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Investigating Okun's Law in Nigeria through the Dynamic Model

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Abstract: Unemployment is a persistent challenge for countries, especially the developing ones. Nigeria as a developing country faces a herculean task reducing the increasing spate of joblessness amongst her citizens. Okun's law explains the relationship between unemployment and economic growth in an economy. This study therefore investigates Okun's law in Nigeria between 1985 and 2015 through the dynamic model. The generalized method of moments estimation result reveals that that present and past output growth are negatively related to unemployment rate. However, only past output growth has a significant effect on unemployment rate. It also shows that past unemployment rate is significantly and positively associated with present unemployment rate. The Toda-Yamamoto Granger non-causality test finds that there is no causality between unemployment and economic growth. This study presents evidence to partially support Okun's law of inverse relationship between unemployment and output growth and suggests that promoting economic growth can be a policy tool for reducing unemployment rate in Nigeria.

Keywords: *Okun's law, unemployment, economic growth, dynamic model*

1. Introduction

A nation, regardless of its level of economic development, faces a daunting task in achieving full employment (i.e. effective maximisation of labour resources). The International Labour Organisation (ILO) reports the unemployment rate for virtually all countries. Hence, it is wise to state that the issue of unemployment is a phenomenon experienced in both advanced and emerging economies. Unemployment is the inability of an individual to engage in a legally acceptable activity that allows him/her to exchange mental and physical efforts for financial gain or compensation. The rate of unemployment in a country is an index for strength of its labour market and the level of utilisation of its labour resources or human capital. There is disparity in the unemployment rate among countries due to the varying level of economic growth among them. This portends that the growth of an economy has the tendency to either increase or decrease the level of unemployment. A theoretical explanation for the bearing of economic growth on unemployment emerged from the seminal work of an American economist named Arthur Okun in 1962. The discovery of Okun (1962) on the US showed that there is a negative association between unemployment rate and economic growth. In other words, Okun found that unemployment and economic growth move in opposite direction (i.e. the higher the growth in the economy, the lesser the rate of unemployment and vice versa). This finding became what is popularly referred to as "Okun's law". Okun's law assumes that economic shocks affect output asymmetrically before influencing unemployment (Lee, Hu, Li & Tsong, 2013). It posits that the behaviour of unemployment in the economy acts in the Keynesian manner to the point that it suggests that failure to utilise productive resources reduces the rate of economic growth in the future (Loría & Salas, 2014).

Okun's law is a statistical relationship between unemployment and output in an economy and not a structural attribute of an economy because the relationship is subject to changes in an ever-dynamic economy (Knotek, 2007). It suggests that unemployment and output are inversely related and there is a bidirectional causal relationship between them. The responsiveness of unemployment to output has been regarded in literature as "Okun's coefficient". Okun (1962) found a coefficient of -0.3 between unemployment and output, thus indicating that unemployment decreases by 3% when output increases by 1% in US. Moosa (1999) estimated that Okun's coefficient is -0.38 in the US economy regardless of whether the model is static or dynamic and irrespective of the lag length in the dynamic model. Prachowny (1993) found that the contribution of 1% decrease in unemployment is about 2% to 3% increase in output in US. Ball, Leigh and Loungani (2013) found that the effect of 1% increase in output differs largely across countries. The Okun's coefficient may vary across countries due to economic conditions (Lal, Muhammad, Jalil & Hussain, 2010).

With the increasing difficulty of graduates in Nigeria seeking employment in the face of increase in output growth, it remains an empirical question if Okun's law exist in the country. If the outcome of this study confirms the existence of the law in Nigeria, it means pursuing improvement in economic productivity can be a strategy to reduce the increasing population of the unemployed. The impetus for this study stems from the opinion of Levin and Wright (2001) which states that unemployment level and output may not be negatively related. Arewa and Nwakanma (2012), Babalola, Saka and Adenuga (2013), Abraham (2014) and Akeju & Olanipekun (2014) have confirmed this opinion in Nigeria. However, existing studies on Nigeria have employed model estimation approaches such as ordinary least squares (OLS) method and error-correction modelling approach which cannot overcome problems of endogeneity, simultaneity bias and omitted variables bias that are commonly present in a regression model. These problems do not allow consistent parameter estimates to be produced. Therefore, this study investigates the Okun's law through the dynamic model by using an instrumental variable (IV) regression method which uses instruments to overcome the aforementioned problems. The study answers the empirical question of whether promoting economic growth can be a panacea to the high unemployment rate in Nigeria. The remaining part of this research is structured as follows into literature review, methodology, empirical findings and discussion and conclusion.

2. Literature Review

Okun (1962) built three versions of models to establish the interaction between unemployment and output. These include: the difference model, the gap model and the dynamic model. The difference model shows the effect of movements in output on change in unemployment rate. It reflects the relationship between unemployment and economic growth. The model is specified as:

$$U_t - U_{t-1} = \sigma + \beta(Y_t - Y_{t-1}) + \mu_t \qquad \cdots(1)$$

U_t is unemployment rate at current period; U_{t-1} is unemployment rate at previous period; Y_t is output at current period; Y_{t-1} is output at previous period; $U_t - U_{t-1}$ is change in unemployment rate; $Y_t - Y_{t-1}$ is change in output; β is Okun's coefficient or estimate of change in output; σ is intercept; μ is error term.

Equation (1) in a simpler form becomes:

$$\Delta U = \sigma + \beta \Delta Y + \mu_t \qquad \cdots(2)$$

ΔU is change in unemployment; ΔY is change in output.

The gap model shows how the difference between potential output and actual output affects current unemployment rate. Okun (1962) used the gap model to explain the output the economy can produce when there is full employment and no inflationary pressure. The model assumes that the economy attains full employment when unemployment is 4% (Arshad, 2011). The gap model is specified as:

$$U_t = \sigma + \beta(Y_t^* - Y_{t-1}) + \mu_t \qquad \cdots(3)$$

U_t is unemployment rate at current period; Y_t^* is potential output; Y_t is actual output; $Y_t^* - Y_t$ is output gap.

The dynamic model assumes that current rate of unemployment is determined by current output, previous output and previous changes in unemployment. Knotek (2007) opines that the model is distinctive because it does not reveal only the relationship between changes in unemployment and output growth but also how past unemployment level affects present unemployment level. The model is specified as:

$$U_t = \sigma + \beta_1 Y_t + \beta_2 Y_{t-1} + \alpha U_{t-1} + \mu_t \qquad \cdots(4)$$

U_t is unemployment rate at current period; Y_t is output at current period; Y_{t-1} is output at previous period; Ut_{-1} is unemployment rate at previous period; β_1 and β_2 are Okun's coefficients.

Okun's law was propounded in 1962 from a study which discovered an inverse relationship between unemployment level and economic growth of the US between 1947Q2 and 1961Q1 and later studies such as Weber (1995); Knotek (2007); Kitov (2011); Ball, Leigh and Loungani (2013); Ekner (2013) and Ball, Jalles and Loungani (2014) provide similar evidence for the US economy. However, Daly and Hobijn (2010) and Gordon (2011) showed that Okun's law is not a norm in US. This implies that Okun's law has generated controversy in the US economy. Similarly, findings not related to US have produced mixed results. Sadiku, Ibraimi and Sadiku (2015), utilising quarterly data from 2000 to 2010, observed the relationship between economic growth and unemployment rate in Macedonia. The findings suggest that Okun's law is not tenable.

Geldenhuys and Marinkov (2007) found that unemployment is inversely related to output in the South African economy over the 1970 to 2005 period and there was evidence of asymmetry in the Okun's relationship. But, Moroke, Leballo and Mello (2014) explored the relationship between unemployment and economic growth of South Africa from 1990Q1 to 2013Q4. The study showed that Okun's coefficient did not conform to the expected sign; thus, affirming that Okun's law is irrelevant in South Africa. Akram, Hussain and Raza (2014), applying ordinary least square method, found that Okun's law does not exist in Pakistan. Noor, Nor and Ghani (2007) evaluated how growth interacts with unemployment in Malaysia from 1970 to 2010. The regression results indicated that the responsiveness of unemployment to growth behaviour is in line with Okun's law. Dritsaki and Dritsaki (2009) estimated Okun's coefficient between 1961 and 2002 for 4 Mediterranean countries of the EU consisting of Italy, Spain, Portugal and Greece between 1961 and 2002 and found the coefficient to be –0.024, –0.017, –0.016 and –0.007 respectively. Kitov (2011) estimated Okun's law for 6 developed countries comprising United States, Spain, United Kingdom, Australia, Canada and France. Using real GDP per capita in place of overall GDP, Okun's law exhibits an astounding predictive power in all the countries. The study showed that the high unemployment rates in these countries would be impossible to reduce if their growth rate does not exceed 2% per annum.

Arshad (2011) observed that Okun's law is evident in Sweden between 1993Q1 to 2009Q2. Elshamy (2013) evaluated the relationship between unemployment rate and output in Egypt between 1970 and 2010. It discovered that Okun's coefficient is negative and statistically significant in both the short and long run. The study of Central Bank of Malta (2013) found that GDP growth above 1.5% - 2.0% reduces the rate of unemployment. However, the influence of GDP growth on unemployment is weak when compared with other European Union (EU) countries. For Spain, Loría and Salas (2014) estimated a quadratic version of the first-difference of Okun's law model for the period between 1995Q1 and 2012Q2. The study disagreed that Okun's law is not stable over time and observed that 7.38% growth rate reduces changes in unemployment. Kargi (2014), in a study of 23 Organisation for Economic and Cooperation Development (OECD) countries, found that unemployment and growth do not move in the same direction. Similarly, Dixon, Lim and van Ours (2016) found that increase in economic growth would reduce unemployment rate as well as have a distributional effect of reducing unemployment among youths in 20 OECD countries. Ball, Jalles and Loungani (2014) found that real GDP growth forecasts and changes in unemployment are inversely related in 9 developed countries. Christopolous (2004) investigated the Okun's law in Greece on regional basis and found that the law is evident in 6 out of the 13 regions reviewed. Similarly, Binet and Francois (2013) found Okun's law to be valid in 14 out of 22 regions in France.

For Nigeria, Sodipe and Ogunrinola (2011) examined the link between employment and Nigerian economic growth with the ordinary least squares (OLS) method. The empirical results suggest that the relatively low influence of GDP growth to promote employment is responsible for the high level of unemployment and that Okun's law does not hold. Arewa and Nwakanma (2012) adopted vector autoregressive (VAR) approach to evaluate the relationship between output and unemployment in Nigeria from 1981 to 2011. The study found that Okun's law does not fit to the Nigerian economy. Babalola, Saka and Adenuga (2013) tested the authenticity of Okun's law in Nigeria from 1980 to 2010. Employing causality test and error-correction model, the findings indicated that causality flow in a unidirectional manner from unemployment to real output growth and the coefficient of Okun is not negative. The study suggests that unemployment rate does not respond to output growth in a manner consistent with Okun's law. Abraham (2014) examined the effect of output on unemployment rate in Nigeria between 1985 and 2013. Using autoregressive distributed lag (ARDL) bounds-test; it was revealed that output variations have no significant impact on unemployment. The study adduced that Okun's law is not applicable to Nigeria. Also, Akeju and Olanipekun (2014) employing the error-correction modelling approach, did not validate Okun's law in Nigeria.

3. Methodology

This study examined the responsiveness of unemployment to changes in output in an attempt to provide evidence on the validity of Okun's law in Nigeria from 1985 to 2015. It modelled unemployment rate (UR) as a function of output growth. The measurement for output growth is the Gross Domestic Product (GDP) growth. Unemployment rate and GDP growth were sourced from the National Bureau of Statistics and World Development Indicators (WDI) database respectively. The econometric expression of the model is:

$$UR_t = \sigma + \beta GDPgrowth_t + \varepsilon_t \ldots (5)$$

Equation (5) was transformed into a dynamic model. The dynamic model posits that present output growth and previous output growth can influence present rate of unemployment. Also, the model captures the impact of previous rate of unemployment on present rate of unemployment. The dynamic model for this study is expressed as:

$$UR_t = \sigma + \beta_1 GDPgrowth_t + \beta_2 GDPgrowth_{t-1} + \alpha UR_{t-1} + \varepsilon_t \ldots (6)$$

UR_t is present year unemployment rate; $GDP\ growth_t$ and $GDPgrowth_{t\text{-}1}$are contemporaneous output growth and one-year period lagged output growth respectively; $UR_{t-1}$is one-year period lagged unemployment rate.

The dynamic model was estimated with an instrumental variables (IV) regression based on the generalized method of moments (GMM) estimator. GDP growth was instrumented and capital (gross capital formation), labour (labour force), one-year period lagged output growth and one-year period lagged unemployment rate were used as IVs.

Okun's argument is that there is a bidirectional causal relationship between unemployment and economic growth (Babalola, Saka & Adenuga, 2013; Loría & Salas, 2014). Therefore, this study also determined the direction of causality between unemployment rate and economic growth. Babalola, Saka and Adenuga (2013) and Ntebogang and Leballo (2014) also examined the causality between unemployment and economic growth in Nigeria and South Africa respectively to provide evidence to validate Okun's Law. The causality between unemployment rate and economic growth was determined using the Toda and Yamamoto (1995) Granger non-causality test performed within a VAR system. A bivariate VAR model tends to suffer from omitted variable bias. Therefore, capital and labour were incorporated to control for their effect on economic growth. The Toda and Yamamoto Granger non-causality requires that the maximum order of integration should be known in order to add extra lag(s) to the VAR model. The variables are specified in the Toda-Yamamoto VAR model in natural logarithm form except for GDP growth. The Toda and Yamamoto VAR model is given as:

$$\begin{aligned} lnUR_t = {} & \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} lnUR_{t-i} + \sum_{j=k+1}^{k+d_{max}} \alpha_{2j} lnUR_{t-j} + \sum_{i=1}^{k} \alpha_{3i} GDPgrowth_{t-i} + \sum_{j=k+1}^{k+d_{max}} \alpha_{4j} GDPgrowth_{t-j} \\ & + \sum_{i=1}^{k} \alpha_{5i} lnCapital_{t-i} + \sum_{j=k+1}^{k+d_{max}} \alpha_{6j} lnCapital_{t-j} + \sum_{i=1}^{k} \alpha_{7i} lnLabour_{t-i} \\ & + \sum_{j=k+1}^{k+d_{max}} \alpha_{8j} lnLabour_{t-j} + \varepsilon_{1t} \ldots . (7) \end{aligned}$$

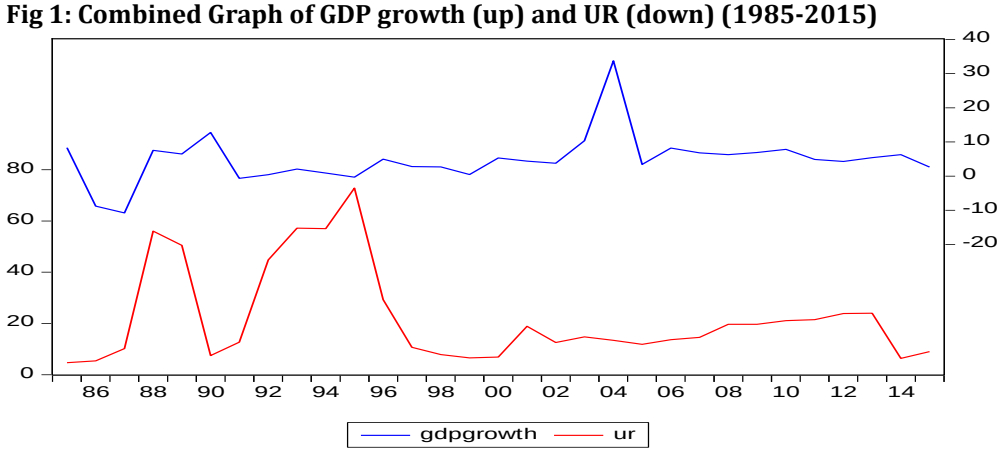
$$\begin{aligned} GDPgrowth_t = {} & \beta_0 + \sum_{i=1}^{k} \beta_{1i} GDPgrowth_{t-i} + \sum_{j=k+1}^{k+d_{max}} \beta_{2j} GDPgrowth + \sum_{i=1}^{k} \beta_{3i} lnUR_{t-i} + \sum_{j=k+1}^{k+d_{max}} \beta_{4j} lnUR_{t-j} \\ & + \sum_{i=1}^{k} \beta_{5i} lnCapital_{t-i} + \sum_{j=k+1}^{k+d_{max}} \beta_{6j} lnCapital + \sum_{i=1}^{k} \beta_{7i} lnLabour_{t-i} + \sum_{j=k+1}^{k+d_{max}} \beta_{8j} lnLabour_{t-j} \\ & + \varepsilon_{2t} \ldots . (8) \end{aligned}$$

$$\begin{aligned} lnCapital_t = {} & \delta_0 + \sum_{i=1}^{k} \delta_{1i} lnCapital_{t-i} + \sum_{j=k+1}^{k+d_{max}} \delta_{2j} lnCapital_{t-j} + \sum_{i=1}^{k} \delta_{3i} lnUR_{t-i} + \sum_{j=k+1}^{k+d_{max}} \delta_{4j} lnUR_{t-j} \\ & + \sum_{i=1}^{k} \delta_{5i} GDPgrowth_{t-i} + \sum_{j=k+1}^{k+d_{max}} \delta_{6j} GDPgrowth_{t-j} + \sum_{i=1}^{k} \delta_{7i} lnLabour_{t-i} \\ & + \sum_{j=k+1}^{k+d_{max}} \delta_{8j} lnLabour_{t-j} + \varepsilon_{3t} \ldots . (9) \end{aligned}$$

$$lnLabour_t = \rho_0 + \sum_{i=1}^{k} \rho_{1i} lnLabour_{t-i} + \sum_{j=k+1}^{k+d_{max}} \rho_{2j} lnLabour_{t-j} + \sum_{i=1}^{k} \rho_{3i} lnUR_{t-i} + \sum_{j=k+1}^{k+d_{max}} \rho_{4j} lnUR_{t-j} + \sum_{i=1}^{k} \rho_{5i} GDPgrowth_{t-i} + \sum_{j=k+1}^{k+d_{max}} \rho_{6j} GDPgrowth + \sum_{i=1}^{k} \rho_{7i} lnCapital_{t-i} + \sum_{j=k+1}^{k+d_{max}} \rho_{8j} lnCapital_{t-j} + \varepsilon_{4t} \ldots (10)$$

4. Empirical Findings and Discussion

Fig 1: Combined Graph of GDP growth (up) and UR (down) (1985-2015)



Source: Authors' computation

Fig. 1 depicts a combined graph of GDP growth and UR in Nigeria between 1985 and 2015. It shows that the relationship between GDP growth and UR is unstable.

Table 1: GMM Estimator Result

Variable	Coefficient	HAC Standard Error	*z*-statistic	*p*-value
Constant	15.25203	2.097252	7.27	0.000*
GDP growth	-0.3426859	0.2850239	-1.20	0.229
$GDPgrowth_{t-1}$	-1.278928	0.3757	-3.40	0.001*
UR_{t-1}	0.5936043	0.428025	13.87	0.000*
Model Diagnostics				
Wald x^2(p-value)	205.79(0.0000)*			
Hansen J-statistic(p-value)	1.22446(0.2685)‡			

Note: * indicates statistically significant at 1% significance level and ‡ implies rejection of null hypothesis.
Source: Authors' computation

Generalized Method of Moments (GMM) Estimation: The GMM utilises IVs which allows the regression model to overcome the problems of endogeneity, simultaneity bias and omitted variables bias. IVs are variables that satisfy the orthogonality condition (i.e. they are uncorrelated to the error term in a regression model). The use of IVs produces consistent regression estimates. Table 1 reports the result of the GMM estimator. Table 1 indicates that contemporaneous effect of output growth on unemployment rate is negative but not significant while one-year period lagged output growth is negatively and significantly related to unemployment rate. It also shows that one-year period lagged unemployment rate is positively and significantly related to present year unemployment rate, thus confirming the appropriateness of the dynamic model. The *F*-statistic is statistically significant at 5% significance level, thus indicating the IVs are not weak.

The *J*-statistic accepts the null hypothesis that the over identifying restrictions are valid, thus confirming that the IVs are orthogonal to the error term.

Unit Root Test: The Dickey-Fuller (DF)-GLS unit root test was performed in order to determine the maximum order of integration (d_{max}) among the variables. The null hypothesis for the test is that the time-series data has unit root. To reject the null hypothesis, the test statistic must have a greater value than the test critical value when both values are considered in absolute term. Table 2presents the DF-GLS unit root test result on UR and GDP growth.

Table 2: DF-GLS Unit Root Test

	Test statistic	Optimal lag	Maximum lag	Order of Integration
lnUR	-2.418907**†	0	4	0
GDP growth	-4.354689*†	0	4	0
lnCapital	-2.942694*‡	2	4	1
lnLabout	-2.339068**‡	0	4	1

Note: * and ** denote rejection of null hypothesis at 1% and 5% critical value respectively and † and ‡indicate that series is stationary at level and first difference respectively. Also, only intercept included in unit root test equation and optimal lag is automatically selected based on Schwarz Information Criterion.

Unemployment rate and GDP growth were established to be stationary series while capital and labour were stationary after first differencing. This implies that the series are integrated in the order of different order. This means that the Toda-Yamamoto Granger non-causality test would be appropriate because of the presence of different order series. The d_{max} among the series is one.

Toda-Yamamoto Granger Non-Causality Test: The causality test shows the predictive ability of a driving variable (*X*) on a response variable (*Y*). It reflects whether past patterns in *X* occurs in *Y* after a time lag. A VAR model was estimated with a lag length of 2 selected based on Akaike information criterion (AIC). After estimation, the VAR model was diagnosed with the VAR serial correlation LM test. The test rejects the null hypothesis of no serial correlation at lag order 2and this indicates that autocorrelation is not present in the VAR model. The VAR model was also found to be stable because the AR roots graph shows that no root lies outside the unit circle. The Toda-Yamamoto Granger non-causality test was done by including an extra lag of 1 in the VAR(2) model. Table 3reports the results of the VAR Granger non-causality test.

Table 3: VAR Granger Non-Causality Test Results

Null Hypothesis	Modified Wald x^2	*p*-value
lnUR does not Granger cause GDP growth	1.511109	0.4698
GDP growth does not Granger cause lnUR	0.177463	0.9151
lnUR does not Granger cause lnCapital	7.771337	0.0205**
lnCapital does not Granger cause lnUR	4.628592	0.0988***
lnUR does not Granger cause lnLabour	2.640361	0.267
lnLabour does not Granger cause lnUR	0.962519	0.6180
GDP growth does not Granger cause lnCapital	3.064589	0.2160
lnCapital does not Granger cause GDP growth	3.245634	0.1975
GDP growth does not Granger cause lnLabour	1.429253	0.4894
lnLabour does not Granger cause GDP growth	0.578917	0.7487
lnCapital does not Granger cause lnLabour	0.286013	0.8667
lnLabour does not Granger cause lnCapital	9.806484	0.0074*

Note: *, ** and *** indicate rejection of null hypothesis at 1%, 5% and 10% significance level respectively.
Source: Authors' computation

Table 3 shows that GDP growth and unemployment rate do not Granger cause each other. This indicates that there is absence of causality between unemployment and economic growth. This finding contradicts Babalola, Saka and Adenuga (2013) which found that there is a unidirectional causality moving from unemployment rate to economic growth in Nigeria.

5. Conclusion

Unemployment is a persistent challenge for countries, especially the developing ones. Nigeria as a developing country faces a herculean task to reduce the increasing spate of joblessness amongst her citizens. Okun's law suggests that promoting economic growth is a potent strategy to reduce unemployment rate. This study investigated Okun's law in Nigeria through the dynamic model. It was discovered that present and past output growth are negatively related to unemployment rate. However, only past output growth has a significant effect on unemployment rate. This implies that unemployment rate reduces when the economy experience growth in its output in the previous year. Also, this study revealed that past unemployment rate has a positive and significant relation with present unemployment rate. This indicates that unemployment rate depends on its own past realisations and it increases due to unemployment rate in the past period. Lastly, it was found that there is no causality between unemployment and economic growth and this implies that Okun's argument of bidirectional causality between unemployment and economic growth is invalid for Nigeria. However, this study presents evidence to partially support Okun's law of inverse relationship between unemployment and output growth in Nigeria. This suggests that promoting economic growth is a policy tool for reducing unemployment rate in Nigeria.

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