

EFFECT OF OIL PRICE VOLATILITY ON MARGINAL FIELD PRODUCTION IN NIGERIA

ABSTRACT

This study investigates the relationship between oil price volatility and oil production from marginal fields in Nigeria using monthly data from October 2005 to April 2016. The GARCH model, Johansen co- integration and Granger Causality test were employed. Results show a significant relationship between oil price volatility and crude oil production ($P < 0.05$). Moreover, Johansen's co-integration analysis exhibits co-integration between oil price and oil production indicating long term equilibrium relationship. Finally, pairwise Granger causality test reveals that oil price Granger cause the oil production since the p-value is small ($P < 0.05$) while there is an absence of an influence of oil production on the price mechanism in the market. This proves that the above cause and effect relationship is unidirectional and not bidirectional. The findings from this study show that the dip in global oil price reduces oil production from marginal fields in Nigeria. Hence, investment in marginal oil field development becomes unattractive. However, the need to diversify and utilise gas from these fields for industrial and domestic purposes instead of flaring becomes an imperative.

Keywords: Oil price volatility, Marginal Fields, Generalized Auto Regressive Heteroskedasticity, Johansen co-integration, Granger Causality.

INTRODUCTION

Many governments of the world have always acknowledged that attracting more businesses will enable them achieve their national goal of sustainable economic and social development. In the last 40 years, Nigeria has witnessed the transformation of the agriculture based economy to oil based. Hence, the Nigerian government has been making frantic efforts to attract many more investors into the oil and gas sector; the mainstay of the economy. As larger fields become exhausted, countries across the world are striving to find a solution to maximise their energy resource by finding a viable solution for small or isolated fields (ABT oil & gas, 2014).

It has been reported that a large reserve of untapped oil conservatively put at over 2.3 billion barrels of Stock Tank Oil Initially in Place (STOIP) exists in about 183 marginal fields in Nigeria (Uche, 2011). The development of these marginal fields would boost the country's daily production of oil. Hence, Nigeria has been trying to develop its marginal fields through its local content initiative. In 2003, the Federal Government of Nigeria through the marginal field programme (MFP) awarded 30 marginal fields of the available 183. The two main objectives of the initiative include the involvement of local companies in the upstream sector of the petroleum industry towards achieving a higher level of indigenization, and growing more reserves of petroleum assets (Idigbe and Bello, 2013). Other reasons include providing alternative sources of funding for exploration of hydrocarbon resources, to encourage capital inflow and to create more employment opportunities for Nigerians (Olorunsola 2012). In other words, it can simply be stated that the MFP was borne out of the government's initiative to promote local participation of Nigerian oil and gas companies in the upstream sector. The MFP allows only the indigenous oil and gas companies to apply for the license to operate the marginal fields. The indigenous companies are allowed to have international partners with equity participation of not more than 40%.

MARGINAL FIELDS OPERATION IN NIGERIA

Marginal Field was defined as, “any oil discovery whose production would, for whatever reasons, fail to match the desired or established rates-of-return of the leaseholder” (Egbogah, 2011). The Nigerian Association of Petroleum Explorations (NAPE, 1996) defined marginal fields as, “non-producing fields whose economics is not considered robust enough using conventional development methods under the prevailing fiscal regime”. However, from an economic point of view, a marginal field is one that can be developed with marginal profits regardless of the actual size of the oil field, and so require special field development planning and reservoir management strategies in order to yield acceptable returns on investment (ROI) (Chijioke, 2013). Table 1 shows the different perspectives of the definition of marginal field in different countries. In Nigeria, Marginal field is usually referred to a field that has been discovered by major international oil companies which has not been developed for over 10years (Kulasingam, 2014).

Table 1: Different perspectives of marginal fields from various countries

S/N	COUNTRY	DEFINITIONS
1	Egypt	Fields with recoverable reserves of about five million barrels of oil (Agiza et al; 1986).
2	Netherlands	A gas field is classified as marginal when it holds less than four thousand millions of reserves. (Nor Aziah AbdManaf et al; 2014).
3	United Kingdom	Oil fields with equivalent 20million barrels of oil (BOE) is classified as ,marginal fields (Ref: plats.com).
4	USA	Marginal oil wells are those that produce ten barrels per day (Netl.doe.gov).
5	Nigeria	A field is regarded as marginal if the field has been left unattended to for a period of ten years. it is usually granted to indigenous companies at the discretion of the president.
6	India	A field is termed marginal due to various factors (geologic, geographic, technological or economic) which do not produce enough net income to make it worth developing at a given time (Nischal et al; 2012).
7	Thailand	A field that is estimated to hold reserves of 15-20million BOE (Moon, 2010).

Source: Adeogun & Omowumilledare (2015)

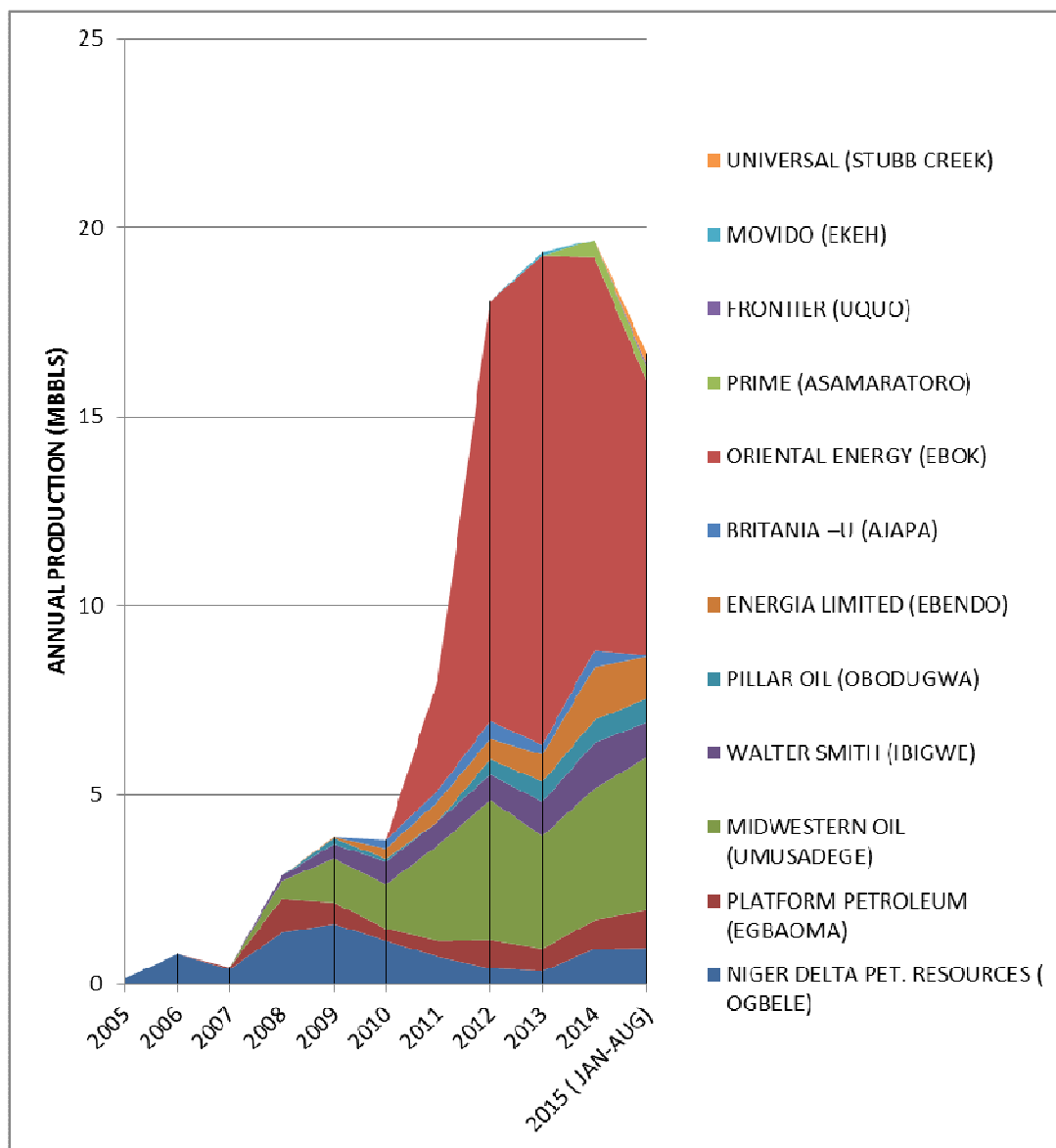


Fig 1: Nigerian Marginal Fields Production 2005-2015, (MBBLS)
Source: [NNPC](#) Statistical Monthly Bulletin

Fig 1 shows the total number of producing marginal fields out of the awarded fields. The marginal fields are producing petroleum assets, crude oil or natural gas. Niger Delta Petroleum Resources Company is the only company that started production in 2005. However, as at August 2015, some progress has been made in marginal fields' development as 12 out of the 30 operators have taken their fields to first oil production.

THE CONTRIBUTION OF MARGNAL FIELDS TO THE OIL & GAS SECTOR IN NIGERIA

According to data obtained from the Nigerian National Petroleum Corporation (NNPC) on oil and gas activities for the year 2014, the marginal fields' operators produced 19.7 million barrels of crude oil, representing a daily average of 53,922.94 barrels. This is against a total of 798.1 million barrels produced by all the operations in the

sector which translates to an average daily crude production of 2.19 million barrels, showing that the marginal fields' operators are yet to make significant impact on Nigeria's petroleum sector. (Fig 2)

Figures 2 and 3 show the distribution of crude oil production by the different contractual arrangements during the period 2005 and 2014 respectively. It shows the performance of Marginal oil fields against the other oil fields operators in Nigeria. Fig 3 shows that Marginal field contributed 0% to the crude oil production in 2005. Niger Delta Petroleum was the first and only marginal field to start production in 2005 (Fig 1). However, by 2014, it can be seen that the contribution of marginal field to oil and gas production increased from 0 to 3%. This indicates that marginal oil fields are yet to make significant impact in the oil and gas industry.

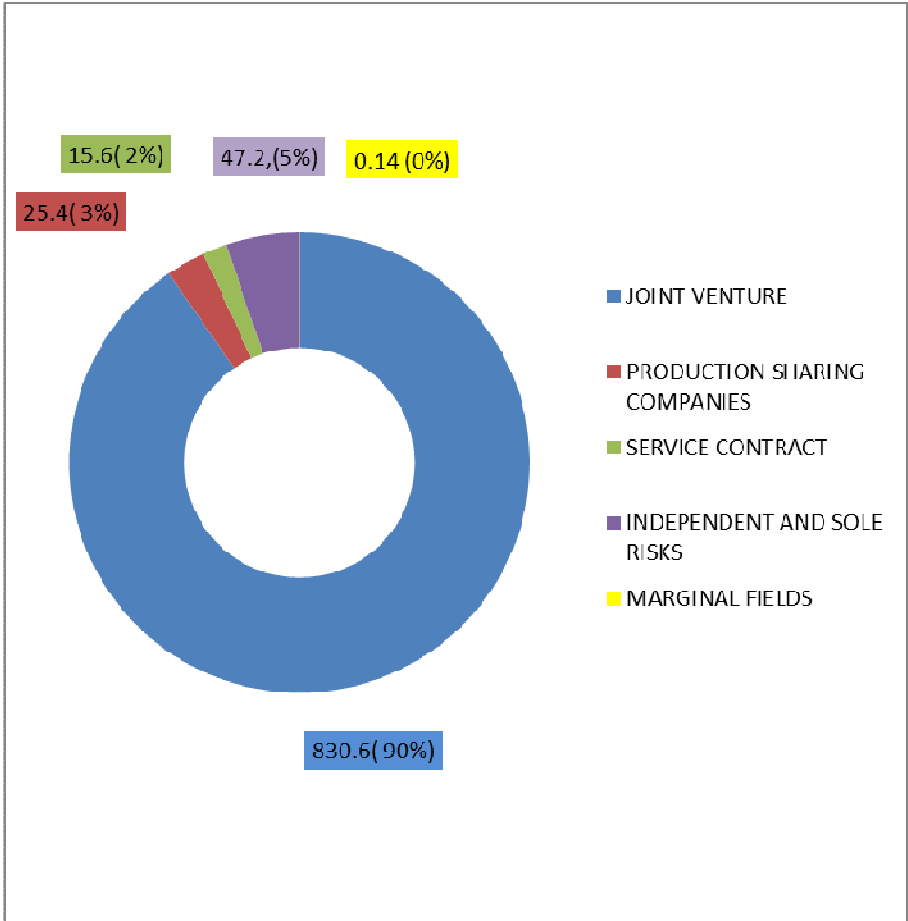


Figure 2: Pie Chart of Total Crude Oil Production 2005 (MMBLS)

Source: Drawn with data from NNPC annual statistical bulletin, 2005

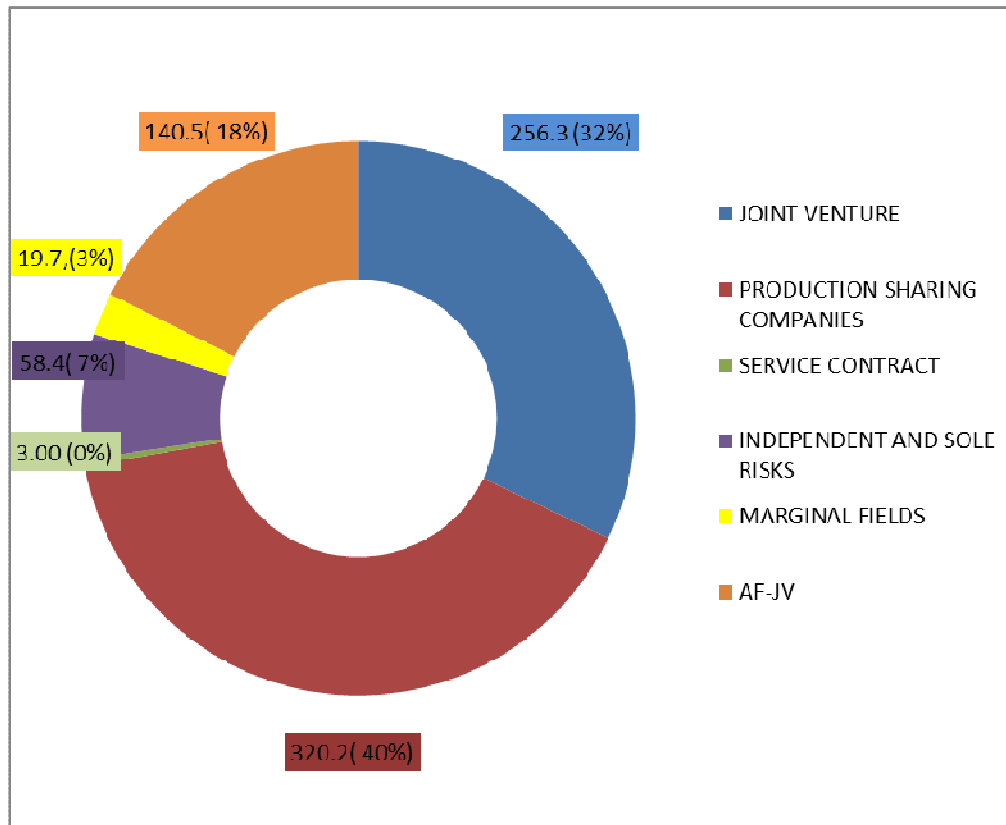


Fig 3: Pie Chart of Total Crude Oil Production 2014

Source: Drawn with data from NNPC annual statistical bulletin, 2014

In 1995, Goldsmith examined the analysis of the economic effects of new, small marginal oil fields in Alaska covering a twenty year production life. It was concluded that if marginal oil field development is successful, it will generate jobs and income for workers, increase states tax base and sales for businesses. Marginal fields have several parameters that affect them. This includes environmental concerns, political stability, access, remoteness and, of course, the price and price stability of the produced gas/liquids. Also, one of the major challenges facing oil companies are investment decision-making associated with the prices of crude oils (Hammad, 2011). For these reasons it is important to ask the following question: Does oil price volatility have an effect on the marginal field production in Nigeria? Therefore, the objective of this study is to investigate the effects of oil price volatility on marginal field production In Nigeria.

LITERATURE REVIEW

GENERAL OVERVIEW OF PRICE VOLATILITY

According to the Economics times, volatility is defined as the rate at which the price of a security increases or decreases for a given set of returns. Volatility can be measured by calculating the standard deviation of the

annualized returns over a given time period. It shows the range to which the price of a security may increase or decrease. If the prices of a security fluctuate rapidly in a short time span, it indicates volatility is high. If the prices of a security fluctuate slowly in a longer time span, it indicates volatility is low.

EMPIRICAL AND METHODOLOGICAL REVIEW OF OIL PRICE VOLATILITY

Many empirical and theoretical studies have been carried out on impact of oil price volatility on the economy. Many macro-economic variables like inflation, exchange rate, GDP and interest rate have been considered in many literatures. Ogundipe and Ogundipe (2011) investigated the impact of oil price shocks on investment in Nigeria, covering the period between 1970-2011. Multivariate VAR analysis using Granger Causality tests, impulse response functions and variance decompositions have been employed to examine relationships among the variables. The model that was estimated in their study, examined Gross Capital Formation (GCF a proxy for Investment) as a function of interest rate, real Gross Domestic Product (GDP), official exchange rate, oil price and savings. Granger causality test which is used to determine whether there is feedback from one variable to another and the direction of such feedback was used to determine whether there is any form of causality between the chosen variables and the direction of such feedback. The results showed a unidirectional causality running from Gross Capital Formation to oil price, meaning that GCF granger causes oil price and exchange rate was found to granger cause oil price and savings. Also, a bi-directional causality was found between savings and oil price. Meaning that oil price granger causes savings and savings granger causes oil price.

Algieri (2012) investigated the relationship between speculation and price volatility. He carefully examined the scope to establish whether speculation drives volatility or volatility drives speculation and whether there are linkages between the two variables. Granger Casualty test was carried out for the period between 1995-2012. Results showed that excessive speculation drives price volatility and there is a bilateral relationship between speculation and price volatilities.

ThankGod and Maxwell (2013) investigated the relationship between oil price volatility and economic growth in Nigeria. Exponential generalized autoregressive conditional heteroskedasticity (EGARCH) and lag-augmented VAR (LA-VAR) models were employed in the study. EGARCH, which is able to demonstrate the existence of asymmetry in volatility with respect to the direction of real growth, was used to estimate the volatility of the oil price and the economic growth, while LA-VAR model was used to investigate the causal relationship between oil price volatility and economic growth. Results showed a unidirectional relationship between oil price, interest rate and exchange rate.

Jawad (2013) analysed the impact of oil price volatility on the economic growth in Pakistan. An Econometric technique of Linear Regression analysis was used to analyse the dependency of oil price, GDP, oil demand and supply, public and private sector and trade balance. His results showed that Trade balance and private sector investments have significant effects on GDP and oil price volatility while public sector investment does not significantly impact on Gross domestic production.

The impact of oil price volatility on economies of India, China, Malaysia, Indonesia, Philippines and Thailand was investigated by Salim and Rafiq (2013). A Granger-causality test based on standard VAR, generalized variance

decompositions and generalized impulse response function was employed to examine the casual relationship between oil price volatility, inflation and output growth in these countries. Results showed that the variables in the model have significant impacts on the future values of each of the variables in the system and oil price volatility impacts output growth in the short run.

Wilson et al. (2014) investigated the relationship between oil prices and macroeconomic variables in Nigeria. The research adopted the granger causality to examine whether there is a relationship between oil prices and macroeconomic variables (Real GDP, exchange rate, inflation, interest rate. Ordinary Least Square (OLS) was used to examine the impact of oil prices on the applied macroeconomic indicators. Results showed that changes in the real GDP are not influenced by oil price volatility in the short run and has no influence on key macroeconomic variables.

Ebrahim et al. (2014) in their research of the behavioural responses of macroeconomic agents to oil price volatility showed that uncertainty advanced by oil price volatility has several damaging and destabilising macroeconomic effects. They identified the three main drivers of oil price volatility as characteristics of oil market fundamentals, speculation in the oil derivatives market and inadequacies in oil market data.

Numerous studies have addressed the effect of price volatility on specific economic parameters, the interactions between global macroeconomic performance and oil price volatility. However, literature is sparse on how oil price volatility affects production which acts as a proxy for the investment decision making in marginal field development. This issue is very relevant at this time as many Nigerian local investors are considering investment opportunities in the marginal fields. On this ground, this study investigates the impact of oil price volatility on the investment decision making in the development of marginal field.

METHODOLOGICAL JUSTIFICATION

Over the years, the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) methodology has become quite useful in modelling volatility of economic time series, including consumer price indices (Omotoshola & Doguwa, 2012).

As posited by Engle (1982), this methodology allows a conventional regression specification for the mean function with a variance which is permitted to change stochastically over the sample period. Within this framework, heteroskedasticity is seen as a variance that should be modelled in a time series perspective. Thus, the application of ARCH model introduced by Engle (1982) and its generalized extension (GARCH) proposed by Bollerslev (1986) in financial modeling have become very popular.

According to Matei (2009), GARCH is the most appropriate model to use when one has to evaluate the volatility of the returns of groups of stocks. The appropriateness of the model is seen through a unidirectional perspective of the quality of volatility forecast provided by GARCH when compared to any other alternative model, without considering any cost component.

EMPIRICAL REVIEW OF MARGINAL FIELDS IN NIGERIA

Many empirical studies have been carried out to identify the reason why marginal field operations have not been fully successful in Nigeria. Chijioke (2013) reviewed the Nigerian marginal oil fields development: status, constraints, prospects and way forward. Osaneku (2013) investigated the challenges and prospects of the indigenous operators in the marginal field. Idigbe and Bello (2013) investigated challenges that confront the local operators and basic roles that will improve the contribution of Marginal fields in Nigeria towards value creation. Adamu et al (2013) provided a perspective on diversification, investment and resource development on offshore marginal field in Nigeria.

The above researches highlighted some of the challenges the marginal oil field operators are facing. These include: legislative and policy bottlenecks, delay in government approval process of marginal fields award, fluctuating assistance from foreign equity partners and local investors, unfavourable tax regime and multiple taxation, local content development policy, delay in finance services, continuous community disturbances, increased asset vandalism and illegal refining of crude oil.

In summary, the relationships between oil price and many other variables have been examined in several developed and developing countries. In this study, we focus on whether these causal relationships exist in Nigeria in respect to marginal oilfield production. We analyse the relationships between oil price volatility and marginal field production volatility based on the data of marginal field production and the price of Brent crude oil price from October 2005-April 2016

DATA

The variables and sources of data used in this study are defined below.

- The marginal crude oil production (*LNDP*) is the total barrels of crude oil produced by an onshore marginal field. The data was gotten from one of the producing marginal fields in Nigeria.
- A key determinant of investment is oil price (*LOILP*) which is measured by Brent Spot price in US dollars. Crude oil price is important because it determines the willingness of people to invest or not. Hence we need to investigate whether crude oil price volatility affects production volatility.

The model to be estimated in this study, examines Marginal crude oil production (*LNDP*) as a function of crude oil price (*LOILP*)

$$LNDP = f(LOILP)$$

- The monthly data was gotten from U.S. Energy Information Administration & the monthly production data was gotten from Nigerian National Petroleum Corporation (NNPC) Monthly Statistical Bulletin.
- Data covered the period from October 2005 to April 2016.

The Trend of the time series data was analysed using Augmented Dickey- Fuller (ADF) and Phillip- Perron (PP) unit root test and analysis of the long run association between the two variables was done with the Johansen Co-Integration test. The natural log returns of the variables were used so as to fit the model well.

METHODOLOGY

GARCH MODEL

This study will use Exponential Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model to examine the impact of oil price volatility on investment decision making in marginal fields development in Nigeria.

Heteroskedasticity is one of the key problems that require attention when performing time series analysis on oil price given the uncertainty in the movement of oil price. The uncertainty in the movement of oil price is referred to as oil volatility and it can be measured using oil price variance and covariance. Engle (1982) suggested the ARCH (autoregressive conditional heteroskedasticity) model as an alternative to the standard time series treatments. After a period of increased volatility, the period of high volatility that is referred to as volatility clustering continues for a while. The high persistence of volatility is taken into consideration by ARCH model and it has become one of the most common tools for characterising changing volatility. The ARCH model relies mostly on daily return (usually squared returns) for the modelling of volatility. The shortcoming of the model is that the returns are rather weak signals about the level of volatility (Hansen & Huang, 2012). This particular observation led Bollerslev (1986) to extend the ARCH model into the Generalized ARCH (GARCH) model. The virtue of this approach is that a GARCH model with a small number of terms appears to perform better than an ARCH model with many terms. There is a notion that during a period of falling growth, volatility is likely to rise and during a period of increasing growth, it is likely to fall (ThankGod and Maxwell, 2011).

An ARCH model is a stochastic process with autoregressive conditional heteroskedasticity. They are simple models that are capable of describing a stochastic process which is locally non stationary but asymptotically stationary. If the stochastic process exhibits volatility, then the ARCH models are useful. It has been applied to many areas of the economies like stock returns, foreign exchange rate and the interest rate. The variance at time t depends on past values and it is characterised by a certain number of parameters. An ARCH (p) model is defined by

$$y_t | \psi_{t-1} \sim N(0, \sigma_t^2) \quad (1)$$

Where ψ_t is the information set of all information up to and including time t .

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_p \varepsilon_{t-p}^2 \quad \sigma_t^2 = \omega + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 \quad (2)$$

The variance function can be expressed more generally as $\sigma_t^2 = \sigma(y_{t-1}, y_{t-2}, \dots, y_{t-p}, \alpha)$ where the unknown parameters $\alpha_0, \alpha_1, \dots, \alpha_p$ are positive constants. ε_t is a random variable, with zero mean and variance σ_t^2 . P is the order of the ARCH process.

According to the specification in equation (2), the conditional volatility is assumed to be a moving average of squared innovations. For conditional variance to be positive and well defined, the parameters must satisfy the following conditions: $\omega > 0, \alpha_i \geq 0$ and $i = 1, \dots, p$.

ARCH model has its shortcomings and the key among them is that it relies mostly on daily return (usually squared returns) for the modelling of volatility which is rather weak. In order to get good results, ARCH models need very long memories (large p). For this reason, Bollerslev (1986) proposed a Generalised ARCH models (GARCH).

The standard GARCH model allows the conditional variance to be dependent upon previous own lags. The basic structure of the symmetric normal GARCH model is GARCH (p, q). A GARCH model is defined by

$$y_t = \mu + \varepsilon_t$$

$$\varepsilon_t = \sigma_t \varepsilon_t, \varepsilon_t \sim N(0,1)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \alpha_p \varepsilon_{t-p}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 \quad (3)$$

Where σ_t^2 denotes the conditional variance since it is a one-period ahead estimate for the variance calculated on any past information thought relevant. For this model to be well defined and conditional variance to be positive, the parameters must follow the following conditions:

$$\omega > 0, \alpha_i \geq 0 \text{ and } i = 1, \dots, p, \beta_j \geq 0, \text{ for } j = 1, \dots, q.$$

The unconditional variance is given by

$$\sigma^2 = \omega / (1 - \sum_{i=1}^p \alpha_i - \sum_{j=1}^q \beta_j) \quad (4)$$

Therefore, the process ε_t is covariance stationary if and only if $\sum_{i=1}^p \alpha_i + \sum_{j=1}^q \beta_j < 1$. This is not a sufficient condition for ε_t to be strictly stationary. Some of the shortcomings of GARCH include the fact that the non-negativity conditions may be violated by the estimated method, since the coefficients of model probably are negative.

The GARCH model can capture the following features associated with any financial time series

- I. Volatility Clustering: This happens when a large change is followed by another large change. Also when small changes are followed by another small changes. Successive volatility can be uncorrelated and serially dependent at the same time. Fat Tails: in most cases, returns on assets exhibit a fatter tail curve of observation that the one usually observed in a normally distributed curve. This is called excess kurtosis.
- II. Leverage effect: decrease in assets returns have a negative impact on the value of equity ownership. Given that long-term debts are usually secured and have priority ownership, any risk associated with higher volatility is usually bearable by equity shareholders (Hammed, 2011).

RESULTS AND DISCUSSIONS

Preliminary Analysis of Data

Preliminary analysis of data was conducted in order to determine the normality of the data, the stationarity of our time series data and to ascertain whether any of the ARCH family models can be used.

Time series properties of data

Unit root test

Available data were gotten from October 2005 to April 2016. Each series was tested for the presence of unit root or stationarity of variables or applicability of Augmented Dickey Fuller and Phillip-Perron tests.

Null hypothesis (H_0) - the variables are not stationary (has unit root)

Alternative Hypothesis (H_1) – the variables are stationary (has no unit root).

From the results of Augmented Dickey – Fuller (ADF) and Phillip – Perron tests (PP), production series rejects the null hypothesis of a unit root for both tests. That is no unit root (stationary at levels) except for the intercept test of the ADF which was not statistically significant at 10%. The oil price series fail to reject the null hypothesis of a unit root. This indicates that the series are non-stationary (has unit root) when the variables are defined in levels. By first differencing the series, in all cases, the null hypothesis of non- stationary process is rejected at the 1% significance level. Many literatures find crude oil prices to be I (1) (Ito 2010). Thus to achieve stationarity of data, all series were differenced once.

OPTIMAL LAG TEST

In order to run Johansen Co-integration and Granger Causality test, the total number of lags required need to be obtained. This was achieved using the VAR estimates in the Eviews. Results showed that from the entire Criterion, 2 lags are the most suitable to be used.

COINTEGRATION

This test was done to determine the long run relationship among the two variables. The Johansen test is a test for co-integration that allows for more than one co-integrating relationship, unlike the Engle–Granger method. In our case we are testing for the existence of long- term relationship between oil price and crude oil production of the marginal fields in Nigeria.

The results of the ADF and PP tests confirmed that there is an existence of a unit root in our variables oil price volatility (*LOILP*) exhibit a unit root @ level for both ADF and PP tests @ interval and Trend + Interval, while the marginal field production (*LNDP*) only exhibited unit root at level for the ADF test at Trend + interval. This suggests that the series are suitable for co- integration testing (Hammad, 2011).

Following the approach of Johansen and Julius (1990) & ThankGod and Maxwell (2011), out of the two likelihood ratio statistics test, the trace statistic and the maxima eigenvalue were considered to determine the number of co-integration vectors. The result of the trace test and the maximal eigenvalues of the models shows that our p-value for 'none' are statistical significant at 5% ($p < 5\%$). This leads to rejection of the null hypothesis and acceptance of the alternate hypothesis. That is, there is a long term relationship between our dependent and independent variable. Therefore, oil price and marginal field oil production are co-integrated.

GARCH MODEL

The GARCH model was used to ascertain if *LOILP* causes volatility in *LNDP*.

REGRESSION ANALYSIS

Regression analysis was carried out to justify the use of an ARCH family model for the analysis. It was observed from the residuals of regression analysis, that periods of low volatility were followed by periods of low volatility (2005-2007) and periods of high volatility were followed by periods of high volatility for a prolonged period (2008-2010). This suggests that residuals or error term is conditionally heteroskedastic and can be represented by ARCH or GARCH model i.e one big shock or fluctuation causes another big shock or fluctuation. When this happen for residuals, then the ARCH family model can be used.

ARCH EFFECT

Another check was done to confirm this using an ARCH test. This indicated that P value = 0.0000 is less than 5% which makes it statistically significant at 1%. The null hypothesis is then rejected and the Alternate hypothesis is accepted.

ARCH FAMILY MODEL COMPARISON

The Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC) were used to determine the best model to be used. The best model is the one with the lowest AIC and SIC. Results as shown in the table below show that GARCH (1,1) is the best.

Table 2 : Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC) for Arch Models

ARCH(5,0)		GARCH(1,1)		TARCH		EGARCH	
AIC	SIC	AIC	SIC	AIC	SIC	AIC	SIC
1.44	1.61	1.43	1.57	1.46	1.59	1.46	1.59

The next stage is to run the diagnostic test on GARCH to check whether the model has fulfilled all the conditions to run the model.

The following tests were carried out

Diagnostic test 1: Correlogram of Standardized Residuals Squared,

Diagnostic test 2; Heteroskedasticity test and

Diagnostic Test 3: Normality assumption.

Results show that the model satisfies the diagnostic test meaning that:

1. There is no serial correlation in our model
2. There is no ARCH effect
3. Our residuals are normally distributed

The variance equation in table 3 shows that oil price (independent variable) is not taking part in the model, which indicates the property of a catalyst. Therefore the independent variable (*LOILP*) is acting as the catalyst. From the mean equation, since the P-value of the oil price (*LOILP*) is equal to zero ($p < 0.05$), therefore catalyst or condition is significantly present in the model. However, from the variance equation, the probability of $\text{RESID}(-1)^2$ [ARCH TERM] is equal to 0.04 ($p < 0.05$), indicating that volatility can be predicted by ARCH term as its P-value is significant. This simply means that previous month's crude oil production can influence present month's crude oil production.

The probability of the GARCH term, that is GARCH (-1) equals zero ($P < 0.05$), shows GARCH term significantly predicts volatility in the model. This means the previous month's crude oil production volatility can influence this month's crude oil production volatility. In a nutshell, crude oil production volatility is influenced by ARCH and GARCH factors. Finally, both the ARCH and GARCH terms have predicted volatility, with the condition Oil price (*LOILP*) being the catalyst. That is oil price volatility (independent variable) has an influence on the volatility of the crude oil production (dependent variable) in the onshore marginal oil field.

Table 3: GARCH model Result

	p-value
Mean equation	
C	0.00
LOILP(-1)	0.00
Variance Equation	
RESID(-1) ²	0.0436
GARCH(-1)	0.0000

GRANGER CAUSALITY TESTS UNDER VAR ENVIRONMENT

Table 4 is the result of the Granger Causality test used to ascertain whether there is a causation or feedback between variables and to determine the direction of such feedback or causality. The first null hypothesis shows that marginal field production (*LNDP*) does not Granger cause oil price volatility (*LOILP*). The F- Stat and the

corresponding p-value were used to ascertain the hypothesis. Results show that the null hypothesis is valid ($P > 5\%$). This simply means that our marginal field production does not affect the Brent oil price volatility.

The second null hypothesis states that oil price volatility (*LOILP*) does not granger cause marginal field production (*LNDP*). Using the F-Stat and the corresponding P-value, the null hypothesis not valid and so the Alternate hypothesis which states that oil price granger cause production ($P < 5\%$) becomes valid. This explains that Brent oil price volatility has an effect on marginal oil field production.

Table 4: Granger Causality Test Result

Null hypothesis	Obs	F-stat	Prob
<i>LNDP</i> does not Granger cause <i>LOILP</i>	125	0.309	0.735
<i>LOILP</i> does not Granger cause <i>LNDP</i>		2.741	0.069

CONCLUSION

In this work, the relationship between oil price and many other variables in selected developed and developing countries was established. The theoretical framework used in this research applies to Nigeria situation holds as the decrease in the global oil price negatively affects production from the marginal fields in Nigeria Nigerian crude oil is traded is global. The findings presented in this study demonstrate that oil price volatility has a substantial effect on oil production from onshore marginal fields industry in Nigeria. The result indicates that oil price and marginal field production are co-integrated, that is having a long term relationship. Also, both the ARCH and GARCH terms predicted volatility, with the condition Oil price (*LOILP*) being the catalyst. Finally the granger causality test showed that Brent oil price volatility granger cause marginal oil field production. This study can be used to show the effect of oil price shock on the macroeconomy and this will be useful for planning.

RECOMMENDATION

Majority of the marginal oil fields still flare a lot of their gas due to inadequate provisions of infrastructures and regulations by the government. This led to loss of 31.8billion naira in the month of February, 2014. Many Countries around the world have taken into considerations the benefits of utilising the gas instead of flaring it. These include; conversion into domestic cooking gas, liquefied natural gas, plastic production and many more. So revenue can still be generated from sales of gas which makes investment in the sector worthwhile. Therefore, the operators of Marginal fields should consider diversification.

NOMENCLATURE

ABT OIL AND GAS	Now Marginal Field Development Company
ADF	Augmented Dickey- Fuller
ARCH	Autoregressive conditional heteroskedasticity
BOE	Barrel of oil Equivalent
EGARCH	Exponential Generalized Autoregressive Conditional Heteroskedasticity

GARCH	Generalized Autoregressive Conditional Heteroscedasticity
LOILP	Natural Log return of oil price
LNDP	Natural log return of Marginal Fields Production
MFP	Marginal Fields Program
MMBBLs	Million Barrels
NAPE	Nigerian Association of Petroleum Explorations
NNPC	Nigerian National Petroleum Corporation
OPEC	Organisation of Petroleum Exporting Countries
PP	Phillip- Perron
ROI	Return On Investment
STIOP	Stock Tank Oil Initially Place

REFERENCES

- ABT Oil& Gas (2014), Economic solutions for marginal fields. www.abtoil&gas.com/marginalfields-economics/(accessed 08-06-2014)
- Adamu,M.A., Ajenka, J.A. and S.S, Ikiensikimama, (2013), Economic Analysis on the Development of Nigerian Offshore Marginal Fields Using Probabilistic Approach, *Advances in Petroleum Exploration and Development* vol. 6(1), pp.11-21
- Adeogun, O. and Omowimilledare (2015), Developing a Framework for Maximising Marginal oil and gas field Economics. Society of Petroleum Engineers Annual International Conference and Exhibition held in Lagos 4-6 August, 2015.
- Aizenman, J, and N. Marion (1999), Volatility and Investment: Interpreting Evidence from Developing Countries. *Economica*, New Series, vol. 66 (262), pp.157-178
- Babatunde S. Omotosho and Sani I. Doguwa, Understanding the Dynamics of Inflation Volatility in Nigeria: A GARCH Perspective. *CBN Journal of Applied Statistics* Vol. 3 (2)
- Bollerslev, T., (1986). Generalized Autoregressive Heteroskedasticity. *Journal of Econometrics* 31, 307–327
- Chijioke, N. (2013). Marginal oil fields development in Nigeria: status, constraints, prospects & way forward.<http://eaglereporters.com/2013/12/07/marginal-oil-fields-development-in-nigeria-status-constraints-prospects-way-forward/>(accessed 06,02,2014)
- Egbogah E.O., “Onshore/Marginal Field Developments: Challenges, Opportunities and Prospects for the Future”, *presented at 2011 SPE Annual Oloribi Lecture and Energy Forum, Lagos, Nigeria, June 30*
- Ebrahim, Z, Inderwildi, O. And D, King (2014), Macro Economic Impacts of Oil Price Volatility: Mitigation and Resilience, *Front Energy*
- Engle, R. (1982) Autoregressive Conditional Heteroscedasticity with Estimates of Variance of United Kingdom Inflation, *Journal of the Econometric journal*, vol. 50 (4), pp.987-1007
- Goldsmith, O.S. (1995). Marginal Oil Field Development: The economic Impact, *Institute of Social and Economic Research, University of Alaska Anchorage*

- Hammed, R. (2011). Modelling the Impact of Oil Price Volatility on Investment Decision Making, *theDegree of Doctor of Philosophy at University of Hull*
- Idigbe, K.I, and K.O.Bello, (2013). Sustainable Operation of Marginal Fields in Nigeria: Oportunities, Challenges and Best Practices, *Journal of Emerging Trends in Engineering and Applied Sciences*, vol.4(4), pp. 686-691
- Jawad, M. (2013). Oil Price volatility and its Impact on Economic Growth in Pakistan, *Journal of Finance and Economics*, vol. 1(4), pp 62-68
- Kulasingan, R. (2014). Nigeria's marginal Fields Process, Opportunities, challenges and Stetson hats!*Journal of Financial Nigeria Magazine*,
<http://www.nigeriadevelopmentandfinanceforum.org/PolicyDialogue/Dialogue.aspx?Edition=219>(access ed 20-02-2015)
- Marius M. (2009). Assessing Volatility Forecasting models: Why Garch Models take the Lead, *Romanian Journal Of Economic Forecasting* – 4/2009
- Nigerian Association of Petroleum Explorationist (NAPE), Marginal Fields: The Issue, (*Nigeria: NAPE*, 1996), p.30.
- Nigerian National Petroleum Corporation, 2005. Annual Statistical Bulletin, www.nnpcgroup.com (Accessed 05-05-2015)
- Nigerian National Petroleum Corporation, 2014. Annual Statistical Bulletin, www.nnpcgroup.com (Accessed 05-05-2015)
- Olorunsola, O. (2012), Emerging Oil and Gas Development Opportunities for Marginal Operators, *ANPPA – PETAN Joint Forum, OTC 2012*
- Osaneku, M. (2013), Marginal Field & Indigenous Operators: Challenges & Prospects.<http://nigerianoilgas.com/?p=1081>(accessed05-05-2014)
- Pierru, A. and W. Matar, The Impact of oil price volatility on welfare in the Kingdom of Saudi Arabia: implications for public investment decision –making
- Salim, R. and S. Rafiq,(2010). The Impact of Crude Oil Price Volatility on selected Asian Emerging Economies
- ThankGod, A. and I. Maxwell, (2013). Macroeconomic Impact of Oil Price Levels and Volatility in Nigeria, *International Journal of Academic Research in Economics and Management Sciences*, vol. 2(4), pp. 15-25.
- Uche, A. (2011),Marginal Fields- The Story So Far. <http://nigerianoilgas.com/?p=509> (Accessed 01-28-2015)
- U.S. Energy Information Administration, Europe Brent Crude Oil Price. <http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=rbrte&f=D>. (Accessed 02-05- 2016)
- Wilson, A., David, U., Inyama, O. and E. Beatrice, (2014), Oil Price Volatility and Economic Development: Stylized evidence in Nigeria, *Academic Journal*, vol. 6(6) pp. 125-133