**Appendices**

Appendix I: Profiles of the oil & gas companies in the sample

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| **Company** | **Profile** |
| CHEVRON NIGERIA LTD. (CNL)  | A company based in Lagos. It is a Joint Venture between Chevron and The Nigerian National Petroleum Corporation (NNPC) and is involved in oil and gas exploration and production activities in Nigeria. CNL is operating under Oil Mining Leases (OML) in Nigeria. |
| TEXACO OVER SEAS NIGERIA PETROLEUM COMPANY ULTD. (TOPCON) | A company based in Lagos. It is a Joint Venture between Chevron and The Nigerian National Petroleum Corporation (NNPC) and is involved in oil and gas exploration and production activities in Nigeria. TOPCON is operating Oil Mining Leases (OML) in Nigeria. |
| NIGERIAN AGIP OIL COMPANY LTD. (NAOC) | A company based in Lagos, is a Joint Venture between Agip, Phillips and The Nigerian National Petroleum Corporation (NNPC) and is involved in oil and gas exploration and production activities in Nigeria. NAOC is operating Oil Mining Leases (OML). |
| NIGERIAN AGIP EXPLORATION (AENR) | A company based in Lagos, is a Production Sharing Contract (PSC) between Agip and the Nigerian National Petroleum Corporation (NNPC). It is involved in oil and gas exploration and production activities in Nigeria. |
| MOBIL PRODUCING NIGERIA ULTD. - (MPNU) | A company based in Lagos, is a Joint Venture between ExxonMobil and The Nigerian National Petroleum Corporation (NNPC) and involves in oil and gas exploration and production activities in Nigeria. The company is operating Oil Mining Leases (OML) and Oil Prospecting Licenses (OPL). |
| ESSO EXPLORATION and PRODUCTION NIGERIA DEEPWATER WEST (EEPN) | This company is based in Lagos and is a Production Sharing Contract (PSC) between Esso and the Nigerian National Petroleum Corporation (NNPC). It is involved in oil and gas exploration and production activities in Nigeria. The company is operating Oil Prospecting Licenses (OPL). |
| SHELL PETROLEUM DEVELOPMENT COMPANY OF NIGERIA LTD (SPDC) |  A company based in Lagos, is a Joint Venture between Shell, Agip, Elf and The Nigerian National Petroleum Corporation (NNPC). The venture involves oil and gas exploration and production activities in Nigeria. SPDC is operating Oil Prospecting Licenses (OPL) and Oil Mining Leases (OML) in Nigeria. |
| ELF PETROLEUM NIGERIA LTD (EPNL) | A company based in Lagos, is a Joint Venture between Total/Elf and The Nigerian National Petroleum Corporation (NNPC) and involves in oil and gas exploration and production activities in Nigeria. |
| Pan Ocean | As a Joint Venture (JV) partner, the NNPC has 60 percent working interest in OML-98 while Pan Ocean has 40 percent. |
| The Nigerian Petroleum Development Company LTD. (NPDC)  | Is a fully-owned subsidiary of the Nigerian National Petroleum Corporation (NNPC). NPDC is engaged in oil & gas exploration and production activities in the hydrocarbon-rich regions of coastal Nigeria, both onshore and offshore; and more recently, around Equatorial Guinea. |
| ADDAX PETROLEUM DEVELOPMENT NIGERIA (APDN) LTD. | A company based in Lagos, is Nigerian subsidiary of ADDAX PETROLEUM and involved in oil and gas exploration and production activities in Nigeria. ADDAX PETROLEUM DEVELOPMENT NIGERIA LTD is operating Oil Prospecting Licenses (OPL) and Oil Mining Leases (OML) in Nigeria. It is a JV between ADDAX & NNPC |
| Source: Department of Petroleum Resources DPR 2010. |

# Appendix II: Equation for converting gas flared in volume to mass of CO2

Nigerian natural gas is scientifically classified as sweet, indicating that the major chemical composition (95% to 98%) is methane gas (CH4) (Maina, 2005). This implies that flaring of Nigerian associated natural gas is essentially combustion/burning of methane gas (Galadima & Garba, 2008). Therefore, flaring of Nigerian natural gas could be represented by equation 1 as follows.

$$CH\_{4 }+2O\_{2}→CO\_{2}+2H\_{2}O (1)$$

This equation means that burning of Nigerian natural in the presence of air will produce carbon dioxide ($CO\_{2}$) and water vapour ($2H\_{2}O$).

Thus, the following can be deduced from the equation.

1. 1 mole of methane (*CH4*) produces 1 mole of *CO2*on complete combustion.
2. 16.0g of *CH4* yields 44.0g of *CO2* on complete combustion (for 1 mole of $CH\_{4 }=16.0g$ of $CH\_{4 }$ and 1 mole of $CO\_{2}=44.0g$ of $CO\_{2}$)

**Assumptions;**

Let, mass of methane flared$ =M\_{m}$;

Volume of methane flared $=V\_{m}$ and

Mass of carbon dioxide produced $=M\_{c}$.

From (ii) above, it can be clearly stated that:

$$^{M\_{c}}/\_{M\_{m}}=^{44.0g}/\_{16.0g}$$

$$^{M\_{c}}/\_{M\_{m}}=2.75$$

Hence,

$M\_{c}=2.75M\_{m}$ (2)

By definition, the density of methane ($D\_{m}$) = mass of methane/volume of methane.

$$D\_{m}=^{M\_{m}}/\_{V\_{m}}$$

 Therefore, the volume of natural gas flared could be converted to mass as follows.

 $M\_{m}=D\_{m}V\_{m} $ (3)

Substitute equation (3) into equation (2) above to create relationship between $M\_{c}$ and $V\_{m}$ .

$M\_{c}=2.75D\_{m}V\_{m}$ (4)

 The density of methane is constant and has a standard value of **Dm = 0.717 Kg/m3**, therefore equations (4) can be reduced to the following form.

$M\_{c}=2.75 X 0.717 X V\_{m}$ (5)

Hence, Nigerian natural gas flared in volumes of cubic meter could be converted to carbon dioxide equivalent using the following equation (assuming 95% is made of up methane):

$M\_{c}=1.97175 X 0.95V\_{m}$(6)

Appendix III: Levin-Lin-Chu panel unit root test

|  |  |  |
| --- | --- | --- |
| **Variable** | **With Intercept** | **With Intercept & Trend** |
| **Coefficient** | **t-value** | **Coefficient** | **t-value** |
| ***CEP1*** | -0.25354 | -4.028\*\* | -0.82335 | -6.328\* |
| ***VDI*** | -0.52425 | -4.856\*\* | -0.90207 | -6.708\*\*\* |
| ***SDI*** | -0.34959 | -4.442\*\*\* | -1.10414 | -8.185\*\*\* |
| ***GUI*** | -0.39130 | -7.885\*\*\* | -0.75995 | -9.568\*\*\* |
| ***GPR*** | -1.22222 | -7.276\*\*\* | -1.95556 | -10.3\*\*\* |
| ***LOG\_OL*** | -0.27732 | -2.04\* | -0.97292 | -3.805\* |
| ***GOR*** | -1.07898 | -2.593\* | -1.79319 | -2.545\* |

H0: TS-CS variable is nonstationarity.

Two other variables (Gas Produced and Crude Oil Price) were found to be non-stationary in level and were excluded from the analysis to avoid complication and misleading results.

\*Significant at 10%

\*\*Significant at 5%

\*\*\*Significant at 1%

Appendix IV: Aggregate crude oil production in Nigeria

|  |  |  |
| --- | --- | --- |
| **Year** | **Crude Oil Produced in Barrels**  | **% of Crude Oil Produced by the Sample** |
| **Study Population/ Sample** | **Nigeria** |
| 1997 | 850,503,745.00 | 855,736,287.00 | 99.39 |
| 1998 | 793,898,485.00 | 806,443,999.00 | 98.44 |
| 1999 | 756,427,048.00 | 774,703,222.00 | 97.64 |
| 2000 | 794,104,915.00 | 828,198,163.00 | 95.88 |
| 2001 | 830,082,702.00 | 859,627,242.00 | 96.56 |
| 2002 | 695,254,970.00 | 725,859,986.00 | 95.78 |
| 2003 | 813,047,014.00 | 844,100,267.00 | 96.32 |
| 2004 | 866,835,027.00 | 911,044,764.00 | 95.15 |
| 2005 | 880,689,241.00 | 918,972,465.00 | 95.83 |
| 2006 | 719,700,190.00 | 869,196,506.00 | 82.80 |
| 2007 | 713,778,640.00 | 803,000,708.00 | 88.89 |
| 2008 | 669,397,107.00 | 768,745,932.00 | 87.08 |
| 2009 | 632,277,799.00 | 780,347,940.00 | 81.03 |
| Total | 10,015,996,883.00 | 10,745,977,481.00 | 93.21 |
| Average | 770,461,298.69 | 826,613,652.38 | 93.21 |