IJEEP
INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY
EJ EconJournals
ISSN: 2146-4553

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2016, 6(3), 617-620.

Gas Flaring Effects and Revenue Made from Crude Oil in Nigeria

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ABSTRACT

The study examines gas flaring and crude oil revenue in Nigeria. The study used secondary data for 14 years from 2000 to 2014 inclusive to analyze the issue using multiple regression analysis. The study employed time series data hence, a unit root test is conducted and found that they are stationary at level. Using three variables, gas flaring as the aggregate amount of gas flared by oil producing companies in Nigeria as an independent variable and crude oil revenue as an aggregate of revenue generated from all oil companies crude oil as dependent variable and tax as penalty on flaring is used as a control variable, the findings of the study show that gas flaring has a negative impact on Nigerian crude oil revenue and is statistically significant. From the research there are strong indications that the implementation of regulations and incentives to abate gas glaring in Nigeria has to be improving in other to increase revenue generated from crude oil. The author suggests that government should embark seriously on gas utilization policy and increase the penalty for companies who still engage in gas flaring. In addition, the government should utilize the gas flaring for electricity generation or implore another means of either utilizing it or curtail it.

Keywords: Gas Flaring, Carbon Emission, Crude Oil Revenue
JEL Classifications: Q51, Q53, Q56

1. INTRODUCTION

Flaring is a means of safely disposing of waste gases through the use of combustion (Boxall et al., 2005). It also considered as burnt of associated gas produced by oil explorers which increase carbon emission. The said emission is one of the fundamental and key problem worldwide and it significantly attract attention globally especially on the issue of global warming. So many factors could lead to increase in carbon that has tremendous effect on our society today. Researchers assert that, gas flaring is one of the major contributor that led to carbon emission. The said gas flaring is released as a result of crude oil production (Akpomuvie and Orhioghene, 2011). Today crude oil, is a major player on global energy market (Akpomuvie and Orhioghene, 2011). To meet up the persistent increase in demand, oil producing states increase their production among which Nigeria is not in isolation. The production of the oil results to release of an associated. Which is termed as gas flaring (Orubu et al., 2004).

Researchers found that gas flaring can be handled in three either ways as follows: (a) To harness for use as liquefied natural gas, (b) to re-inject into the earth and finally, (c) to vent or flare it (Bassey, 2008). The latter is not economically, socially and environmentally friendly yet, many companies find it easy to flare than utilising it as a result of the high cost attributed to utilisation of associated gas (Malumfashi, 2007). As at 2004 however, World Bank assert that, oil producers flare and vent gas equivalent to the combined gas consumption of Central and South America annually (World Bank Group, 2004) and Africa is not in isolation since the companies operated in Africa flares and vents gas equivalent to half its power consumption (Anomohanran, 2012). This also include Nigeria which is among the highest country that flare gas globally (Ishisone, 2004). In the report of World Bank, it was reported that natural gas is flared annually to the tune of 25% of gas consumption in the United State of America and 30% of European Union gas consumption equivalent. The flares of which 13% in the world comes from Nigeria alone World Bank added.

This quantity is enough to meet Nigeria's energy needs and leave a healthy balance for export (Okoji, 2000). Through this obnoxious act, the country lost $2.5 billion annually (Malumfashi, 2008). This could definitely affect the revenue generated by any country provided the country depends on crude oil.

As prescribed by so many studies, Nigeria is among the highest gas flares in world (Orubu, 2005), yet it is increasingly recognized by a wide range of stakeholders, including the petroleum industry itself, that flaring and venting of gas constitute a waste of economically valuable resources (Nwokeji, 2007; World Bank Group, 2004). For that reason, a question can be raised as to the extent of how flaring of gas affect crude oil revenue in Nigeria. That needs an answer.

Despite the record of vast association and non-associated gas reserves, the production of gas has been low while its commercial exploration has is not comparable to that of oil, instead, flaring of associated gas persisted (Aghalino, 2009; Bankole, 2001). It was found out by the World Bank that developing countries account for more than 85% of gas flaring and venting, with Nigeria, Iraq, and the Islamic Republic of Iran as the highest flares (Malumfashi, 2008). Countries such as Norway, the United States, and the United Kingdom in contrast, utilize their gas and flare or vent <2 m^3 for every barrel of oil and that improve in their oil revenue (World Bank, 2008).

The gas flaring is defined by a World Bank-sponsored study as "the wasteful emission of greenhouse gases that causes global warming," hence reduces expected revenue (Oni and Oyewo, 2011) in which the United Nations Framework Convention on Climate Change, Printed in 1992 came into force in March 1994, as well as Kyoto Protocol 1997 seek to address (Seungyong, 2001). For that reason Akinlawon (2006) revealed that gas increases government revenues and significantly increases foreign exchange thus monetizes previously wasted resource where in the case of flaring the loss to the national treasure. The author added that, if this flaring in form of carbon emission is traded, it could also increase government revenue.

For that reason, there is need to empirically establish the impact of gas flaring on revenue generated from crude oil. Thus, the question is raised;

Does gas flaring affects crude oil revenue?

The broad objective of this research is to examine the impact of gas flaring on Nigerian crude oil revenue. Base on the said objective, an alternative hypothesis is developed for testing.
H_1: Gas flaring has effect on Nigerian crude oil revenue.

The research shall address the problems, which will benefit Nigerian government and also other major oil producing nations that are flaring gas. The results of the study will also contribute to the academic community.

2. METHODOLOGY

The research uses multiple linear regression models. Regression is used when the mean of the outcome variable is relatively high (Imbens and Lemieux, 2008; Leng et al., 2007; Rasmussen and Williams, 2006; Rossi, 2005). The model generalizes ordinary least square regression for use with many different types of error structures and dependent variable (Lewis, 2007). In this case of this research, we deemed it necessary to use multiple regression models which will describe the impact of the gas flaring on Nigerian revenue and its impact on carbon trading.

In general regression model is described as follows:

$$Y_t = f(X_t\, I\, \theta, \Omega_t) + \delta_t\, \varepsilon_t \quad (1)$$

In the above equation, Y_t is the dependent variable and X_t is assume to influence y with model relationship as $f(X_t\ I\ \theta, \Omega_t)$ where θ represents a set of parameters needed for the model. In the model Ω_t represent the information available at a time. Therefore, the $f(X_t\, I\, \theta, \Omega_t)$ describe the relationship between Y_t and X_t based on the information available at a time y and when time proceed to next year then will transform from θ to θ + 1 while Ω will also be Ω + 1 and ε is an error term.

2.1. Sources of Data

The data used is secondary and obtained from Central Bank of Nigeria (CBN) Statistical Bulletin (2015). Hence, data for gas flaring is retrieved from the CBN statistical bulletin (Central Bank of Nigeria, 2015), and the World Bank fact book for 14 years (2000-2014) under study. The selection of the time for this study is solely in relation to the time when the Nigerian government pay more attention to carbon emission from oil/gas production. The Nigerian gas flaring and oil revenue were obtained from the CBN, covering the period of 12 years. While the carbon emission, which is converted to carbon trading value from Nigeria, is soured from World Bank. This covered the period used as estimation period, policy implementation period as well as carbon trading and schemes introduction period.

2.2. Model

To capture the area where the gas flaring is affected the research considers two independent variables. These are crude oil revenue in Nigeria and carbon emission in Nigeria. Since the interest of this research however lies in establishing the impact of gas flaring on Nigerian revenue then there is need for justification for analysis of the policy purpose. The basic model takes the form,

$$LGFLR = f(LCOR, LTAX) \quad (2)$$

Where,
LGFLR = Natural log of quantity of gas flared annually,
LTAX = Natural log of tax as a penalty for flaring of gas.

Therefore the basic estimated equation is:

$$LCOR_t = \beta_0 + \beta_1 LGFLR_t + \beta_2 LTAX_t + \varepsilon_t \quad (3)$$

$\beta_0 > 0; \beta_1 > 0; \beta_2 > 0$

Where, β_0, β_1 and β_2 are parameters to be estimated; ε_t is the stochastic error term. The parameter β_1, which is the coefficient

of gas flaring in Equation (3), is expected to be negative with exception that when the gas flaring is effective then the crude oil revenue will decline. If the gas flaring significantly reduces the Nigerian crude oil revenue, then β_1 should be negative and statistically significant. The parameter β_2 is the slope effect of tax as penalty in Equation (3), which is introduced as control variables in the equation. The data collected is measured annually. In addition, the coefficient of determination R^2 is explained in other to determine the percentage of explanatory variables explained the dependent variable. Since the data is time series in nature, to deal with the issue of furious results, a stationarity/unit root test is conducted using augumented Dickey Fuller (ADF) test.

2.3. Model Analysis

The result on Table 1 shows the unit root test using ADF test. And all the data are stationary at level.

Table 1 shows the findings of ADF test and all the data of the variables *GFLR*, *COR* and *TAX* are stationary at level. This mean as they are stationary at level it satisfied the condition for stationarity, therefore the data can be used for further analysis.

Using the Equation (3) as specified above the value for which of all the parameters summarized from the regression result is in Table 2. Thus,

$$LCOR_t = 8.6 - 0.24\ LGFLR_t + 0.03\ LTAX_t$$

Empirical evidence from the crude oil equation in Table 2 revealed that there is negative relationship between crude oil revenue and gas flaring which has negative sign as expected. This can be seen from the parameter β_1 with a value of −0.24. This means 1% change in gas flaring will decrease crude oil revenue by 24% with the economic assumption of other factors remain constant. It is important to note that, the use of percentage instead of a unit in the regression is as a result of the fact that both the dependent and independent variables are in natural log version. At 1% level of significant the coefficient of gas flaring is statistically significant because the $P < 1\%$. Therefore, gas flaring is found to be significant in explaining changes in crude oil revenue. With an adjusted R^2 of 0.75, it means gas flaring and tax with their total observations accounted for 75% of all the variations in Nigerian crude oil revenue.

On the other hand, the control variable tax parameter is denoted as β_2 from Equation (4) which takes the value of positive 0.03. Therefore, a percentage increase in tax will increase crude oil revenue by 2.4% other factors remain constant. With joint F-test is (0.00) that means gas flaring and tax accounted are jointly significant in explaining changes in crude oil revenue. The value of Durbin–Watson of 2.0 shows the absence of serial correlation among the independent variables in the estimation.

3. MULTICOLLINEARITY TESTS RESULTS

Table 3 summarised the multicollinearity results for crude oil revenue, Tax tax respectively. The result shows the absence of multicollinearity. Given that the model satisfied all other diagnostic tests, therefore, the validity of the results is not questionable.

The results of multicollinearity test for crude oil revenue model in Table 3 revealed that, going by the two criterions used in conducting the multicollinearity, there is no evidence of multicollinearity among the variables of the model because the correlation coefficient among the variables is not up to 70%. The weaker the correlation the more the absence of multicollinearity (Gujurati, 2010).

From Table 4 diagnostic and specification tests results show there is clearly evidence that, the estimates of the combination of the model obtained in this research is efficient; therefore, the study assumed that the standard errors, the t- and F-statistics values are correct at one 1% significant level; in addition and the most important issue is the results can be used for policy purposes.

4. FINDINGS

This study found the existence of negative relationship between crude oil revenue and gas flaring as proposed earlier base on the hypothesis. This implies that the more the flaring of gas by the companies the less the oil revenue generated by the government. Except or else specified that there is efficiency in other aspect such as technology, the revenue derived from crude oil will remain

Table 1: Results of stationarity (unit root) test

Variables	ADF-statistics	Critical values	Order of integration
GFLR	6.60007	1%=−3.46	Level
	(0.0001)	5%=−3.00	
		10%=−2.67	
COR	−5.43141	1%=−3.25	Level
	(0.0031)	5%=−3.00	
		10%=−2.34	
TAX	3.12322	1%=−3.76	Level
	(0.0000)	5%=−3.11	
		10%=−2.35	

Source: Author's computation (using E-Views 7.0 software). ADF: Augumented Dickey Fuller

Table 2: Natural log of gas flaring model results

Variables	Coefficients	t-statistic	P value
C	8.60	3.00	0.00
LGFLR	−0.24	−3.6566	0.01
LTAX	0.03	2.5885	0.00
R^2	0.79	Durbin–Watson	2.00
Adjusted R^2	0.75	Prob (F-Stats)	0.00

Source: Author's computation (using E-Views 7.0 software)

Table 3: Multicollinearity result

	LGFLR	*LTAX*
LGFLR	1.0	
LTAX	0.3	1.0

Source: Author's computation (using E-Views 7.0 software)

Table 4: Specification test results

Version	Products	F-statistic	P value
Static model	Crude oil revenue	6.80	0.00

Source: Author's computation (using E-Views 7.0 software)

declining if the gas flaring increase as tested on this study. The coefficient of determination adjusted R^2 on the regression above indicate relatively the good fitness of the model thus, it signified that gas flaring and the tax accounted for 75% of all the variations in crude oil revenue. Thus, some other factors must be behind the remaining 25%. Specifically, the government policy is not reducing gas flaring in Nigeria but other factors like technology enhancement which this research did not take into account may also contribute to the reduction of gas flaring. One of the important reason for the companies that flare gas is that, the said oil companies find it cheaper to flare than to utilize it or harness it, therefore, they prepared to flare more of gas. Since the research shows that if flaring is reduced then oil revenue will increase then the government should control the flaring in other to yield more revenue. The tax introduced by government could not control the flaring since the parameter of the tax turned positive which indicate increase and not decrease. In that case, the government should either increase the amount for the penalty so that it will be cheaper for the companies to re-inject than to flare the gas. This will help the government to control the flaring of the gas and that will save the huge amount of money the government use to spend to control environmental hazard and degradation among others.

5. CONCLUSION

There is evidence of negative relationship between crude oil revenue and gas flaring which is the focus of this research. Thus, there is need to control the flaring of the gas provided the government of Nigeria is willing to improve crude oil revenue as seen from the parameters derived from the model of this study presented in Table 2. Even though the government of Nigeria imposed tax as penalty on the companies that flare gas for curtailing the flaring of the gas however, the ugly scenario persists since the companies find it less expensive to flare the gas than curtailing it. Thus, the study recommends the increase on the tax so that companies that flare gas will find it difficult to flare hence; flaring of gas could be reduced thereby resulting to an increase in crude oil revenue of Nigerian government.

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