Asymmetric Cointegration and Causality between Natural Gas Consumption and Economic Growth in Nigeria

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Abstract
This paper investigates asymmetric cointegration, asymmetric adjustment, and causality between natural gas consumption and economic growth in Nigeria using the momentum threshold autoregressive (M-TAR) model and the Granger-causality test in a momentum threshold error correction model (M-TECM). The results revealed evidence of asymmetric cointegration, asymmetric adjustment which suggests that the negative discrepancies from the equilibrium error adjust more rapidly than the positive discrepancies and that there is bidirectional causality between the two variables. The implication of the results is that a shock that decreases the impact of natural gas consumption on economic growth adjusts more rapidly than a shock that increases it and that a consistent natural gas supply increases growth and similarly a rise in growth leads to rise in natural gas consumption. Therefore, policymakers in Nigeria need to confine more attention to the shocks stemming from the decrease in natural gas consumption and the country should adopt energy exploration policies.

Keywords: Asymmetric Cointegration, Asymmetric Adjustment, Causality, Natural Gas Consumption, Economic Growth

INTRODUCTION
Since the oil boom of the early 1970s, the relationship between energy consumption and economic growth has become an issue of discussion in the literature (Zhixin and Xin, 2011). However, studies on energy consumption often tend to evaluate whether the economic benefits
from high energy consumption can neutralize the externalities generated by its consumption and other energy-related economic activities (Adelman, 1993). A plethora of econometric techniques have been employed by various studies to investigate the relationship between natural gas consumption and economic growth across the world. Nonetheless, only little attention has paid to Africa and in particular Nigeria which is construed as the economic giant of the continent. This paper is a didactic attempt to examine asymmetric cointegration and causality between natural gas consumption and economic growth in Nigeria using the momentum threshold cointegration tests of Enders and Siklos (2001) with asymmetric error-correction process. To the best of the authors’ knowledge this is the first paper to use such technique over non-linear cointegration and causality between natural gas consumption and economic growth in Nigeria. These techniques can be deemed more robust statistically than the traditional linear cointegration tests with symmetric adjustment if the true adjustment process is asymmetric (Woo and Jia, 2013). In addition, the momentum threshold cointegration method allows the model to display differing speeds of autoregressive decay depending upon whether the changes in discrepancies from equilibrium are climbing up or falling down (Enders and Siklos, 2001). The analysis of threshold adjustment is supportive to smooth out the large fluctuations.

However, the specific objectives of this paper is to examine nonlinear dynamics between natural gas consumption and economic growth in Nigeria, to investigate the causal relationship between natural gas consumption and economic growth and to offer policy recommendations based on the findings of the paper.

The paper is structured into five sections, namely, the introduction, literature review methodology, empirical results and conclusion.
LITERATURE REVIEW

The literature on the relationship between natural gas consumption and economic growth can be categorized into four aspects. The first aspect relates to unidirectional growth hypothesis, the second aspect relates to the conservation hypothesis, the third aspect postulates bidirectional hypothesis and is termed as “feedback” hypothesis; the last aspect is based on neutral hypothesis which delineates no causality between natural gas consumption and economic growth. Among these studies, Lee and Chang (2005) have analyzed energy consumption and economic growth in Taiwan from 1954 to 2003. The variables used are the coal, oil, natural gas consumption, electricity and GDP. Using weak exogeneity test and Johansen cointegration techniques they found unidirectional causality running from natural gas consumption to economic growth. Zamani (2007) investigates the relationship between energy consumption and economic activities in Iran for the period 1967 – 2003. The variables used are the real GDP and Natural gas consumption. Using Johansen cointegration test and VECM granger causality approach, evidence of cointegration and bidirectional causality has been observed between the two variables. Olusegun (2008) has examined the relationship between energy consumption and economic growth in Nigeria for the period 1970 – 2005. The variables used are: Total energy consumption, oil consumption, gas consumption, electricity consumption, and gross domestic product. Using ARDL model and Toda & Yamamoto (1995) non-causality test he found no evidence of cointegration between natural gas consumption and economic growth but only a unidirectional causality running from natural gas consumption to economic growth. Apergis and Payne (2010) investigated the relationship between natural gas consumption and economic growth for a panel of 67 countries within a multivariate framework from 1992-2005. The variables adopts include real GDP, natural gas consumption, real gross fixed capital formation,
and labor force. Using Pedroni’s (1999, 2004) heterogeneous panel cointegration test, they found a long-run equilibrium relationship between these variables. Moreover, they noted that the bidirectional causality between natural gas consumption and economic growth in is found.

Adegbemi et al. (2013) evaluate the causal nexus between energy consumption and economic growth in Nigeria from 1975 to 2010. The variables used are economic growth, total energy consumption, petroleum, natural gas, electricity, and coal. Using Johansen cointegration test and ordinary least square (OLS) techniques they obtained evidence of cointegration between gas consumption and economic growth. Sahbi and Muhammad (2014) have examined the role of natural gas consumption and trade in Tunisia for the period 1980 – 2010. The variables used are gas consumption, GDP, trade and real gross fixed capital formation. Using ARDL model and Toda-Yamamoto (1995) approach they found evidence of cointegration and bidirectional causality between GDP and gas consumption. Shahbaz et al. (2014) have pored over the dynamic relationship between natural gas consumption and economic growth in Pakistan using quarterly data from 1972Q1 to 2011QIV. The variables used are the Natural gas consumption, labour, capital and economic growth. They employed ARDL model and Granger causality test and found evidence of cointegration and bidirectional causality between natural gas consumption and economic growth.

**METHODOLOGY**

The paper adopts the Momentum Threshold Autoregressive Model (M-TAR) and Momentum Threshold Error Correction Model (M-TECM) based Granger Causality were employed to investigate the relationship. The data used is an annual time series data collected through secondary sources consisting of 35 observations. The choosing variables are real GDP and natural gas consumption while following Apergis and Payne, (2010); Kum et al. (2012); Shahbaz
 et al. (2014); Dogan (2015), labour and capital were added as additional determinants of economic growth and natural gas consumption. The data real GDP data, labour, and capital were sourced from the World Bank Development Indicators (2016) statistical bulletin while that of natural gas consumption was sourced from the Organization of Petroleum Exporting Countries (2016) statistical bulletin.

The econometric specification of the model takes the following form:

\[
\Delta \mu_t = \rho_1 I_t \mu_{t-1} + \rho_2 (1 - I_t) \mu_{t-1} + \nu_t
\]

(1)

where

\[
I_t = \begin{cases} 
1 & \text{if } \mu_{t-1} \geq \tau \\
0 & \text{if } \mu_{t-1} < \tau 
\end{cases}
\]

(2)

\(I_t\) denotes the heaviside indicator, \(\rho_1\) and \(\rho_2\) represent the speed of adjustment coefficients in the two regimes, \(\tau\) is the value of the threshold, and \(\nu_t\) is the error term which is independent of \(\mu_j (j < t)\). The consistently estimated value of \(\tau\) which is called attractor since \(\Delta \mu_t\) has an expected value of zero when \(\mu_{t-1} = \tau\), can be searched for from equation (1). Adjustment in the series is said to be symmetric if \(\rho_1 = \rho_2\), otherwise it is asymmetric. Nevertheless, it is noteworthy that from equation (2), the TAR model allows \(\mu_t\) to display differing amounts of autoregressive decay depending on whether its previous value \(\mu_{t-1}\) is greater or smaller than the threshold value.

Enders and Siklos (2001) appealed that equation (1) may not be sufficient to capture the dynamic adjustment of \(\mu_t\) towards the long run equilibrium value. However, in working with time any time series model, it is essential to ensure that the errors approximate a white-noise process. Enders-Siklos shows that the different amounts of autoregressive decay depend on whether the
previous change in $\mu_{t-1}$ is climbing up or falling down, and since the exact nature of the nonlinearity might be unknown, it is possible to allow the adjustment to depend on the change in $\mu_{t-1}$ (i.e. $\Delta \mu_{t-1}$) instead of the level of $\mu_{t-1}$ (Hu and Lin, 2013). Enders and Skilos (2001) argued that a convenient way is to augment (1) with lagged changes in the $\mu_t$ sequence and this give birth to the momentum threshold autoregressive (M-TAR) model with the following specification:

$$\Delta \mu_t = \rho_1 M_t \hat{\mu}_{t-1} + \rho_2 (1 - M_t) \hat{\mu}_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta \hat{\mu}_{t-i} + \nu_t$$

(3)

where

$$M_t = \begin{cases} 1 & \text{if } \Delta \mu_{t-1} \geq \tau \\ 0 & \text{if } \Delta \mu_{t-1} < \tau \end{cases}$$

(4)

The $M_t$ represents the heaviside indicator. The M-TAR adjustment i.e. $p_1$ and $p_2$ can be especially useful when policy makers are viewed as attempting to smooth out any large changes in series under investigation (Enders and Siklos (2001). For example, Nigerian authorities might take strong measures to offset shocks in natural gas consumption if such shocks are considered to induce decrease in natural gas consumption by widening the discrepancies in the relationship between natural gas consumption and economic growth in Nigeria.

According to Enders and Siklos (2001), to test the threshold cointegration there are two sequential steps to follow – one is to test for the linear cointegration and the other one is to test for the nonlinear adjustment process. The first step is the cointegration test which tests the null hypothesis that $\rho_1 = \rho_2 = 0$ using the $F$-statistic. But, the $F$-statistic is non-standard under the null hypothesis and, the corresponding critical values are those of Enders and Siklos (2001) obtained from simulation and are found in Table 5 of Enders and Siklos (2001). If the $F$-joint statistic is greater than the critical values which implies rejection of the null hypothesis of no cointegration,
then the null hypothesis of whether there is symmetric adjustment i.e. $\rho_1 = \rho_2$ with the standard $F$- statistic, which in this paper is represented by $F$-equal. The $F$-equal is used to test the null hypothesis of symmetric adjustment behavior against the alternative of asymmetric adjustment in the series. If the null hypothesis of $\rho_1 = \rho_2$ is rejected, then there asymmetric adjustment in the series or in other words, there is asymmetric cointegration between the series. Moreover, the above threshold coefficient ($\rho_1$) accounts for the positive phase of the natural gas consumption disequilibrium while the below threshold coefficient ($\rho_2$) accounts for the negative phase of the natural gas consumption disequilibrium (Aviral and Mihai, 2016).

**The Momentum Threshold Error Correction Model (M-TECM)**

After testing for cointegration, the next thing is to examine speed of adjustment in the system and by extension test for the causal relationship among the series. It is noteworthy that as distinct from the conventional Granger causality test which is conventionally applied to check for linear causality, in this case the paper adopts the momentum threshold error correction model (M-TECM) and thus, nonlinear/asymmetric error-correction model (NECM). This will be used to estimate the long run cointegration adjustment – expansionary (increase) and contractionary (decrease) and to test for Granger nonlinear causality. Using equation (5), the long run adjustment of the nonlinear cointegration relation are to be measured based on the coefficients of $\rho_{1y}$ and $\rho_{2y}$.

The momentum error correction model M-TECM is:

$$
\Delta \log y_t = a_0 + M_1 \rho_{1y} \mu_{t-1} + (1-M_1) \rho_{2y} \mu_{t-1} + \sum_{i=1}^{r} a_{1i} \Delta \log y_{t-j} + \sum_{i=1}^{r} a_{2i} \Delta \log G_{t-j} + \sum_{i=1}^{r} a_{3i} \Delta \log L_{t-j} + \sum_{i=1}^{r} a_{4i} \Delta \log K_{t-j} + \epsilon_t
$$

(5)

where $\alpha_0$ is the intercept, $\rho_{1y}$ and $\rho_{2y}$ are the asymmetric adjustment coefficients to be estimated for positive and negative deviations from the long run equilibrium. The coefficients on the
lagged asymmetric error correction terms i.e. \( \rho_1 \) and \( \rho_2 \) represent the long-run adjustment back to equilibrium whereas the coefficients on the lagged differences for the variables denote the short-run dynamics.

The optimal lag order is \( r \) chosen based on the model criterion, and \( \varepsilon_i \) is the error term that is assumed to be white-noise. The significance of the coefficients \( \rho_1 \) and \( \rho_2 \) depends on the value of \( \tau \). If the value of \( \tau \geq \rho_1 \), it implies that the upper regime is significant and, if the value of \( \tau < \rho_2 \), it means the lower regime is significant. Woo and Jia (2013) viewed that M-TAR adjustment can be especially useful when policy makers are viewed as attempting to smooth out any large changes in a series and therefore, authorities might take strong measure to offset shocks to the natural gas consumption if such shocks are deemed as significant enough to influence the relationship between natural gas consumption and economic growth and how the response variable deviates from equilibrium in the shortrun.

**The Granger-Causality Test in a Momentum Threshold Error Correction Model**

The evidence of causality is useful for policy makers. If natural gas consumption causes economic growth, information on natural gas consumption should offer valuable predictive power about economic growth and then it can help policy makers to predict future economic growth. Similarly, if economic growth causes natural gas consumption, information on economic growth should offer valuable predictive power about natural gas consumption and then it can help policy makers to predict future natural gas consumption.

However, Granger causality causality test in this paper is based on the following specification:

\[
\hat{\Delta \log y_t} = \hat{a}_0^M + M^\prime \hat{\rho}_1^M \hat{\mu}_{t-1} + (1-M_t) \hat{\rho}_2^M \hat{\mu}_{t-1} + \sum_{i=1}^{r} a_{1i} \hat{\Delta \log Y_{t-j}} + \sum_{i=1}^{r} a_{2i} \hat{\Delta \log G_{t-j}} + \sum_{i=1}^{r} a_{3i} \hat{\Delta \log L_{t-j}} + \sum_{i=1}^{r} a_{4i} \hat{\Delta \log K_{t-j}} + \varepsilon_{1t}
\]  
(6)
\[
\Delta \log G_t = \hat{\beta}_0 + M_t \text{log}_G \mu_{t-1} + (1 - M_t) \rho_{2G} \mu_{t-1} + \sum_{i=1}^r \hat{\rho}_{1i} \Delta \log G_{t-j} + \sum_{i=1}^r \beta_{2i} \Delta \log Y_{t-j} + \sum_{i=1}^r \beta_{3i} \Delta \log L_{t-j} + \sum_{i=1}^r \beta_{4i} \Delta \log K_{t-j} + \varepsilon_{2t}
\] (7)

where \( \alpha_0 \) and \( \beta_0 \) are the intercepts, and \( \rho_{1y}, \rho_{2y}, \rho_{1G}, \rho_{2G} \) are the asymmetric adjustment coefficients to be estimated. The optimal lag order will be determined / chosen based on the value of \( r \) from the model. The \( \varepsilon_{1t} \) and \( \varepsilon_{2j} \) are error terms that are assumed to be white-noise disturbances. The equation (6) will be used to test for causality between the series. The hypothesis to be tested is: \( H_0 : \rho_{1y} = \rho_{2y} = \alpha_{2j} = 0 \), against \( H_1 : \rho_{1y} = \rho_{2y} \neq 0 \) for all \( j \) with the standard Wald statistic. The inclusion of \( \rho_{1y} = \rho_{2y} = 0 \) in the causality test is because of the inclusion of \( \log G \) series in the previous period’s disequilibrium denoted as \( \mu_{t-1} \) (Woo and Jia, 2013). If the Wald statistic indicates rejection of the null hypothesis that \( \log G \) does not Granger-cause \( \log Y \), then \( \log G \) Granger causes \( \log Y \). However, the direction of causality from \( \log Y \) to \( \log G \) can equally be tested using equation (7) under the null hypothesis: \( \rho_{1G} = \rho_{2G} = \beta_{2j} = 0 \), for all \( j \). Similarly, the inclusion of \( \rho_{1G} = \rho_{2G} = 0 \) in the causality test is due to the inclusion of \( \log Y \) series in the previous period’s disequilibrium \( \mu_{t-1} \). If the standard Wald statistic can indicates rejection of the null hypothesis that \( \log Y \) does not Granger-cause \( \log G \), then it can be inferred that \( \log Y \) Granger causes \( \log G \).

**RESULTS AND ANALYSIS**

The Momentum Threshold Autoregressive (M-TAR) Non-linearity Test

To allow for the possibility of nonlinearity in the adjustment process, the paper uses the \( F \)-joint test from the M-TAR model to examine asymmetric cointegration between the variables.

The hypothesis to be tested is:
H₀: There is no asymmetric cointegration between natural gas consumption and economic growth in Nigeria.

H₁: There is asymmetric cointegration between natural gas consumption and economic growth in Nigeria.

**Table 1: The Asymmetric Cointegration Test**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Threshold</td>
<td>-0.181908</td>
<td>0.147451</td>
</tr>
<tr>
<td>Below Threshold</td>
<td>-1.628933</td>
<td>0.254825</td>
</tr>
<tr>
<td>Differenced Residuals(t-1)</td>
<td>0.010264</td>
<td>0.136772</td>
</tr>
<tr>
<td>Threshold value (tau):</td>
<td>-0.077515</td>
<td></td>
</tr>
<tr>
<td>F-equal:</td>
<td>23.943420</td>
<td>(8.313637)*</td>
</tr>
<tr>
<td>T-max value:</td>
<td>-1.233685</td>
<td>(-2.176070)*</td>
</tr>
<tr>
<td>F-joint (Phi):</td>
<td>21.275560</td>
<td>(9.015526)*</td>
</tr>
</tbody>
</table>

Source: Researchers’ computation

*Simulated critical values for 5% significance level

Number of simulations: 10000

Elapsed simulation time: 0 hours 1 minute 55 seconds.

From Table 1 above, it can be observed that the null hypothesis $\rho_1 = \rho_2 = 0$ of no asymmetric cointegration can be rejected at 5% level. Moreover, it can be observed that the null hypothesis $\rho_1 = \rho_2$ of symmetric/linear relationship between the variables can be rejected at 5% level.

Hence, the variables are cointegrated and that the adjustment mechanism is asymmetric.

From the table, the threshold value is -0.077515 and this is an appealing result considering the fact that the value is very close to zero. It can be seen that the above threshold coefficient is not significant while the below threshold coefficient is significant at 1% level. However, the negative sign in both the $\rho_1$ and $\rho_2$ suggest convergence and since $|\rho_1| < |\rho_2|$, then the negative discrepancies from the equilibrium error adjust more rapidly than the positive discrepancies.
The implication of the results is that a shock that decreases the impact of natural gas consumption on economic growth adjusts more rapidly than a shock that increases it. Therefore, policymakers in Nigeria need to confine more attention to the shocks stemming from the decrease in natural gas consumption.

However, the estimates form equations (3.17) and (3.18) are:

$$
\Delta \mu_t = -0.181908 M_t \mu_{t-1} -1.628933(1-M_t) \mu_{t-1} +0.010264 \Delta \mu_{t-1} + v_t
$$

where $M_t = \begin{cases} 
1 & \text{if } \Delta \mu_{t-1} \geq -0.077515 \\
0 & \text{if } \Delta \mu_{t-1} < -0.077515 
\end{cases}$

**The Momentum Threshold Error Correction (M-TEC)**

Since the long-run relationship (i.e., cointegration) between the test variables holds, an asymmetric error-correction model can be used to investigate the movement of variables to the long-run equilibrium relationship. It is worth noting that after estimation, one could trim down the number of lags to check whether the results could be more statistically robust in order to ensure statistical adequacy of the model.

**Table 2: The Momentum Threshold Error Correction Results**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.929985</td>
<td>0.403172</td>
<td>-2.306674</td>
<td>0.0293</td>
</tr>
<tr>
<td>DLOGY(-1)</td>
<td>0.153520</td>
<td>0.147119</td>
<td>1.043503</td>
<td>0.3063</td>
</tr>
<tr>
<td>DLOGG</td>
<td>-0.001288</td>
<td>0.038149</td>
<td>-0.033775</td>
<td>0.9733</td>
</tr>
<tr>
<td>DLOGL</td>
<td>36.90727</td>
<td>15.61977</td>
<td>2.362856</td>
<td>0.0259</td>
</tr>
<tr>
<td>DLOGK</td>
<td>0.112261</td>
<td>0.043117</td>
<td>2.603668</td>
<td>0.0150</td>
</tr>
<tr>
<td>ZPLUS</td>
<td>-0.195899</td>
<td>0.173984</td>
<td>-1.125961</td>
<td>0.2705</td>
</tr>
<tr>
<td>ZMINUS</td>
<td>-0.830275</td>
<td>0.190633</td>
<td>-4.355363</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

Source: Researchers’ computation
Table 2 above reports the estimate of the momentum threshold error correction model (M-TECM). It presents the nonlinear short run coefficients and the speed of adjustment of the asymmetric cointegrating relationship. From the table, it can be observed that the coefficients of the lagged value of economic growth and natural gas consumption are insignificant and thus, not contributing to economic growth in the short run. This statistically insignificant link between natural gas consumption and economic growth in the short-run is not quite surprising due to the fact that growth and the gas sector development do require time and resources to develop. Hence, the impact might not be felt immediately in the short run. However, the coefficients of labour and capital are both statistically significant at 5% level which implies that the two variables contribute to economic growth in the short run. The $z$-plus and $z$-minus are the asymmetric long run speed of adjustment parameters which measure the speed at which the model adjusts to the long run equilibrium whenever there is disequilibrium in the short run. In the model, they are denoted as $\rho_{\delta Y}$ and $\rho_{2Y}$. Nonetheless, from Table 2 it can be gleaned that both the coefficients of $\rho_{\delta Y}$ and $\rho_{2Y}$ have the correct mathematical sign (negative) but only the latter is statistically significant. Error correction terms indicate that 20% of positive deviations are eliminated per year during the increase/ positive shocks whereas negative deviations are eliminated at a rate of 83% during same time frame. Moreover, these adjustment coefficients indicate that any short-run deviations from the steady-state equilibrium during period of high natural gas consumption will take 5.1years to automatically correct / adjust to the long-run equilibrium while in the period of low natural gas consumption it takes 1.2years to adjust. This implies that the speed of adjustment towards steady-state equilibrium in the lower regime is faster than in the higher regime.
The estimates of the M-TEC model are as follows:

\[
\Delta \log y = -0.929985 - 0.195899 \, M_t \mu_t - 1 - 0.830275(1 - M_t) \mu_t - 1
\]

\[
+ a_{11}(L)\Delta \log Y_{t-1} + a_{12}(L)\Delta \log G + a_{13}(L)\Delta \log L + a_{14}(L)\Delta \log K + \varepsilon_t
\]

where \( L \) is the lag operator, t-statistics are in parentheses, \( F_{ij} \) is the prob-value that all coefficients in the polynomial \( aij(L) = 0 \), and \( M_t \) is the M-TAR indicator.

Having confirmed the presence of cointegration in the relationship with its long run adjustment, the paper can now focus on testing for causality between natural gas consumption and economic growth. As previously discussed, the will examine the causal effect between natural gas consumption and economic growth under the null hypothesis \( \rho_{1y} = \rho_{2y} = \alpha_{2j} = 0 \) and from economic growth to natural gas consumption under the null hypothesis \( \rho_{1G} = \rho_{2G} = \beta_{2j} = 0 \) for all \( j \) with the aid of standard Wald test. The results are reported in Table 3 below.

**Table 3: The Non-linear Granger Causality Test**

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Wald Statistics</th>
<th>p-value</th>
<th>Direction of Causality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log G does not Granger cause Log Y</td>
<td>6.888641</td>
<td>0.0014*</td>
<td></td>
</tr>
<tr>
<td>Log Y does not Granger cause Log G</td>
<td>6.688400</td>
<td>0.0017*</td>
<td>↔</td>
</tr>
</tbody>
</table>

Source: Researchers’ computation

Note: * denotes the statistical significance at 1% level of significance with t-statistics in ( ) and p-values in [ ] while ↔ means bidirectional causality.

Table 3 above shows the evidence of bidirectional causality between natural gas consumption and economic growth. Therefore, the null hypothesis that natural gas consumption does not Granger cause economic growth and the null that economic growth does not Granger cause natural gas consumption are rejected at 1% level of significance.

The implication of the results is that a consistent natural gas supply increases growth and similarly a rise in growth leads to rise in natural gas consumption. Therefore, policymakers in Nigeria should adopt energy exploration policies.
CONCLUSION AND POLICY RECOMMENDATION

This paper has investigated asymmetric cointegration, asymmetric adjustment, and causality between natural gas consumption and economic growth in Nigeria from 1981 to 2015. The paper has employed the Momentum Threshold Autoregressive (M-TAR) model to examine non-linear dynamics between natural gas consumption and economic growth in Nigeria. It further implements Granger-causality test based on the Momentum Threshold Error Correction Model (M-TECM) to investigate the causal relationship between the series. The results revealed evidence of asymmetric cointegration, asymmetric adjustment which suggests that the negative discrepancies from the equilibrium error adjust is more rapidly than the positive discrepancies and that there is bidirectional causality between the two variables. The implication of the results is that a shock that decreases the impact of natural gas consumption on economic growth adjusts more rapidly than a shock that increases it and a consistent natural gas supply increases growth and similarly a rise in growth leads to rise in natural gas consumption. Therefore, policymakers in Nigeria need to confine more attention to the shocks stemming from the decrease in natural gas consumption and the country should adopt energy exploration policies.
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