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MODELLING THE OKUN'S LAW IN THE MIDST OF STRUCTURAL BREAKS: EVIDENCE FROM NIGERIA

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Abstract

Purpose
This study aims to examine the relationship between economic growth and unemployment in Nigeria, specifically investigating the validity of Okun's law.
Design/methodology/approach
The study employs both linear and non-linear specifications using quarterly data from 1991Q1 to 2019Q1. Cointegration techniques that account for structural breaks are applied.
Findings
Unemployment and economic growth are found to be cointegrated. Both linear and non-linear specifications show a positive relationship between growth and unemployment, but the impact of unemployment on growth is not statistically significant. The study concludes that the growth experienced in Nigeria during the study period did not lead to reduced unemployment, thus invalidating Okun's law.
Research limitations/implications
The study's findings are based on data up to 2019Q1 and may not reflect more recent trends. The analysis relies on the accuracy and reliability of the data sources used.
Originality/value
This study contributes to the understanding of the relationship between economic growth and unemployment in Nigeria, highlighting the need for policies targeting sectors with high employment potential.

Keywords: Growth, Cointegration, Linear and non-linear dynamics, Nigeria, Okun's law, Unemployment

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1. INTRODUCTION

Okun's Law (Okun, 1962) describes how unemployment can fall by a fixed ratio as output grows above a certain rate and thus important in understanding the association between growth and unemployment in the short-run. Two versions were estimated by Okun on the unemployment-production relationship, i.e.(1) The "difference" version, which relates the change in output (expressed as a change in the logarithm of real GDP) to changes in the unemployment rate: $\Delta u_t = a + \Delta y_t$; (2) The "gap" version, which relates the difference of actual unemployment with respect to its natural value to the output gap: $ut = c + d*Outputgap_t$.Using quarterly data from 1947 to1960for the United States, Okun concluded that one percentage point increase in output leads to a decrease in unemployment by around 0.3 percentage points.

However, Okun noted that potential problems could arise because of the simplicity of the equations, and was therefore of the view that current unemployment level can be influenced by past and current level of output. In light of this, economists have proposed variations in Okun's original relationships. Thus, in the difference version, it would mean that some important regressors have been omitted. Essentially therefore, the *dynamic versions* have been widely used. For example, in the dynamic version, the dependent variable has current change in the unemployment rate, while past growth in real output including changes in past rate of unemployment are explanatory variables, the latter as a means to address serial correlation in the error terms which are preponderant when difference values are utilized.

Different methodologies have been deployed in the economic literature to evaluate the Okun's law (for a review, see Knotek, 2007). Most of them used linear techniques. Only a few have deployed the non-linear frameworks. For the latter, different techniques have been used to estimate and control for asymmetry. For instance, Busetta and Corso (2012) used the Heaviside step function where growth rate is split into positive and negative effects. Similarly, Kim et al. (2020) examined the Okun's law for the ASEAN-6, using time-varying parameter model to simultaneously consider nonlinearity, and found that except for Thailand, Philippines, and Malaysia, the Okun's law is not valid. Huang and Lin (2005) deployed the Flexible Nonlinear Inference on unemployment and output data on the United States economy from 1948:1-2004:2. The study found overwhelming evidence of nonlinearity and inverse relationship between cyclical components of unemployment and output, thus providing strong support of the existence of non-linear relationship and the Okun's law.

This paper is however novel in its econometric contribution to the literature investigating the Okun's law on the Nigerian economy, despite the several empirical investigations conducted, albeit with mixed results (e.g. Shodipe & Ogunrinola, 2011; Babalola et al., 2013; Onwioduokit, 2013; Bankole & Fatai, 2013; Abraham, 2014; Adeyeye et al., 2017; Abu, 2017; Salisu, 2018). None to the best of our knowledge incorporated structural breaks in both the linear and non-linear techniques used. Importantly, while linear frameworks are attractive, the results can be misleading when in fact the underlying series are non-linearly related. This is even more imperative given that the relationship that exists between macroeconomic variables could be nonlinear (Enders & Siklos, 2001; Tang & Bethencourt, 2015). Thus this paper differs from previous studies on Nigeria, by considering linear and non-linear techniques in the midst of structural breaks. With a non-linear framework, one is able to determine the separate effect of either a positive or negative change in growth on unemployment.

Subsequent to the introduction, the paper is organized as follows. Related literature is reviewed in Section 2. Data and methodology are presented in Section 3. The results and ensuing discussion are in Section 4. The conclusion is contained in Section 5.

2. LITERATURE REVIEW

2.1 Theoretical Literature

Modern macroeconomics is usually divided into two main areas, i.e. the long run theory and the short-run theory. While the long run theory is concerned with the analysis of economic growth, the short run theory deals with business cycles. Because in the long run, emphasis is on full-employment, the analysis of unemployment is thus the preserve of the short run business cycle theory. Solow (1956), regarded as a standard growth model, predicts that growth rate is independent of unemployment rate. However, Okun (1962) provided a basis for a negative relationship between the rate of change in unemployment rate and output. In numerical terms, Okun reported that a 1 percentage point reduction in unemployment rate was associated with a 3 percentage point increase in output for the economy of the United States.

However, in view of the experience of several countries, it has been pointed out that apart from being a short term issue, unemployment can also be a medium term phenomenon. In essence, modern economies experience medium term changes that short run or long run macroeconomic subdivisions are difficult to explain. This has led to scholars calling for the development of macroeconomics of the medium-run (see Blanchard, 1997), a call supported by Solow (2000) in which he suggested the integration of the Okun's law and growth models. It needs to be noted that the law has so far remained an empirical observation rather than one derived from theory, although some scholars such as Prachowny (1993) have attempted to provide a theoretical basis.

2.2 Empirical Literature

The empirical investigation of the Okun's law is well documented, while different methodologies have been employed in the economic literature to investigate its validity. The empirical literature is reviewed in three strands, namely single country studies, panel studies, and the studies on Nigeria. In the first strand bordering on single country investigations, Singh and Nurudeen (2022) studied the applicability of Okun's law in China using data from 1991 to 2020. Youth unemployment and urban unemployment were used as proxies of unemployment rate. The study reported that Okun's law is valid. Al-Sawaie (2020) in a study on Jordan from 1976 to 2018, and deploying the Autoregressive Distributed Lag cointegration and Causality tests to uncover the relationship between unemployment and economic growth reported an inverse relationship while finding bidirectional causality. Three countries, namely Nigeria, South Africa, and the United States of America were examined for the Okun's law validity by Onakoya and seyingbo (2020). Results from the Ordinary Least Squares technique found relevance for the dynamic version of the Okun's law, although in the case of Nigeria, evidence from the difference version indicated that there was no significant relationship between economic growth and unemployment.

On the economy of Saudi Arabia, and using the autoregressive distributed lag bounds test, Louail and Riache (2019) found that a 1% rise in GDP is associated with a 0.29% fall in unemployment rate, thus validating the Okun's law. A study by Altunöz (2019) on the real output-unemployment rate link in the Eurozone from 2000 to 2012revealed that Okun's Law was valid, although the co-integration coefficient was lower than the Okun's coefficient obtained in other studies for the developed countries. The US was included in the sample, being the strongest economy in the world in addition to developing countries, due to their relatively higher growth and unemployment volatilities.

The nexus between unemployment and growth on the manufacturing industry in Turkish was examined by Bariş-Tüzemen and Tüzemen (2019), using quarterly data

spanning 2005 to 2017. Cointegration was not found between unemployment and growth in the manufacturing industry, a result that was buttressed by the symmetric causality test, thereby indicating the non-validity of Okun's law. Despina (2019) investigated whether youth and total unemployment rates and GDP growth have a relationship in North Macedonia, deploying the Autoregressive Distributed Lag Model, from 1991 to 2017. A significant relationship was reported in the long-run between total unemployment and GDP.

Using quarterly data from 1994Q1 to 2016Q4 and the ARDL model, Makaringe and Khobai (2018) explored the influence of unemployment on economic growth in South Africa and reported that while unemployment and economic growth are cointegrated, an inverse relationship was found between the variables in both the long run and the short run. Acaroğlu (2018) investigated the Okun's Law in G-20 countries from 1991 to 2014. While the Okun's law relationship was found for most of the countries, the reverse was the case for Indonesia, China, Turkey and Saudi Arabia. The study concluded that the Okun's coefficients in the G-20 countries differ based on their output heterogeneities and development structure. Pata et al. (2018) examined the nexus between GDP and unemployment in Turkey, covering quarter 2of 2006 to quarter 4 of 2014. Results of the causality tests indicated that in the short term, there was a negative unidirectional causation from GDP to unemployment rates.

Garavan (2017) examined whether the growth-unemployment relationship continued to hold during troubled economic times for the Eurozone from 2002 to 2013. Validating the Okun's law, the relationship was found to be asymmetric, as positive and negative growth rates had statistically different short-run relationships with unemployment. Chand et al. (2017) in a study on India found evidence of the Okun's law and reported that GDP accounted for 48% of the change in the unemployment rate. Dixon al. (2017) examined the evidence for the Okun law for the period 1985–2013 in OECD countries and found that a rise in economic growth decreases the aggregate unemployment rate, including the distributional effect of reducing youth unemployment. Banda (2016) in a study on South Africa reported that while there is a long-run relationship between unemployment and economic growth, there is however a positive relationship between the variables, and thus inconsistent with the Okun's law. Sadiku et al. (2015) deployed four types of models, i.e. difference model, dynamic model, ECM, and VAR) to examine the unemployment-growth nexus in Macedonia from 2000 to 2012. The study concluded that there is no clear proof in support of the Okun's law.

In the second strand of literature, which deals with panel studies, several empirical panel studies have been done on the Okun's law. In a study on the Eurozone, Altunöz (2019) examined the relationship between economic growth and unemployment from 2000-2012, using panel integration techniques and the results suggested that the Okun law is valid in the period of investigation. Soylu et al. (2018) examined the relationship between economic growth and unemployment in Eastern European countries from 1992 to 2014, using Pooled Panel OLS and Panel Johansen Co-integration tests and found that a 1% rise in GDP reduced unemployment by 0.08%. Similarly, Nebot et al. (2019) examined four countries in Europe, namely Germany, France, Spain and the Netherlands. Without any imposition of as specific functional form, the authors used a nonparametric procedure which identifies possible regimes with several thresholds endogenously. The framework also controlled for the Euro area crisis which might have effects on domestic unemployment rate variations. The study reported that two regimes existed in each country and there were significant differences in thresholds across countries. The results obtained for Germany, the Netherlands and France were similar in terms of steepness, unlike Spain where it is much steeper. The authors noted that the risk aversion hypothesis could explain the differences observed between the reported coefficients above and below the threshold, while the differences observed among

countries could be explained by the hypothesis of labour hoarding. For Spain where a negative threshold value was reported, it was stressed that it may be due to institutional rigidity hypothesis.

On the Eurozone, Zwick (2018) investigated the behaviors of Okun coefficients from the point of view of instability and asymmetry from 2001Q1 to 2017Q2. The study reported that in both the positive and negative changes in unemployment, the Okun's coefficient was characterized by asymmetric switching behavior. Moreover, output in the Eurozone is less sensitive to changes in cyclical unemployment during recession than in expansion while in most countries, the sensitivity of outputs to positive movement in unemployment was lower than when it is negative. Kargi's (2016) study was on OECD countries for 1987 to 2012. Results from the cointegration techniques indicated that Okun's law existed for 23 OECD countries in the long run. Karim and Aomar (2016), using difference and the gap models and non-parametric MARS methodology on 46 African countries from 1991 to 2015 found mixed results. While the law is valid for all specifications in 9 countries, it was invalid for all specifications in 20 countries.

On the Nigerian economy, several studies have been conducted. Ojapinwa and Kemi (2016) tested the association between output and unemployment on Nigeria, using data spanning 1980-2014, and found that although there is positive relationship, it is not statistically significant. In addition, GDP growth and unemployment rate were causally independent. Abu (2017), using the ARDL technique explored the connection between unemployment and growth in Nigeria from 1970 to 2014 and reported the presence of cointegrat¬ion between economic growth, oil prices and unemployment rate. In the long term, whereas unemployment was found to have a significant indirect effect on economic growth, the effect from oil was positive. In another study, Adeyeye et al. (2017) investigated the output-unemployment nexus in Nigeria from 1985 to 2015, using the GMM technique, and found that past and present growth in output have negative relationship with unemployment rate. Importantly, unemployment rate was significantly impacted only by past output growth, and thus evidence that partially supports the Okun's law.

3. RESEARCH METHODS

Okun (1962) pointed out that unemployment and output are inversely related. Basically, the 'levels' form has the following specification:

$$U_t - U^* = \theta(Y_t - Y^*) \tag{1}$$

Where the unemployment rate is symbolized by U and real GDP (in log form) is represented by Y. According to Okun, U^* is the 'full employment' while Y^* is the 'potential output'.

A difference form in the unemployment and output relationship was also pointed out by Okun, of the following form:

$$\Delta U_t - \beta(\Delta Y_t - \mu) \tag{2}$$

Where ΔU denotes the change in unemployment rate, ΔY represents growth in log GDP, while $\mu$is the GDP growth rate that is in line with stable unemployment. Owing to the non-stationary properties of most time series (including those in this study), the difference form was used in the present study.

3.1 Data

Quarterly data spanning 1991 Q1– 2019Q1 were used. Data on unemployment are from the economic data of the Federal Reserve (https://fred.stlouisfed.org) while data on economic growth are from the Central Bank of Nigeria (2014, 2020).

Quarterly data on unemployment was not available.Standardtime-series econometric technique was therefore used to disaggregate the annual employment data to quarterly data. Several authors have disaggregated annual to quarterly data in the empirical literature including Kemal and Arby (2004), Abeysinghe and Lee (1998), and Arby and Batool (2007). Consequently, the cubic spline technique was used to generate quarterly from annual estimates.

There are two main strands in the literature on how to deal with the aforementioned problem. While the first strand generates disaggregated higher frequency from observed low frequency (e.g. Litterman, 1983; Guerrero, 1989); the second strand deals with the interpolation of a time series data based on univariate techniques (e.g. Chan, 1993). The popular techniques or approaches developed in the economic literature include the cubic spline process, Denton (1970), and Chow-Lin (Chow& Lin, 1971).

While the Denton (1970) and Chow-Lin (1971) approaches use related series as indicators when converting low-frequency to high-frequency data, univariate framework is the basis of the cubic spline process. The cubic spline methodology is favoured in the present study as it produces a seamless curve that goes through each of the time series over the period used for estimation. Consequently, it can be used for a given interval to find both the rates of change as well as the cumulative change. In essence, the procedure interpolates data points which are evenly spaced. It has some advantages over the Denton (1970) and the Chow-Lin (1971) approaches. One, in relation to the low-frequency variable, the higher-frequency indicator variable is not needed. Two, its implementation or computation is relatively easy. Three, it fits between each observation of the data unique cubic polynomials, thus ensuring effective and efficient correlation of each of the data points, and this is achievable even in cases where the data may appear in a random manner. The procedure is briefly discussed as follows.

In the interpolation process, weights are given to each interval based on the estimated coefficients on the cubic polynomial, so that a curve passes through different points of the data. Consequently, the piecewise function *(j)* to produce *n*equally-spaced intervals of a given data is given by:

$$S(j) = \begin{cases} S_1(j) & if \quad j_1 \le j \le j_2 \\ S_2(j) & if \quad j_1 \le j \le j_3 \\ \quad . & . \\ \quad . & . \\ S_{n-1}(j) & if \quad j_{n-1} \le j \le j_n \end{cases} \tag{3}$$

4*n* parameters in total (to be computed) will be required in order to define *S* (j); this is because there are four coefficients and *n*evenly-spaced intervals. Consequently, the coefficients twist the curve so that without any interruption, it passes through each of the observations, thus indicating that there is no break in continuity of the curve. For the procedure, *(j)* is third degree polynomial function with the following specification:

$$S_i(j) = \alpha_{3i}(j - j_i)^3 + \alpha_{2i}(j - j_i)^2 + \alpha_{1i}(j - j_i) + \alpha_{0i} \quad for\ j \in (j_i, j_{i+1}) \tag{4}$$

To generate the cubic polynomial interpolation, the two conditions necessary for each interval to be matched with the values of the low-frequency variables at both ends are defined by:

$$S_i(j_i) = p_i \ \ and \ \ S_i(j_{i+1}) = p_{i+1} \tag{5}$$

where in equation (5), *pi*is obtained from equation (4), so that both conditions generate a continuous function, such that at the two ends of the intervals, each of the sub-functions must join at the data points.

For the smoothness and seamlessness of the curve across the interval points, and for it to pass through each of the data points over the sample period, continuity is assumed of the first and second derivatives as a basic requirement:

$$S'_{i-1}(j_i) = S'_{i-1}(j_i),\ S''_{i-1}(j_i) = S''_{i-1}(j_i)\ \forall i = 1, 2, \ldots, n-1 \tag{6}$$

3.2 Model Specification

To explore the Okun's law, a dynamic model (in the form of an autoregressive distributed lag of order p and n is specified as follows:

$$y_t = \sum_{i=1}^{p} \lambda_i y_{t-i} + \sum_{i=0}^{n} n_i' x_{t-i} + \varepsilon_t \tag{7}$$

where λi (the coefficients) are scalars and n'i are row vectors, xt is a K-dimensional column vector process and Ɛt is the disturbance term.

Equation (7) for unemployment and growth is presented asan autoregressive distributed lag model, which in the unrestricted form is:

$$\Delta Unemployment_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \Delta Unemployment_{t-i} + \sum_{i=0}^{k} \alpha_{2i} \Delta Growth_{t-i} + \sum_{i=0}^{k} \psi_1 Unemployment_{t-1} + \psi_2 Growth_{t-1} + \psi_{3i} Dummy_t + \mu_t \tag{8}$$

where Δ is the first-difference operator, k is the lag length, α_i : i = 1, 2 are the dynamic coefficients in the short-run, while the ψ_i : i = 1, 2are multipliers in the long-run. The dummy variable is incorporated in Equation 8 to capture structural breaks that are endogenously determined. The corresponding error correction model has the following specification:

$$\Delta Unemployment_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \Delta Unemployment_{t-i} + \sum_{i=0}^{k} \alpha_{2i} \Delta Growth_{t-i} + \alpha_3 Dummy_t + \delta_1 ECM_{t-1} + \varepsilon_t \tag{9}$$

where δ_1= coefficient of the lagged error correction term; and ε_t= white-noise error term. Equation (9) is transformed into a nonlinear ARDL model by decomposing growth into partial sum processes of the form:

$$Growth\_pos_t = \sum_{j=1}^{t} \Delta Growth\_pos = \sum_{j=1}^{t} \max(\Delta Growth\_pos_j, 0) \quad (10)$$

$$Growth\_neg_t = \sum_{j=1}^{t} \Delta Growth\_neg_j = \sum_{j=1}^{t} \min(\Delta Growth\_neg_j, 0) \quad (11)$$

where: $Growth\_pos_t$ and $Growth\_neg_t$ are the partial sums representing changes (positive and negative) in growth at period t, respectively and substituting them into equation (10). *A priori*,thepositive growth coefficients should be negative while the negative growth coefficients shoud be positive.

3.3 Procedure for Estimation

To uncover the underlying features of the variables used in the study, two forms of unit root tests were utilized. The first is the Augmented Dickey-Fuller (Dickey & Fuller, 1979; Said & Dickey, 1984), the DF-GLS (Elliot, Rothenberg & Stock, 1996), and the Phillips and Perron (1988) tests. These tests are often used but have low power and size distortion and are especially biased when there are structural breaks. The second types of tests make allowance for structural breaks that are endogenously determined and in the current study, consists of the Lee and Strazicich (hereafter L&S) (2003, 2004) tests.

The study used the L&S tests as against say the Zivot and Andrews (1992) tests because the latter has been criticized because under the null hypothesis breaks are not allowed, a situation that may lead to a bias and result in size distortion. Thus, the advantage of the L&S tests, which allow for breaks under both hypotheses, is that, it avoids the problems of bias and spurious rejections of the null hypothesis, so that the alternative hypothesis signifies that the series is trend-stationary.

The framework developed by L&S is based on Perron (1989), aimed at testing their structural break in which two changes are included in the level of the variable, i.e. Model A ("crash") and the level and trend of the variable incorporating two breaks, i.e. Model C ("break"). The data generation process is given by:

$$y_t = \sigma' X_t + \mu_t \quad (12)$$

where X_t is a vector of exogenous variables, $\mu_t = \alpha e_{t-1} + \varepsilon_t$, and ε_t is a white noise.

Considering that breaks can considerably distort inferences made on cointegration tests, it is crucial to account for breaks in order to make plausible inference on cointegration. This study followed the Johansen, Mosconi and Nielsen (2000) (hereafter JMN) cointegration test in which underlying series are modeled by a Vector Autoregressive process which accounts for one or two breaks. In addition, the study complements the JMN tests with the Saikkonen and Lütkepohl (2000a, 2000b, 2000c) (S&L subsequently) cointegration tests. In each of the two cointegration tests, specifications with level shifts and without level shifts were considered. Finally, the Gregory and Hansen (1996a, 1996b) (consequently GH) test was implemented, accounting for one break (determined endogenously) including a level shift, a regime shift, change in level and trend, and a regime (with a trend) shift.

Evidence of cointegration necessitated the exploration of the short- and long-run connection between growth and unemployment through the Error Correction Model (ECM), as it is more appropriate in a cointegrated system (Engle and Granger, 1987). First the cointegrating and long-run forms were estimated, and to ensure parsimony in the short-run

estimates (the focus of the study), the General to Specific (GETS) methodology (Hendry, 1986) was followed. However, in view of the study objective, our interest is the short-run relationship between growth and unemployment. Thus, only the estimated short-run (cointegrating) coefficients are reported.

4. FINDINGS

Table 1. Results of Unit Root Tests (without breaks)

Panel A: Results of Linear Unit Root Tests (with constant)

Variable	ADF	DF-GLS	PP
Unemployment	-0.846214	0.309033	-1.019394
Growth	-0.488932	0.096723	-0.510604
Δ Unemployment	-3.906175*	-3.899840*	-2.979627**
Δ Growth	-10.37192*	-10.31121*	-10.37346*

Panel B: Results of Linear Unit Root Tests (Constant and trend)

Variable	ADF	DF-GLS	PP
Unemployment	-2.433734	-2.250461	-1.799634
Growth	-1.974075	-1.607065	-1.974075
Δ Unemployment	-3.897309**	-3.959211*	-2.803732
Δ Growth	-10.35629*	-10.41608*	-10.35905*

Note: * and **represents rejection at 1% and 5% significance level respectively.Δ denotes first difference.
Source: Calculated by authors.

Table 1 shows the unit root test results (without structural breaks).The results of the unit root tests in both Panels A and B indicate that the null hypothesis of a unit root is not rejected in the levels variable. However, in their first difference, the null hypothesis is rejected, implying stationarity. Thus, in both cases, the variables are integrated of order 1. All three test types are thus consistent in suggesting non-stationary of the variables in levels, except in first differences. In conclusion, the test results with intercept (Panel A) and intercept and a linear trend (Panel B) indicate that both variables are non-stationary and integrated of order 1. The results of the L&S tests are provided in Table 2.

Table 2. Unit Root Test Results (with structural breaks)

Variable	Break in Intercept		Break in Intercept and Trend	
	1 break	*2 breaks*	*1 break*	*2 breaks*
Unemployment	-2.940618 (2013Q3)	-3.174592 (2013Q1, 2013Q4)	-3.467977 (2006Q3)	-8.630333* (2005Q3, 2013Q4)
Growth	-1.726656 (2011Q3)	-2.022801 (2003Q4, 2009Q4)	-3.163216 (2009Q3)	-2.644707 (2002Q3, 2008Q1)
Δ Unemployment	-5.495567* (2007Q4)	-5.756061* (2007Q1, 2007Q4)	-6.231655^ (2016Q1)	-8.564998* (2012Q2, 2015Q2)
Δ Growth	-10.61447* (2007Q4)	-10.49026* (1995Q3, 2008Q4)	-11.32921* (2009Q1)	-55.65334* (2009Q3, 2010Q3)

Note: *, and ** denote significant at1% and 5% level respectively.Δ symbolizes first difference
Break dates are in parenthesis.
Source: Calculated by authors.

As shown in Table 2, the hypothesis that series are not stationary when structural breaks are present is not rejected for growth and unemployment, except when two breaks exist and assuming a break in intercept and trend (in the case of unemployment). The implication is that both series are non-stationary with a break in either intercept or intercept and trend. However, in the differenced series, the reverse is the case at the 1% significance level. Put another way, the test results for the differenced variables indicate that growth and unemployment are stationary with breaks. Overall, the variables are non-stationary and have a break at the endogenously identified dates.

Tables 3 and 4 present the tests results for cointegration. It needs to be noted that the JMN cointegration tests were implemented by incorporating the break dates found in the levels variables in the L&S unit root test results.

Table 3. JMN Test Results for Cointegration

Model A		*Model C*		
Breaks	$H_c(r)$	Breaks	$H_c(l)$	$H_0(H_1)$
2011Q3	46.97*	2009Q3	90.58*	r ≥ 1
	2.27		13.36	r ≥ 2
2003Q4	30.26***	2002Q3	86.74*	r ≥ 1
2009Q4	11.38	2008Q1	15.94	r ≥ 2
2013Q3	23.11***	2006Q3	53.10*	r ≥ 1
	5.38		7.31	r ≥ 2
2013Q1	48.14*	2005Q3	72.83*	r ≥ 1
2013Q4	1.71	2013Q4	19.54	r ≥ 2

Note: *, and *** denote rejection of the null hypothesis at 1% and 10% level of significance respectively.
Source: Calculated by authors.

Table 4. S&L Cointegration Test Results

Model	$(p - r_0)$	LR	$\hat{k}$
Trend	0	19.83*	1
	1	1.01	
Trend and intercept	0	18.22**	2
	1	0.61	

Note: ** and ** denote rejection of the null hypothesis at 1% and 5% level of significance respectively. $\hat{k}$ represents the lag length used.
Source: Calculated by authors.

From Table 3, the no cointegration hypothesis is rejected in all cases, based on the break points in the unit root test results. The complimentary S&L cointegration test results

in Table 4 reinforce the conclusion in the results resented in Table 3 that there is a long-run relationship between growth and unemployment.

To further evaluate whether unemployment and growth are cointegrated, the study deployed the GH cointegration test. The main advantage of this is was to uncover the break date in the relationship, instead of initially incorporating the break dates in the unit root test results prior the test for cointegration. The results of the GH cointegration test are presented in Table 5.

Table 5. GH Test for Cointegration

			Critical Values		
	Statistic	Breakpoint	1%	5%	10%
Panel A: Change in Level					
ADF	-9.99	2009q3	-5.13	-4.61	-4.34
Zt	-10.04	2009q3	-5.13	-4.61	-4.34
Za	-107.08	2009q3	-50.07	-40.48	-36.19
Panel B: Change in Regime					
ADF	-10.10	2009q3	-5.47	-4.95	-4.68
Zt	-10.14	2009q3	-5.47	-4.95	-4.68
Za	-108.17	2009q3	-57.17	-47.04	-41.85
Panel C: Change in Level and Trend					
ADF	-10.54	2009q3	-5.45	-4.99	-4.72
Zt	-10.59	2009q3	-5. 45	-4.99	-4.72
Za	-113.02	2009q3	-57.28	-47.96	-43.22
Panel D: Change in Regime and Trend					
ADF	-10.51	2009q3	-6.02	-5.50	-5.24
Zt	-10.56	2009q3	-6.02	-5.50	-5.24
Za	-103.47	2009q3	-69.37	-58.58	-53.31

Source: Calculated by authors.

Results in Table 5 suggest that the hypothesis of no-cointegration with a break is rejected for all three test statistics. The estimated coefficients are presented in Table 6. To estimate the coefficients, a maximum lag of 4 was initially set, based on the lag order criteria (see the Appendix), and as earlier mentioned, the GETS methodology was followed to achieve parsimony. Importantly, the dummies that appear as explanatory variables relate to the those of unemployment (the dependent variable). In other words, the structural breaks in the dependent variable were used as fixed regressors, in line with the model specification. The GETS methodology is particularly useful as it enables one to sequentially eliminate non-statistically significant coefficients.

Table 6. Estimated Coefficients

Panel A: Estimated Linear Coefficients

Variable	1	2	3	4
Δ Unemployment$_{t-1}$	2.443624*	2.427042*	2.386424*	2.364404*
Δ Unemployment $_{t-2}$	-2.261243*	-2.227428*	-2.188631*	-2.161043*
Δ Unemployment $_{t-3}$	0.793299*	0.781031*	0.751836*	0.737240*
Δ Growth	0.000011	0.000012	0.000010	0.000008
Δ Dummy2002q3	-	-	-	-0.000154**
Δ Dummy2005q3	-	-	-	0.000155**
Δ Dummy 2013q4	-	-	-0.000137***	-0.000157**
Δ Dummy2016q1	-	0.000189*	-	-
ECM(-1)	-0.003557*	-0.003577*	-0.006806*	-0.009358*

Panel B: Estimated Non-linear Coefficients

Variable	1	2	3	4
Δ Unemployment$_{t-1}$	2.451812*	2.433715*	2.391922*	2.365635*
Δ Unemployment $_{t-2}$	-2.279829*	-2.243942*	-2.198903*	-2.163007*
Δ Unemployment $_{t-3}$	0.807117*	0.793122*	0.758958*	0.739504*
Δ Growth_pos	0.000020	0.000019	0.000013	0.000013
Δ Growth_neg	-0.000004	0.000060	-0.000004	-0.000003
Δ Dummy2002q3	-	-	-	-0.000155**
Δ Dummy2005q3	-	-	-	0.000161**
Δ Dummy2013q4	-	-	-0.000136***	-0.000151**
Δ Dummy2016q1	-	0.000196**	-	-
ECM(-1)	-0.004348*	-0.004027*	-0.006927*	-0.009610*

Note:
[1]Based on GH, L&S tests (1 break in intercept, and break in intercept and trend, levels variables)
[2]Based on L&S tests (1 break in intercept and trend, differenced variables)
[3]Based on L&S tests (2 breaks in intercept)
[4]L&S tests (2 breaks in both intercept and trend).
*, ** and ***symbolize rejection of H_0at 0.1% and 0.05% level of significance respectively.
Source: Authors' computations.

The short-run growth coefficients in both the linear and non-linear specifications presented in Panels A and B of Table 6 indicate that they are inconsistent with the Okun's law. In all cases, it is positive and not statistically significant, implying that both unemployment and growth are positively related in the Nigerian case. Consequently, growth is not accompanied by corresponding reduction in the level of unemployment, implying that the growth experienced in the country under the period of investigation is one of joblessness. Additionally, the lagged values of unemployment is direct and statistically significant in both the estimated linear and the non-linear coefficients, an indication of an increase in the unemployment rate due to historical episodes of unemployment.

Growth that is unemployment mitigating is envisaged in the literature, even though it does not necessarily reflect wellbeing (Wu and Li, 2013). That growth experienced in Nigeria has done little if anything to reduce the unemployment level is documented elsewhere (see African Economic Outlook, 2012; Oloni, 2013). Of note is that unemployment has been on the rise in the country over time. For Nigeria, growth has not been critical in the implementation of public programmes which address unemployment. Consequently, public policy in Nigeria has been impotent in dealing with high unemployment levels and their associated adverse consequences. It is even curious that the performance of the economy from the point of view of employment creation was relatively

worse from 1999 to 2014 (a period of democratic rule) than from 1983 to 2008 (a period of military incursion) (Iyoboyi, 2016). However, the unemployment level in Nigeria is much more about the wider context rather than strictly a growth phenomenon. Much as elsewhere, economic policies, technological progress, economic crisis, skill-gaps and population growth are implicated (Lenagala & Ram, 2010).

5. CONCLUSIONS

Using quarterly data from 1991Q1 to 2019Q1, this paper examines whether the law credited to Okun is valid in Nigeria. Utilizing a battery of techniques that account for structural breaks, cointegration was found to exist between unemployment and growth. The estimated growth coefficients indicate that unemployment and growth are positively related and that the impact of the latter on the former is not statistically significant. The conclusion is that under the period of investigation, Nigeria experienced jobless growth and the Okun's law is inapplicable.

It is concluded that policies aimed at merely growing the economy will not reduce unemployment in Nigeria. Consequently, growth should be stimulated via carefully planned sectorial inputs which take account of labour intensity, in order to pull out as many people as possible from unemployment. It is clear from the empirical findings that growth has not helped solve the endemic problem of unemployment in Nigeria, and that growth must be targeted at sectors capable of absorbing many people (such as agriculture, mining, construction and services sectors).

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