2.483807
JARQUE-BERA	80.53257	443.6144	38.29739	4.162853
PROBABILITY	0.000000	0.000000	0.000000	0.124752
SUM	551.8537	1095.603	1585.988	-108.9413
SUM SQ DEV	356.4486	278.6056	283.8053	136.8599
OBSERVATION	248	248	248	248

The descriptive statistics of panel B shows that the series **display (displays)** **a** high level of consistency like that of panel A **since (as)** the mean and the median are within the maximum and minimum values. The growth rate of the GDP is 6.39% which is 1% below the oil producing countries. The standard deviation is relatively low in which **volatility of oil price (oil price volatility)** is the most stable of all the variables follow by inflation with standard deviation of 1.201296.

The results of correlation matrix of Panel B are presented in table 4 below. The results of correlation matrix of Panel B consisting of non oil producing countries **are (is)** not different from the result of Panel A consisting of oil producing countries as all the variables are negatively correlated with GDP. This means that the **volatility of oil price (oil price volatility)** has **a** negative relationship with economic growth in non oil producing countries in sub-Saharan Africa.

Table 4: Correlation matrix of Panel B

	INF	REXC	GDP	OPV
INF	1.0000			
REXC	-0.0078	1.0000		
GDP	-0.1620	-0.5719	1.0000	
OPV	-0.1183	0.3364	0.0970	1.0000

Due to the fact **the** correlation matrix **cannot (can not) be (provide)** a reliable indicator of association (in a manner which controls for additional explanatory variables. Therefore,) we **(now move on to)** use **the** panel data. **The results of both panel A and panel B (Both the panel A and panel B results consisting oil exporting countries and non oil producing countries in sub-Saharan Africa)** are presented below in Table 5 and 6 respectively.

Table 5: Estimates of Panel data A

Variables	Pool OLS effect	Fixed effect	GMM
C	13.9991*** (21.4181)	7.4199*** (12.1185)	16.1289*** (20.7034)
OPV	0.03019 (0.16464)	0.0994 (0.1808)	0.1240 (0.6119)
INF	-0.7253*** (-5.2757)	0.1100 (0.8071)	-1.0646*** (-5.7472)
REXC	-1.1239*** (-9.8415)	0.0765 (0.6856)	-1.4294*** (-10.514)
Adjusted R ²	0.35	0.83	0.35
F-Statistics	39.7347	25.55	
D-Watson stat	0.37	1.05	0.488445
J-Statistics			118.2605
No of Observation	225		200
Cross section Included	10	10	10

NB: The list of instrument employed for GMM include: c gdp (-1) rexcv (-1) opv(-1) inf (-1)
***denote significant at 1%, ** significant at 5 %

Table 6: Estimates of Panel B

Variables	Pool OLS effect	Fixed effect	GMM
C	9.4473*** (34.1548)	4.6092*** (21.7608)	9.9710*** (30.8087)
OPV	0.1255	0.04530	0.0827

	(1.5926)	(1.2586)	(0.8721)
INF	-0.1395*** (-3.0349)	-0.0565*** (-3.8123)	-0.3361*** (-4.1811)
REXC	-0.6081*** (-11.0848)	0.4371*** (9.4419)	-0.6202*** (-10.3407)
Adjusted R ²	0.36	0.97	0.33
Adjusted R ²	0.35	0.96	0.32
F-Statistics	46.04	197.40	
D-Watson stat	0.0731	0.38	0.1542
J-Statistics			190.6601
No of Observation	248		226
Cross section Included	10	10	10

NB: The list of instrument employed for GMM include: c gdp (-1) rexcv 304 (-1) opv (-1) inf (-1)

***denote significant at 1%, ** significant at 5 %

In order to determine the impact of the **volatility of oil price (oil price volatility)** on the economic growth in sub-Saharan Africa, **we used three, functional forms of estimation techniques, namely the pooled ordinary least squares (OLS), the fixed effect model (FEM) and the generalized moment method (GMM).** (three functional forms of estimation techniques were used; the pooled ordinary least squares (OLS) the fixed effect model (FEM) and generalized moment method (GMM) estimation are obtained for both oil exporting countries and non oil exporting countries. The generalized methods of moment will serve as robustness check. **We choose (GMM) as robustness check due to its advantage of eliminating any trace of serial correlation.)**

Referee's Note: The sentence in pink should not be here, it should be below.

The result of pooled OLS of panel A shows that **(that) the volatility of oil price (oil price volatility)** is positive but statistically **insignificant (insignificance)**. The pooled OLS results also show that inflation is negatively signed and statistically significant at 1% **which means (meaning)** that inflation has **a** negative effect on **the** economic growth of oil exporting countries in sub-Saharan Africa. **The** real exchange rate is also negative and statistically significant at 1% under pooled OLS. This also means that real exchange rate **has a negative impact on the (negatively impacted)** economic growth in oil exporting countries in sub-Saharan Africa. **On the other hand, the results of the GMM model (The generalized method of moment results on the other hand,)** show that the **volatility of oil price (oil price volatility)** is positive and statistically insignificant. **In other words, the volatility of oil price (This means that oil price volatility)** has **a** positive effect on economic growth in sub-Saharan Africa. **Despite the fact that (But both) the** inflation and real exchange rate are negatively signed and statistically significant at 1% **, both of them (This means that inflation and exchange rate)** have **a** negative effect on **the** economic growth in oil exporting countries in sub-Saharan Africa. The positive effect of **the volatility of oil price (oil price volatility)** on oil exporting countries found in this study **may (might)** be due to the fact that **the increases in oil prices will encourage and motivate investors to invest in the oil exporting countries, leading to an increase in the investment funds in African oil exporting countries. (when oil price increase it will encourage and motivate investors to invest in oil exporting countries so as to earn the rate of return in investment and this will lead to an increase the investment fund in Africa's oil exporting country.) As a result, this oil windfall will create (create)** the opportunity to increase the government revenue in oil exporting country **and will boost (,thus boost)** the economic growth in the oil exporting sub-Saharan Africa countries (UNCTAD, 2006).

The results of pooled OLS in Panel B show that **the volatility of oil price (oil price volatility)** has a positive **(effect) but statistically insignificant** effect on economic growth. **(but it is statistically insignificant)**. This **(positive)** effect of **the volatility of oil price (oil price volatility)** on oil importing countries **may have probably occurred because such countries identify and explore alternative sources of energy so that they are protected from the impact of price volatility or they may adopt measures⁵ to reduce the level of dependency on oil international markets. (though insignificant might occurred probably the oil importing countries has identify and explored alternative source of energy so that they are cushioned from the impact of oil price volatility. Or they might have adopted measures aimed at transforming and reforming economic structures in order to reduce the level of dependency on international oil markets for oil.)** Measures such as decreasing **the share of fossil fuels (the fossil fuel share)** in the national energy portfolio, increasing **the efficiency of energy (energy efficiency)** and developing structural and technological alternatives to make **the** production processes less fossil fuel intensive can all reduce **the** dependency on oil. Since these structural policy measures have long-term time horizons, they can be complemented with short-term risk management instruments such as physical reserves, strategic purchasing contracts and financial instruments which are all a common practice among many large private companies for hedging their supply risks [21]. **In addition, (Also)** the positive effect of **the volatility of oil price (oil price volatility)** on oil importing countries **may be due to the fact that (might be that high oil price problem) the problem of high oil price** is offset through foreign aid or **(through)** government subsidies **(on the high oil price)**. **Especially the** subsidiaries given by government help to reduce the burden of poor people so that **the** nation **(still)** can **still** buy products at cheaper price. Besides, **(through subsidiaries,)** the production cost remains low **through the subsidiaries and** this creates the chance to attract more foreigners to invest in the local [3].

(Both inflation and real exchange rate are negative and statistically significant at 1%.) The results of fixed effect of panel B **are (is)** not different from pooled OLS as the **volatility of oil price (oil price volatility)** is positive but **statistically insignificant (not statistically significant)** and **(also)** both **the** inflation and real exchange **rates (rate volatility)** are negative and statistically significant at 1%. This result is consistence with [7].

The pink sentence above should be here: The generalized method of moment (GMM) which we choose due to its advantage of eliminating any trace of serial correlation will serve as a robustness check. This method (The generalized method of moment which serves as robustness check) shows no difference from both **the** pooled OLS and fixed effect as the **volatility of oil price (oil price volatility)** is positive but statistically **insignificant (insignificance)**. Inflation and real exchange rate **show (has)** negative **signs (sign)** and both are statistically **significant (significance)**. The adjusted **variable** is satisfactory in all the estimations, **with the values of 0.36 under pooled OLS, 0.97 under fixed estimation and 0.33 under GMM. (The under polled OLS is 0.36 while it is 0.97 under fixed estimation and under (GMM) it is 0.33.)**

With respect to (From) the results of Panel A and Panel B, **a comma here (it shows clearly that)** the impact of the **volatility of oil price (oil price volatility)** on oil exporting countries is the same with **that of** the oil importing countries in sub-Saharan Africa. This result is **consistent (consistence)** with the study **(of)** [22] **where no statistically significant difference was found between the economic performance of commodity and non-commodity exporters. (they found in their study on sub-Saharan Africa that there is no statistically significant difference between the economic performance of commodity exporters and non-commodity exporters.)**

⁵ The target of such measures is to transform and reform economic structures.

6.0 Conclusion

(We examined the impact of the oil price volatility on the economic growth of selected, sub-Saharan Africa countries.) Although there are many studies which especially focus on the volatility of oil prices in a single country and other regions, such as OECD countries and OPEC members, such studies do not usually examine the countries in sub-Saharan Africa. (Though, a lot of studies have been done in this area especially in a single country and other region such as OECD countries and members of OPEC countries. But in sub-Saharan Africa not many study has been done.) Therefore, we examined the impact of the volatility of oil price on the economic growth of selected, sub-Saharan African countries. Our study is different from the other studies as we divide the selected, a comma here sub-Saharan countries into two groups as Panel A and Panel B. (which form panel A and panel B.) Panel A consists of oil exporting countries while panel B consists of non oil exporting countries. (And) We used three different estimations namely, the pooled OLS, fixed effect, no comma here and Generalised Method of Moment (GMM) to determine the effect of the volatility of oil price (oil price volatility) on the economic growth in sub-Saharan Africa. The results of this study show that the volatility of oil price (oil price volatility) has a positive but insignificant impact on the economic growth of both the oil exporting and (oil) importing countries (though not significant.) The insignificant effect of the volatility of oil price (oil price volatility) in panel A reveals (reveal) that whether the oil exporting countries will benefit from an increase in oil prices in the international markets will depend on how these countries spend their oil windfall. (weather increase in the price of oil in international market will benefit the oil exporting countries depends on how these countries spent their oil wind fall.) Therefore, it is (therefore) necessary for oil exporting countries to channel their oil windfall (wind fall) to various sectors of the economy in order to (so as) to stimulate economic growth.

Referee's Note: But what about the situation in Panel B, the oil importing countries? Although information about the oil importing countries in Panel B is mentioned in the discussion part, there is not even a sentence about them in the Conclusion. If the result for Panel B is the same with that of Panel A, it should be mentioned with a sentence in the conclusion.