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U. Aminu

*Central Bank of Nigeria*

A. Abel

*Central Bank of Nigeria*

A. R. Garba

*Central Bank of Nigeria*

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# Does the Okun's Law Hold in the BRICS Countries and Nigeria?

Aminu, U., Abel, A., and Garba, A. R. \*

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## Abstract

The unemployment-output nexus is a topical issue in developing countries, particularly with some evidence against the trade-off suggested by Okun's law. This study, therefore, investigates the validity of Okun's law in the BRICS countries and Nigeria, based on annual data between 1993 and 2020, using the Panel ARDL model. We validate the Okun's law with evidence of an inverse relationship between output and unemployment in the BRICS countries and Nigeria. We, therefore, recommend that policymakers should boost both nominal and potential output by fully diversifying the economy to enhance productivity and reduction in the unemployment rate. We also recommend that the BRICS countries and Nigeria should deploy more of their population into technology-driven economic activities such as the information and communication technology (ICT) sub-sector of the economy and productive sectors that are labour intensive such as agriculture to absorb the available labour and boost output and lower unemployment rate.

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Keywords: BRICS countries, Okun's law, panel ARDL, potential output, unemployment

JEL Classification : C23, E24, F43, J62, O47

## I. Introduction

The relevance of Okun's law in explaining the nexus between output and unemployment in modern economies has continued to dominate discussions among policymakers and governments (Ahmed et al., 2011; Kangasharju et al., 2012; Hashmi et al., 2021; Karadzic et al., 2021; Villaverde & Maza-Fernández, 2021). The significance of the law derives from the importance of its two core variables (unemployment and economic growth) to the attainment of macroeconomic objectives. In its most basic form, Okun's law seeks to examine the unemployment-economic growth nexus of a country. In his seminal work, Okun (1962) employed quarterly data, spanning 1947Q2 to 1964Q4, to examine the relationship between the unemployment rate and real GDP growth rate of the United States. The major conclusion reached by the study was that a 1.0 per cent increase in unemployment was associated with about 4.0 per cent contraction in the growth rate of output and vice versa. The study emphasised large gains in output if efforts to boost employment were undertaken (Prachowny, 1993).

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\* The authors are staff of the Research Department, Central Bank of Nigeria, Abuja. The usual disclaimer applies.

While the inverse relationship between unemployment and output is widely accepted among economists, a broader set of labor market variables such as the size of the labor market, the average number of hours worked, as well as the productivity levels of workers can significantly affect production. Various attempts to verify the validity of Okun's law across different economies using the alternative versions of the law such as gap, difference, and dynamic versions, have presented varying outcomes in reaction to the divergent economic climate, business cycle, and employment trend peculiar to the economies (Akram, 2014; Obst, 2022).

Related studies by Pehlivanoglu and Tanga (2016) and Hashmi et al. (2021) conducted for the BRICS countries show divergent outcomes. While Hashmi et al. (2021) confirm the existence of the Okun's law in BRICS countries, Pehlivanoglu and Tanga (2016) observed that the law does not hold for Brazil, South Africa and Turkey. In addition, Pehlivanoglu and Tanga (2016) and Hashmi et al. (2021) investigated only the link between unemployment and output, ignoring the role of population growth in determining unemployment, particularly, in the BRICS countries that have high populations. Population expansion tends to increase the level of unemployment in an economy if not effectively managed (Keynes, 1930 cited in Ali et al., 2021). This opposing outcome and the lack of inclusion of population growth in their models form part of the motivation for undertaking this study.

We also draw our motivation from the fact that the systemic fragility that often characterises emerging market economies across the globe exposes them to high unemployment and low growth and policymakers need to have a strong understanding of the direction and degree of relationship that exists between unemployment and output in order to design relevant policies. The current study seeks to also ascertain if the advantage of a high population prevalent in the BRICS, particularly China and India, as well as Nigeria could translate into improved productivity so as to provide bespoke policy suggestions suitable to the peculiarities of the BRICS countries and Nigeria. Theoretically, increase in output is expected to create employment and reduce unemployment. This may not be the case in most of the developing countries and emerging economies, including BRICS and Nigeria. It is observed that output and unemployment coexist (output and unemployment increase simultaneously) in most of these countries such as India and Nigeria. This could be attributed to the expansion in population without corresponding increase in employment opportunities in the countries. Therefore, the specific objectives of the study are to validate the Okun's law using output (GDP), potential output (GDP\*) and output gap (OGAP)

in order to engender a clear understanding of the inherent relationship that exists between output and unemployment and help strengthen policy formulation.

The contribution of our study is in the area of estimation of various forms of the Okun's law by incorporating the role of population growth in determining unemployment in the BRICS countries and Nigeria. In addition, our study sheds light on the significance of considering population growth in estimating the Okun's law. The choice of BRICS countries and Nigeria is informed from the fact that they constitute more than 40.0 per cent of the world population, and population growth is an important component of efforts to curb unemployment rate and boost productivity. The inclusion of Nigeria in the study was informed by the fact that Nigeria and most of the BRICS countries share somethings in common particularly in the area of population size and level of economic development. To the best of our knowledge, no previous studies on the subject in respect of the BRICS accounted for the impact of population.

The paper is structured into five sections. Section I presents the introduction, Section II presents relevant literature review. Section III focuses on the methods and materials of the study, while Section IV renders the results and discussion. Section V concludes the paper and offers policy recommendations.

## II. Literature Review

### II.1 Theoretical Literature

The theoretical framework for our study is the Okun's law, which explained the inverse relationship between output and unemployment. The Okun's law can be further explained with traditional economic theories of the Keynesian school, classical school, and the Phillips curve. The Keynesian theory focuses on aggregate demand and posits that there exists a trade-off between unemployment and inflation. The theory also emphasises the impact of aggregate demand on inflation and output. Keynes proposed that to curb unemployment, the government should boost its fiscal activities to encourage aggregate demand (Logan, 2022; Yoshikawa, 2022), as this will have a positive impact on growth. The theory suggests that changes in aggregate demand will result in a greater impact on output and employment in the short-run. Keynesian school of thought emphasizes cyclical unemployment and contends that involuntary unemployment does not exist because it is illogical (Kahn, 2022). The absence of involuntary unemployment leads to demand and supply equilibrium. Similar views were presented in the Phillips Curve proposition, which illustrates the trade-off between unemployment and inflation. It suggests that economic growth would be accompanied by inflation which would also lead to more jobs

and a decline in the unemployment rate. However, the events of the 1970s which saw both inflation and unemployment rising, culminating in stagflation, has somewhat disproven the original concept of the Philips curve. The New Classical approach gained prominence in the early 1970s following the pioneering works of Lucas (1997). It assumes wage and price flexibility and concludes that the economy can attain its long-run equilibrium spot at full employment and possible output due to the flexibility of wage and price (Otani et al., 2022). The new classical model argues that labor supply has a direct link to changes in productivity (Darity & Goldsmith, 1996).

The Keynesian postulation has been criticised for its strong focus on aggregate demand. Government spending can potentially crowd-out the private sector which is expected to be the major employer of labour (Kaharudin & Ab-Rahman, 2022). The theory has also been criticised for leaning towards a centrally planned economy and ignoring the effects of market forces, thus projecting a totalitarian system (Hayek, 2009).

## II.2 Empirical Literature

There exist a plethora of empirical studies seeking to ascertain the relevance, significance, and validity of Okun's law across jurisdictions and time. Though consensus exists supporting the inverse relationship between unemployment and output in literature (Elshamy, 2012; Alamro et al., 2014; Yildiz et al., 2017), some studies have divergent findings (Kreishan, 2011; Kallman & Nordell, 2012; Guisinger et al., 2015; Srinivas, 2018). Also, the question around the validity and significance, as well as the magnitude of estimated coefficients, which have been found by several studies to vary across jurisdictions, have led to mixed conclusions. This often form the basis for empirical discussions on Okun's law.

Lee (2000), Moazzami and Dadgoster (2009), Kitov (2011), Kargi (2016) and Rahman and Mustafa (2017) centered their works on developed countries and countries of the Organisation for Economic Co-operation and Development (OECD). While examining the validity of Okun's law for 19 selected developed economies over 1970-2013, Rahman and Mustafa (2017) found co-integrating relationship between the rate of unemployment and real GDP growth in all the countries except for Germany. Their estimates of the bivariate error-correction model (ECM) revealed the validity of Okun's law in the USA and South Korea, but relatively weaker evidence of the validity of the law in Canada, France, Italy, Japan, Finland, Netherlands, UK, Australia, and New Zealand. In a similar study, Kitov (2011) found the validity of Okun's law in developed countries like the United States, France, the United Kingdom, Australia, Canada and Spain.

Kitov's findings showed that the countries did not exhibit structural unemployment and the persistence of high unemployment was a fallout of a low rate of real GDP growth.

Moazzami and Dadgostar (2011), using quarterly data from 13 OECD countries examined the validity of the inverse relationship between unemployment and real economic growth within an error correction modelling (ECM) framework and found overwhelming support for Okun's law. Similarly, from Kargi (2016), result of the test conducted for 34 OECD countries showed valid evidence for the reversed relationship between unemployment and growth proposed by Okun. Nonetheless, Kargi's study did not see a consistent unemployment rate in high-growth-rate OECD countries, while the unemployment rate in countries with the lowest growth rate exhibited a high trend.

Using three filtering techniques, Acaroglu (2018) tried to validate the consistency of Okun's law in G-20 countries with the gap specification method. The study confirmed the existence of Okun's proposed inverse relationship between unemployment and output in most of the countries, but the divergent development structures and productivity heterogeneities of the countries engendered different Okun's coefficients, while countries like China, Indonesia, Saudi Arabia and, Turkey did not satisfy the Okun coefficient.

The applicability of Okun's law in the context of developing economies exists, albeit less impressive compared with developed economies. This is largely a fallout of a myriad of other structural challenges, which have an important impact on output. Ball et al. (2019) posited that the fit of the law in developing economies is half as good relative to advanced economies. They noted that indices of overall labor and product market flexibility do not play a consistent role with the Okun coefficient. An earlier study conducted by Moosa, (2008) for four Arab countries of Algeria, Egypt, Morocco and Tunisia revealed that Okun's law coefficient is not statistically significant and output growth does not translate into higher employment. A similar study carried out by Ahmed et al. (2011) to test the relevance of Okun's law in Pakistan's economy using a different version and the gap version, revealed that neither of the models proved the existence of Okun's law in the Pakistani economy. Bankole and Fatai (2013) also held the same position in their study conducted for Nigeria using time series data from 1980-2008. Their regression result showed a positive coefficient, thus defying Okun's inverse relationship proposition. Their outcome differs from that of Ola-David et al. (2016) who found that a long-run inverse relationship exists between unemployment and output in Nigeria. However, the result showed a weaker

relationship with a coefficient of 1.8 per cent relative to the 3.0 per cent coefficient in the original Okun's law.

A recent study by Elhorst and Emili (2022) using data from twelve provinces in the Netherlands, covering four major economic downturns over the period 1974-2018 revealed that Okun's law is dominated by the relationship that runs from output growth to unemployment and the degree to which spillover effects to neighboring regions and output multiplier effects are accounted for determines the level of growth required to reduce unemployment level. Kizilkaya and Kuzucu, (2022) tested the validity of Okun's law in the so-called Fragile Five countries of Brazil, Indonesia, India, South Africa and Turkey using unemployment and GDP data spanning the period 1991-2000. The result from the Durbin-H cointegration test reveals no long-term cointegrating relationship between the real GDP output gap and the unemployment output gap. Their findings also show that an increase in GDP does not always culminate in a decrease in unemployment in the countries of the Fragile Five.

Other studies sought to ascertain the behavior of Okun's law in a business cycle by applying regime-dependent specification of the law, where the negative relationship that exists between output and unemployment is varied across recessions and expansions. The study by Crespo-Cuaresma (2003) for the US economy showed that the contemporaneous effect of output on unemployment is asymmetric and higher during recessions compared to expansions. Shocks to unemployment were also found to be more persistent during the period of expansion. Later works of Onyang and Sekhposyan, (2012), and Donayre (2022) had similar findings. Onyang and Sekhposyan (2012) found that business cycles and the breakdowns in Okun's law appear to be closely related and the biggest shifts in the coefficients' detected break dates coincided with recessions. Similarly, Donayre (2022) computed a threshold regression of output and unemployment using US data for 1949-2020. The study concluded that the link between Okun's Law and three endogenously determined regimes namely, expansions, light recessions and major recessions, becomes steeper, thus highlighting the necessity for various government's response during recessions.

The relevance of Okun's law in BRICS has also been tested in the works of Pehlivanoglu and Tanga (2016) and Hashmi et al. (2021). Hashmi et al. (2021) used disaggregated data covering pre and post-global financial crisis periods of 1991-2008 and 2009-2018, respectively. Findings from the three econometric models; constant-coefficient method (CCM), fixed effects method (FEM) and pooled mean group (PMG) employed in the study support the validity of Okun's

law in BRICS. However, Okun's law estimates were found to be larger in the post-crisis period compared with estimates in the pre-crisis period and those from the full sample. The disaggregated data results revealed that private consumption, government expenditures, exports, and imports were relevant in determining changes in the unemployment rate but consumption expenditure is the main determinant of unemployment rate. Pehlivanoglu and Tanga (2016) used annual time series data covering 1990-2014 for BRICS countries and Turkey and employed the Engle granger co-integration test and Fully Modified OLS. Their findings reveal that Okun's law is not valid for Brazil, South Africa and Turkey.

The review above shows that much effort has been put into verifying the validity of Okun's law in different economies. However, none of the studies, including those of Pehlivanoglu and Tanga (2016) and Hashmi et al. (2021), which were specific to BRICS included population growth in their models. This constitutes a major contribution of our paper, as the inclusion of population growth could change the dynamics of the outcome especially as countries of BRICS and Nigeria make up over 40.0 per cent of the world population. In addition, none of the studies conducted for the BRICS included Nigeria, a gap, which our study hopes to bridge. Given that Nigeria is an important emerging economy and the largest economy in Africa, understanding the relationship between its unemployment and output in relation to other notable emerging economies could throw up important outcomes necessary for policy.

### III. Methods and Materials

We investigate the existence of Okun's law in the BRICS countries (Brazil, Russia, India, China, and South Africa) and Nigeria. A panel Autoregressive Distributed Lag (PARDL) model was employed in the analysis. The Hausman test was conducted to determine which of the mean group (MG), pooled mean group (PMG) and dynamic fixed effect (DFE) is consistent and efficient in explaining the relationship between unemployment and output in the BRICS and Nigeria. The PARDL was employed to estimate the relationship between output proxied by GDP and unemployment, between potential output and unemployment and between the output gap and unemployment. The Panel Autoregressive Distributed Lag (PARDL) model propounded by Pesaran and Shin (1999) was used because the variables under study were found to be integrated in a mixed order of  $I(0)$  and  $I(1)$ .

Annual data from 1993 to 2020 for Brazil, Russia, India, China, South Africa (BRICS) and Nigeria were sourced from the World Bank (2020) database. The period 1993 to 2020 was chosen due to data availability at the time of this study. We draw



our theoretical framework from the original Okun's law model. The simple Okun's law suggests that employment rate and output relate positively, hence output and unemployment relate negatively. Okun's law posited that to achieve a 1.0 per cent reduction in unemployment, output (GDP) should grow by 4.0 per cent. Also, the law postulated that potential output should grow annually by 2.0 per cent to achieve a 1.0 per cent reduction in unemployment (Okun, 1962).

Variables captured in our models are based on theoretical foundation, institutional knowledge and empirical evidence. The Okun's law is about the connection between unemployment and output, which we intend to establish. The inclusion of population growth as the determinant of unemployment was backed by the Keynes (1930) theory of unemployment which observed a strong relationship between unemployment and population growth. Also, studies such as Afolabi and Babalola (2020) and Ali et al. (2021) support the assertion that population growth could be a major determinant of unemployment in an economy.

Following the simple Okun's law (1962):

$$U_t = \beta Y_t + \varepsilon_t \quad (1)$$

where,  $U_t$  represents unemployment rate,  $Y_t$  represents the output,  $\beta$  is a negative coefficient that shows that the Okun's law relates output and unemployment negatively.

We adapt the simple Okun's law (model), and modify it to incorporate population growth as a control variable, given the role of population growth in determining unemployment and output.

The PARDL model specified in accordance with the Okun's law is as follows:

$$\Delta UNEM_{i,t} = \alpha_{0,t} + \sum_{i=1}^p \alpha_{i,t} \Delta UNEM_{i,t-p} + \sum_{i=0}^{q1} \beta_{1,t} \Delta \text{LogGDP}_{i,t-q1} + \sum_{i=0}^{q2} \beta_{2,t} \Delta \text{POP}g_{i,t-q2} + \tau 1 \text{ECM}(-1) + \varepsilon_{1,t} \quad (2)$$

where,  $i$  is the cross-sectional identifier ranging from 1, 2, -----,  $N$ ,  $N$  is the last country understudied,  $t$  is the period identifier ranging from 1, 2, 3, -----,  $T$ ,  $T$  is the end period of the study,  $UNEM$  is unemployment rate,  $\text{LogGDP}_{it}$  is the natural logarithm of GDP,  $\text{POP}g_{it}$  is population growth at the time  $t$ ,  $\alpha_{0t}$ ,  $\alpha_{it}$ ,  $\beta_{1t}$  and  $\beta_{2t}$  are the vectors of the parameters of the model,  $\tau 1$  is the error correction term or the speed of adjustment and  $\varepsilon_{1t}$  is the error term for the model. Following the Okun's

proposition, GDP should grow by 4.0 per cent to achieve 1.0 per cent reduction in unemployment.

This implies that a 1.0 per cent increase in the growth rate of output (GDP), will lead to a 0.3 per cent reduction in unemployment in an economy, hence 0.3 is a prior achieved from the Okun's law.

The second model of this study was specified using potential output (GDP\*) as the independent variable in place of GDP as shown in equation (3).

$$\Delta UNEM_{i,t} = \alpha_{1,t} + \sum_{i=1}^p \beta_{3,t} \Delta UNEM_{i,t-p} + \sum_{i=0}^{q1} \beta_{4,t} \Delta \text{LogGDP}^*_{i,t-q1} + \sum_{i=0}^{q2} \beta_{5,t} \Delta \text{POP}g_{i,t-q2} + \tau 2 \text{ECM}(-1) + \varepsilon_{2,t} \quad (3)$$

where, LogGDP\* is the natural logarithm of potential output in the BRICS countries,  $\alpha_{1,t}$ ,  $\beta_{3,t}$ ,  $\beta_{4,t}$ , and  $\beta_{5,t}$  are the parameters of the model and  $\tau 2$  is the Error Correction term and the speed of adjustment. Equation (3) was modified to capture the Okun's proposition that potential output is important in determining unemployment. To him, potential output needs to grow by 2.0 per cent to achieve a 1.0 per cent reduction in unemployment.

The third model of this study was specified using output gap (OGAP) as the independent variable in place of GDP and GDP\* as shown in equation (4).

$$\Delta UNEM_{i,t} = \alpha_{2,t} + \sum_{i=1}^p \beta_{6,t} \Delta UNEM_{i,t-p} + \sum_{i=0}^{q1} \beta_{7,t} \Delta \text{OGAP}_{i,t-q1} + \sum_{i=0}^{q2} \beta_{8,t} \Delta \text{POP}g_{i,t-q2} + \tau 3 \text{ECM}(-1) + \varepsilon_{3,t} \quad (4)$$

where, OGAP is the output gap (difference between actual output and potential output) in the BRICS countries and Nigeria,  $\alpha_{2,t}$ ,  $\beta_{6,t}$ ,  $\beta_{7,t}$ ,  $\beta_{8,t}$  are the parameters of the model and  $\tau 3$  is the Error Correction term and the speed of adjustment.

From the foregoing arguments, we estimate the Okun's law using the two approaches introduced by him in his theoretical foundation. In the first approach, we estimate equation (2) with GDP as the output and independent variable. Secondly, we estimate equation (3) with potential output GDP\* as the independent variable. Finally, equation (4) was estimated with the output gap as the independent variable. Population growth in all the models is the control variable given the level at which the population is growing in these countries.

## IV. Results and Discussion

### IV.1 Summary statistics

Table 1 presents summary statistics for unemployment, gross domestic product and population growth in the BRICS countries and Nigeria. On average, the unemployment rate, GDP, potential GDP, population growth and output gap for the BRICS countries and Nigeria stood at 9.2 per cent, US\$1,595.91, US\$1,595.91, 1.2 per cent and stood at 0.0 per cent, respectively. The standard deviation of unemployment and population growth were found to be less than the mean, hence there is a low deviation, while the standard deviation of GDP, potential GDP and the output gap are higher than the mean, implying that there was high deviation of the mean of GDP from the actual GDP.

Table 1: Summary Statistics

<b>Var.</b>	<b>Observation</b>	<b>Mean</b>	<b>SD</b>	<b>Min.</b>	<b>Max.</b>
<b>UNEM</b>	168	9.18	7.36	2.60	29.20
<b>GDP</b>	168	1595.91	2705.50	27.75	14722.73
<b>GDP*</b>	168	1595.91	2101.26	-214.33	9165.72
<b>POPg</b>	168	1.23	0.87	-0.42	2.72
<b>OGAP</b>	168	0.00	1303.01	-6035.87	7701.29

Source: Author's compilation.

Note: GDP is Gross Domestic Product, GDP\* is potential GDP, UNEM is unemployment, POPg is population growth. SD is standard error, Min is minimum, Max is maximum and Var is variables.

### IV.2 Correlation Results

Table 2 presents the correlation coefficients that show the degree of the relationship between unemployment, GDP, population growth rate and the output gap in the BRICS countries and Nigeria. The result reveals a negative correlation between unemployment rate and output (GDP), unemployment rate and potential output (GDP\*), and unemployment and output gap (OGAP), while a positive correlation was found between unemployment rate and population growth rate in the BRICS countries. This is consistent with the Okun's law, which is the theoretical framework of this study. Since the correlation coefficients were less than 0.8, then we conclude that there is no multicollinearity between the independent variables of this study.

Table 2: Pairwise Correlation Coefficients

Variables	UNEM	GDP	GDP*	POPg OGAP
UNEM	1.000			
GDP	-0.28	1.000		
GDP*	-0.22	0.88	1.00	
POPg	0.05	-0.35	-0.31	1.000
OGAP	-0.22	0.65	0.22	-0.22
				1.0000

Source: Authors' compilation.

Note: GDP\* is potential GDP.

### IV.3 Unit Root Test Result

Tables 3a and 3b contain the panel unit root test result using Im, Pesaran and Shin (IPS) and Levin-Lin-Chiu (LLC). The IPS test result reveals that potential output and population growth rates across the BRICS countries and Nigeria were stationary at levels as indicated by their probability values of less than 1.0 per cent, while unemployment rate, output (LogGDP) and output gap (OGAP) became stationary at first difference as indicated by their probability values of greater than 5.0 per cent. This implies that the null hypothesis of the unit root was rejected at levels for potential output and population growth rate, while at the first difference for unemployment rate (UNEM) and output (LogGDP). On the other hand, the LLC test result shows that all the variables of the model except unemployment rate were stationary at levels. This implies that the null hypothesis of the unit root was rejected at levels for population growth rate (POPg), while at the first difference for unemployment rate (UNEM), output (LogGDP), potential output (LogGDP\*) and output gap (OGAP). The unit root result shows a mixed level of integration of the variables of the study (that is I(0) and I(1)). This justifies the choice of PARDL as a model of analysis in this study.

Table 3a: Panel Im-Pesaran-Shin (IPS) Unit Root Results

Variables	Levels	First Dif.	Levels of integration
UNEM	0.170	-4.335***	I(1)
LogGDP	0.564	-3.293***	I(1)
LogGDP*	-17.392***		I(0)
OGAP	-1.190	-4.266***	I(1)
POPg	-2.404***		I(0)

Source: Authors' compilation.

Table 3b: Panel Levin-Lin-Chiu (LLC) Unit Root Results

<b>Variables</b>	<b>Levels</b>	<b>First Dif.</b>	<b>Levels of integration</b>
<b>UNEM</b>	0.838	-3.219***	I(1)
<b>LogGDP</b>	-1.690**		I(0)
<b>LogGDP*</b>	-17.166***		I(0)
<b>OGAP</b>	-3.638***		I(0)
<b>POPg</b>	-3.047***		I(0)

Source: Authors' compilation.

Note: \*\*\*, \*\* and \* is stationary at 1%, 5% and 10% significance level, respectively.

#### IV.4 Hausman Test

Hausman test was conducted to ascertain the estimator that is consistent and efficient among the mean group (MG), pooled mean group (PMG) and the dynamic fixed effect (DFE) estimators under the null hypothesis that difference in coefficients is not systematic. The decision to accept or reject the null hypothesis lies on the probability values of the Hausman statistics. This study adopts the 5.0 per cent significance level for the choice of the estimators used. Table 4 presents the Hausman test results for models I, II and III respectively. The results reveal that for model I, the dynamic fixed effect estimator is the best and more efficient in assessing the relationship between unemployment and output in the BRICS and Nigeria. The study also finds that for model II, the mean group (MG) estimator is the best and most consistent in assessing the relationship between unemployment and potential output in the countries being studied. For model III, pooled mean group (PMG) is the best estimator to assess the relationship between unemployment and output gap in the BRICS and Nigeria given their probability values. The study, therefore, interpreted the results of the dynamic fixed effect for model I, the mean group for model II and pooled mean group for model III, as shown in Table 4.

Table 4: Hausman Test Results

Model I		Model II		Model III	
Chi-Square	Probability	Chi-Square	Probability	Chi-Square	Probability
(MG&PMG)		(MG&PMG)		(MG&PMG)	
1.50	0.4713	6.72	0.0347	4.72	0.0945
Accept PMG & reject MG		Reject PMG & Accept MG		Accept PMG & reject MG	
(PMG&DFE)				(PMG&DFE)	
7.16	0.0279			-18.09	
Reject PMG & Accept DFE				Rejected DFE & accept PMG	
DFE was interpreted		MG was interpreted		PMG was interpreted	

Source: Authors' computation.

#### IV.5 Panel ARDL Regression Results

Table 5 presents the panel ARDL regression results of the models selected based on the Hausman test. The results of the dynamic fixed effect, mean group and pooled mean group estimators show that the coefficients of their respective measure of output carried the expected negative sign. Furthermore, coefficients of output (-3.20), and output gap (-0.003) were statistically significant at the 1.0 per cent and 5.0 per cent levels of probability respectively, implying that an increase in these two measures of output, in the short-run, could engender a significant reduction in unemployment in the reviewed countries. Precisely, a 1.0 per cent increase in actual output (GDP), and output gap (OGAP) could lead to a 3.2 per cent, and 0.003 per cent reduction in unemployment, respectively, in the short-run. This corroborates the Okun's law which proposed a negative relationship between unemployment and output. It also corroborates Hashmi et al. (2021) who found a negative relationship between output and unemployment, emphasising that the Okun's law was valid and can be used for policy formulation aimed at increasing growth and reducing unemployment. However, our study differs from Hashmi et al. (2021) by incorporating population growth into our model and adding Nigeria to BRICS countries, based on the assumption that, they have some common features, especially India and China. This finding is contrary to the finding of Ahmed et al. (2011) and Bankole and Fatai (2013) who in their separate studies found a positive relationship between output and unemployment rate. However, our study is an extended study, as it captures more than one country, while Ahmed et al. (2011) studied the validity of Okun's law in Pakistan and Bankole and Fatai (2013) focused on the validity of Okun's law in Nigeria.

In all three models, besides showing mixed signs, population growth did not exert any significant influence on unemployment in the BRICS countries and Nigeria, in the short-run. This is not the case in models II and III, where population growth had a negative but insignificant influence on unemployment. This finding shows that population growth does not have a significant influence on unemployment in the countries reviewed in the short-run. Model I shows a consistent result with a positive coefficient but models II and III show an inconsistent result. This could be inconsistent with the theoretical expectation of this study, but an increase in population, particularly the active population may likely increase the labour force available for productive activities, which could translate into enhanced economic growth, thereby reducing unemployment. This implies that population could reduce unemployment rate if directed to production. Again, this is not surprising as some of the BRICS countries, especially China and India deployed

their population effectively in productive activities, which translates into an increase in output and a reduction in unemployment rates.

The long-run result for actual output and the output gap mirrored those reported for the short-run. Actual output (GDP) and the output gap significantly and negatively impacted unemployment in line with a priori expectations. This implies that an increase in output and output gap could reduce unemployment in the long-run the BRICS and Nigeria. Precisely, a 1.0 per cent increase in output, and output gap may likely lead to 0.8 per cent and 0.004 per cent reduction in unemployment in reviewed countries in the long-run. This also corroborates the Okun's law (1962). It also corroborates Hashmi et al. (2021) who found a negative relationship between output and unemployment, but contrary to the finding of Ahmed et al. (2011) and Bankole and Fatai (2013) who found a positive relationship between output and unemployment rate.

In the long-run population growth was found to have a negative and significant impact on unemployment when actual output was used, but had a negative and insignificant impact on unemployment when potential output and output gap are considered. The negative coefficient of population growth of -4.20 implies that a 1.0 per cent rise in population growth may likely lead to 4.2 per cent reduction in unemployment when actual output was used. This is not consistent with the Keynesian theory of unemployment, but effective utilisation of population, particularly in productive ventures could raise output thereby reducing unemployment in the economy. This further supports the short-run results and shows how the BRICS countries and Nigeria used their population to achieve high output and employment in the long-run.

Table 5: The Short and Long-run Panel ARDL Regression Results

Var.	Model 1(DFE)	Var.	Model 2(MG)	Var.	Model 3(PMG)
<i>Short-run</i>					
C	4.07(1.18)***	C	16.87(4.21)***	C	1.15(0.79)
$\Delta\text{LogGDP}$	-3.20(0.55)***	$\Delta\text{LogGDP}^*$	-1.46(1.61)	$\Delta\text{OGAP}$	-0.003(0.001)**
$\Delta\text{POPg}$	0.36(1.97)	$\Delta\text{POPg}$	-3.22(5.49)	$\Delta\text{POPg}$	-0.78(5.88)
ECM	-0.19(0.05)***		-0.50(0.12)***		-0.05(0.06)
<i>Long-run</i>					
LogGDP	-0.77(0.56)	LogGDP*	-2.89(2.40)	OGAP	-0.004(0.002)**
POPg	-4.20(1.75)**	POPg	-7.59(5.22)	POPg	-1.92(1.22)

Source: Authors' compilation.

Note: Values in the parenthesis () are the standard errors,\*\*\*, \*\* and \* is 1%, 5% and 10% significance levels, respectively, Var is variables.

#### IV.5 Cross-sectional Panel ARDL Regression Results

Table 6 presents the short-run panel ARDL results for the individual countries to ascertain the presence or otherwise of Okun's law in the countries. The results revealed that actual output, potential output and output gap all have a negative and significant impact on unemployment in Brazil, Russia, India and South Africa. The implication of the result is that increase in actual output, potential output and output gap may likely lead to a reduction in unemployment in the short-run in Brazil, Russia, India, and South Africa. This conforms to the validity of the Okun's law in the respective countries. In Nigeria only LogGDP and OGAP have a negative and significant impact on unemployment in the short-run, implying that an increase in actual output and output gap may likely lead to a reduction in unemployment in Nigeria. The result also reveals that only the output gap (OGAP) has a negative and significant impact on unemployment in China in the short-run. This implies that an increase in the output gap may likely reduce unemployment in China in the short-run.



Table 6: Cross-sectional Panel short-run ARDL Results

Var.	Model 1	Var.	Model 2	Var.	Model 3
<i>Brazil</i>					
C	5.30(8.15)	C	7.13(25.01)	C	1.85(1.11)
$\Delta\text{LogGDP}$	-2.04(0.94)	$\Delta\text{LogGDP}^*$	-6.71(20.39)	$\Delta\text{OGAP}$	- 0.002(0.000)***
$\Delta\text{LogGDP}(-1)$	-1.24(1.14)				
$\Delta\text{POPg}$	19.54(316.53)	$\Delta\text{POPg}$	-0.86(405.05)	$\Delta\text{POPg}$	27.40(94.17)
$\Delta\text{POPg}(-1)$	-7.40(302.02)				
ECM	-		-		-0.05(0.01)***
	0.19(0.001)***		0.20(0.004)***		
<i>Russia</i>					
C	6.21(7.06)	C	9.45(13.01)	C	2.06(0.59)**
$\Delta\text{LogGDP}$	-2.92(0.58)**	$\Delta\text{LogGDP}^*$	-9.54(9.68)	$\Delta\text{OGAP}$	- 0.000(0.000)***
$\Delta\text{LogGDP}(-1)$	0.67(0.65)				
$\Delta\text{POPg}$	3.46(104.59)	$\Delta\text{POPg}$	9.03(33.41)	$\Delta\text{POPg}$	-5.23(9.47)
$\Delta\text{POPg}(-1)$	-1.27(103.06)				
ECM	-0.36(0.02)***		-0.36(0.02)***		-0.27(0.01)***
<i>India</i>					
C	24.32(96.09)	C	8.79(10.53)	C	-1.51(1.38)
$\Delta\text{LogGDP}$	-0.70(0.74)	$\Delta\text{LogGDP}^*$	-1.73(0.68)*	$\Delta\text{OGAP}$	- 0.002(0.000)***
$\Delta\text{LogGDP}(-1)$	0.93(0.66)				
$\Delta\text{POPg}$	-16.00(31.90)	$\Delta\text{POPg}$	-10.12(37.16)	$\Delta\text{POPg}$	-0.78(5.88)
$\Delta\text{POPg}(-1)$	17.63(45.54)				
ECM	-1.16(0.26)**		-0.29(0.01)***		-0.05(0.06)
<i>China</i>					
C	-0.08(0.70)	C	0.35(0.34)	C	-0.003(0.002)
$\Delta\text{LogGDP}$	0.01(0.51)	$\Delta\text{LogGDP}^*$	0.61(0.10)***	$\Delta\text{OGAP}$	- 0.000(0.000)***
$\Delta\text{LogGDP}(-1)$	0.49(0.32)				
$\Delta\text{POPg}$	-3.71(21.77)	$\Delta\text{POPg}$	-3.73(5.76)	$\Delta\text{POPg}$	-3.74(2.42)
$\Delta\text{POPg}(-1)$	-0.96(7.89)				
ECM	-0.003(0.001)		-		-
			0.02(0.000)***		0.002(0.000)***
<i>South Africa</i>					
C	9.09(45.32)	C	28.71(68.52)	C	4.07(12.50)
$\Delta\text{LogGDP}$	-5.80(8.00)	$\Delta\text{LogGDP}^*$	-0.16(1.57)	$\Delta\text{OGAP}$	- 0.004(0.000)***
$\Delta\text{LogGDP}(-1)$	-4.26(9.65)				
$\Delta\text{POPg}$	32.58(206.63)	$\Delta\text{POPg}$	-14.98(118.60)	$\Delta\text{POPg}$	-9.49(95.30)
$\Delta\text{POPg}(-1)$	-28(206.23)				
ECM	-0.22(0.03)***		-0.61(0.04)***		-0.13(0.01)***

Nigeria					
C	0.24(0.91)	C	1.08(3.26)	C	0.42(0.49)
ΔLogGDP	-2.38(0.84)*	ΔLogGDP*	2.11(2.81)	ΔOGAP	-0.008(0.000)***
ΔLogGDP(-1)	-1.85(0.86)				
ΔPOPg	15.16(206.37)	ΔPOPg	-26.22(148.17)	ΔPOPg	-12.59(55.62)
ΔPOPg(-1)	-				
	15.90(161.73)				
ECM	0.02(0.002)***		-		-0.02(0.01)**
			0.03(0.004)***		

Source: Authors' compilation.

Note: Values in the parenthesis () are the standard errors,\*\*\*, \*\* and \* is 1%, 5% and 10% significance levels, respectively, and Var is variables.

#### IV.6 Robustness Checks

Table 7 presents the robustness results for the Okun's law in the BRICS countries only without Nigeria using the PARDL/PMG panel analysis. The results revealed that both actual output (LogGDP), potential output (LogGDP\*) and the output gap (OGAP) affect unemployment in the BRICS countries negatively both in the short- and long-run. This implies that an increase in the actual output, potential output and the output gap in the short- and long-run may likely lead to a decrease in unemployment rate in the countries. This is consistent with the theoretical expectation of this study, and also supports the results obtained in the main analysis, which support the existence of the Okun's law in the BRICS countries even without Nigeria.

Table 7: Robustness Results (ARDL/PMG)

Variables	Model 1	Variables	Model 2	Variables	Model 3
<i>Short-run</i>					
C	5.53(3.25)*	C	18.91(7.66)**	C	3.30(2.73)
LogGDP	-	LogGDP*	-10.85(8.19)	OGAP	-
	2.45(0.88)***				0.001(0.00)***
POPg	7.37(5.01)	POPg	0.62(3.79)	POPg	6.93(8.44)
<i>Long-run</i>					
LogGDP	-	LogGDP*	-	OGAP	-0.04(0.03)
	4.08(0.93)***		3.31(0.62)***		
POPg	3.79(2.90)	POPg	-	POPg	-3.46(3.29)
			8.05(1.55)***		

Source: Authors' computation.

Note: Values in the parenthesis () are the standard errors, \*\* and \* is 1% and 5% significance levels, respectively.

## V. Conclusion and Policy Recommendations

This study investigates the validity of the Okun's law in the BRICS countries and Nigeria using annual data between 1993 and 2020 from the World Bank database (2020). We employ Panel Autoregressive Distributed Lag (PARDL) model in estimating the relationship in the selected countries. We find that both actual output and output gap affect the unemployment rate negatively and significantly, in the BRICS countries and Nigeria, while, potential GDP affects unemployment negatively but insignificantly. This validates the Okun's law in the BRICS and Nigeria. It was found that a 1.0 per cent increase in actual output, and output gap may lead to a 3.2 per cent and 0.003 per cent reduction in unemployment in the BRICS countries and Nigeria. The study, concludes that the Okun's law exists in Brazil, Russia, India, South Africa and Nigeria, but exists in China only when the output gap is used as the independent variable. This study also, concludes that an increase in actual output, potential output and output gap may likely lead to a reduction in unemployment in the BRICS countries and Nigeria.

We, therefore, recommend the need for policymakers to take proactive measures to boost both nominal and potential output by fully diversifying the economy to enhance productivity in all sectors of the economy; this could achieve a desired reduction in the unemployment rate. We also recommend that the BRICS countries and Nigeria should deploy more of their population into technology-driven economic activities such as information and communication technology (ICT) and productive sectors that are labour intensive such as agriculture to absorb the available labour and boost output in order to lower unemployment rate.

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