The Impact of GDP and Its Expenditure Components on Unemployment Within BRICS Countries: Evidence of Okun’s Law From Aggregate and Disaggregated Approaches

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Abstract
This article examines the responsiveness of changes in the unemployment rate to changes in output for Brazil, Russia, India, China, and South Africa (BRICS) using aggregate and disaggregated data from 1991 to 2018. We also split the entire sample period into two subsamples (from 1991 to 2008 and 2009 to 2018) to see the responsiveness of changes in the unemployment rate to changes in the GDP in pre and post global financial crisis period of 2007–2008. Three different econometric methods were employed for conducting the analysis. Results obtained from aggregated and disaggregated data for the entire sample and two subsamples confirm the validity of the Okun law for BRICS. The postcrisis period Okun’s law estimates are larger than those from the full sample and precrisis period. Disaggregated data results show private consumption is the main determinant of the unemployment rate and its estimate is negative and significant. Along with consumption expenditures, other variables that have relevancy in determining changes in the unemployment rate are government expenditures, exports, and imports. Based on aggregated and disaggregated data results, it is recommended that the relevant authorities must focus sustainable economic growth for reducing unemployment rate in the country. Particularly, they must incentivize consumption and government expenditures, boost exports, and curtail imports for reducing the unemployment rate.

Keywords
Okun’s Law, BRICS, unemployment, panel regression, GDP and its expenditure components

Introduction
The inverse relationship between economic growth and unemployment rate, originally discovered and empirically estimated by Okun (1962), has evolved into a major macroeconomic postulation since then and is known as Okun’s law in his honor. It is termed as “empirical regularity” and is considered as a core constituent of macroeconomic theory and empirical research [Blinder (1997), Sørensen and Whitta-Jacobsen (2010), Dornbusch et al. (2011), Romer (2012), Sogner and Stiassny (2002), Mankiw (2012), Huang and Yeh (2013), and Ball et al. (2014)]. Okun (1962) observed fall in the unemployment rate in the years when the real output growth rate was high and vice versa. This phenomenon provides the basis for the theoretical relationship between unemployment rate and output growth: The increased workforce (reduced unemployment) must produce more goods and services. Okun’s relationship arises from the fact that more labor is typically required to produce more goods and services within the economy (Knotek, 2007). Economic growth creates employment opportunities and this has a negative effect on unemployment in the economy (Higgins, 2011).

Okun (1962) presented the relationship between economic growth and unemployment rate in a simple equation and it has been used as a rule of thumb since then (Knotek, 2007). Okun (1962) not only postulated a strong inverse relationship between gross national product (GNP) growth but also empirically estimated the magnitude of this relationship for the US. The underlying theory of this inverse relationship between GNP and...
unemployment is based on the fact that GNP includes receipts from abroad made as factor of payments to domestically owned factors of production. The empirical findings of Okun (1962) suggest that a 3% increase in output corresponds to a 1% decline in the rate of unemployment, that is, the ratio is 1:3. In other words, 1% fall in the unemployment rate results in 3% rise in gross domestic product (GDP) and vice versa. This magnitude of impact of output on unemployment and vice versa empirically estimated through Okun’s Coefficient is also known as Okun’s law coefficient (OLC).

This study also estimates Okun’s (1962) law for Brazil, Russia, India, China, and South Africa (BRICS) and makes two contributions to the relevant empirical literature. First, it uses disaggregated data to examine the impact of expenditure components of GDP/aggregate demand on unemployment rate. Second, the article focuses on BRICS, which have received less attention from researchers around the world. There are few studies that have examined different aspects of Okun’s law such as its validity, stability, and linearity/symmetry for BRICS. Pehlivanglu and Tanga (2016) focused the validity of Okun’s law for Turkey and BRICS. They employed Engle cointegration test and fully modified ordinary least square (FMOLS) for estimating the law in gap and first version. Their findings presented mixed results: Okun’s law is valid only for China, India, and Russia. Using Engle Granger co-integration tests and FMOLS estimated gap version of Okun’s law. Like Pehlivanglu and Tanga (2016), this study also finds mixed results; that is, it is valid for some countries and invalid for others. Our article is different from the preceding studies in three respects. First, it uses a disaggregated as well as aggregate data. Second, it uses three different econometric techniques; that is, constant coefficient method (CCM), fixed effects method (FEM), and pooled mean group (PMG) for estimating difference version of Okun’s law. It is also important to examine nexus between unemployment rate and GDP for BRICS because apart from South Africa, rest of the member countries house 42% of the world population (i.e., 3 billion). Also combined GDP of countries and invalid for others. Our article is different from the preceding studies in three respects. First, it uses a disaggregated as well as aggregate data. Second, it uses three different econometric techniques; that is, constant coefficient method (CCM), fixed effects method (FEM), and pooled mean group (PMG) for estimating difference version of Okun’s law. It is also important to examine nexus between unemployment rate and GDP for BRICS because apart from South Africa, rest of the member countries house 42% of the world population (i.e., 3 billion). Also combined GDP of BRICS constituted 25.6% of the Global GDP in 2015 and is projected to reach 33% of the global economy by 2020 (Siddiqui, 2017). Hence, it is important to find out validity of Okun law for BRICS countries.

“Literature Review” section of the article presents a related literature review on various aspects of Okun’s law. “Model and Methodology” section discusses models for both aggregate and disaggregated approaches employed for examining interaction between changes in the unemployment rate and changes in the GDP. It also highlights econometric techniques used in the estimation. In “Data and Empirical Results” section, data discussion and results are provided. This includes discussion on cross-section dependency and panel unit root test results of the variables and “Model Estimation and Results” section presents estimation results from aggregate and disaggregated data along with detailed discussion. The “Conclusion” section provides conclusions drawn from the article.

Literature Review

Despite its empirical regularity and incorporation as a major macroeconomic rule, Okun’s Law (1962) has been extensively examined by the researchers around the world for ascertaining its validity, significance, and relevance over time and across regions/countries. Based on focus of the studies, empirical literature on Okun’s law can be classified into different categories. First, the major portion of the literature evaluates the validity of Okun’s law; that is, to ascertain whether there exists an inverse relationship between GDP growth and unemployment rate as found by Okun (1962). Such studies use different econometric methods on the data from individual countries as well as data on cross-section panels for estimating the difference version of Okun’s law and present mixed evidence. For instance, Weber (1995); Smith (2010); Elshamy (2012); Alamro and Al-Dalaien (2014); Khan and Saboor (2013); Yildiz et al. (2017); and Makaringe and Khobai (2018) lend support in favor of Okun’s law whereas Barreto and Howland (1993); Knotek (2007); Guisinger et al. (2015); Kreishan (2011); Kallman and Nordell (2012); Sadiku et al. (2015); Akram et al. (2014); Banda et al. (2016); and Srinivas (2018) conclude that Okun’s law does not hold in the sample countries. Furthermore, the magnitude of estimated Okun’s coefficients varies from country to country and is often markedly different from the one suggested by Okun (1962), that is the ratio of 1:3 does not hold in most of these studies.

However, panel studies that include Aghion and Howitt (1992); Baker and Schmidt (1997); Moazzami and Dadgostar (2009); Moosa (1997); Ball et al. (2017); Ball et al. (2014); Huang and Yeh (2013); Tatoglu (2011); Soylu et al. (2018); Dogru (2013); Garavan (2017); Altunoz (2019) confirm the validity of Okun’s Law. In this regard few exceptions are Moosa (2008); Lal et al. (2010); Pehlivanglu and Tanga (2016); and An et al. (2016). Panel studies further reveal that Okun’s law remains valid in almost all developed countries including the United States, Australia, Canada, New Zealand, Japan, and the countries in Europe/Eurozone except Sweden [Kallman and Nordell (2012)]. However, empirical panel studies on BRICS other developing and low-income countries in Asia, Africa, and South America do not lend support to Okun’s law [Moosa (2008); Lal et al. (2010); Pehlivanglu and Tanga (2016); Tanga (2016) and An et al. (2016)]. Bartolucci et al. (2018), however, finds support in favor of general validity of Okun’s law in developing as well-developed countries albeit showing differences in Okun’s coefficient between high- and low-income countries.

In addition to evaluating the validity of Okun’s law, several studies have focused the stability of estimated parameters of Okun’s law. Same to literature on the validity of Okun’s law, literature on the stability of estimated parameters from Okun’s law also presents mixed evidence. For example, Lee (2000), Huang and Chang (2005), Knotek (2007), Meyer and Tasci (2012), Zanin and Marra (2012), Anderton et al. (2014), Guisinger et al. (2015), Christl et al. (2017) conclude that Okun’s coefficient is not stable over time. On the contrary,
Weber (1995), Sogner (2001) and Michail (2019) find evidence of stability of OLC over time.

Another strand of literature evaluates nonlinearity and asymmetry in Okun’s law. Several studies analyze whether the relationship between unemployment and economic growth is linear or nonlinear. In other words, this strand of literature checks whether the impact of output on unemployment is the same during expansions and recessions (linear relation) or different during opposing business cycles (nonlinear relation); that is, a nonlinear association between unemployment and economic growth makes the relationship curve zigzag. In this regard, Viren (2001), Crespo-Cuaresma (2003), Huang and Chang (2005), Huang and Lin (2006), Fouquau (2008), Cevik et al. (2013), and Phiri (2014) find nonlinear relationship between the unemployment rate and the economic growth.

A similar thread of literature on Okun’s law studies asymmetry in the relationship between unemployment and economic growth. Asymmetry in the Okun’s law implies asymmetric effect of changes in output on changes in unemployment rate (Huang & Yeh, 2013). Harris and Silverstone (2001); Silvapulle et al. (2004); and Holmes and Silverstone (2006) find asymmetric relationships between output and unemployment over business cycle, whereas Lee (2000) studying 16 OECD countries find mixed evidence on asymmetric relationships between unemployment and economic growth. However, Fouquau (2008); Cevik et al. (2013); Coşar and Yavuz (2019) and Christopoulos et al. (2019) conclude asymmetric behavior of Okun’s Law over the business cycle. Asymmetric relation between the changes in unemployment rate and changes in output growth is attributed to wage rigidity, labor market regulation, labor hoarding, varying resource substitution, and changes in the growth rates of different sectors [Harris and Silverstone (2001) Holmes and Silverstone (2006) and Christopoulos et al. (2019)].

A common characteristic of all these studies is that they use an aggregate approach to study Okun’s Law by associating changes in the unemployment rate to changes in economic/GDP growth; that is, they evaluated the impact of changes in GDP on changes in the unemployment rate. However, the literature examining the effect of changes in aggregate demand components of GDP on changes in unemployment rate is limited. That is the effect of GDP components (e.g., expenditure components of GDP, i.e., consumption, investment, government expenditure, exports and imports; production components of GDP, i.e., agriculture, manufacturing, service sectors, and other sectors; and income components of GDP, i.e., share of wages, rental income, interest rate and profit) on unemployment rate has not received due focus from the researchers and policy makers despite huge policy implications.

Anderton et al. (2014) examine the effects of expenditure components of GDP on unemployment rate of 17 Euro area countries. Using the first difference version of Okun’s law and applying three different econometric techniques that include FEM, mean group, and generalized method of moments, they find that unemployment rate in Euro is sensitive to the changes in consumption component of GDP. Andonova and Petrovska (2018) also evaluate the impact of expenditures components of GDP using similar approach as in Anderton et al. (2014) albeit for a single country; that is, Macedonia, and suggests that domestic components of aggregate demand have a much larger impact on unemployment rate than the foreign demand.

**Model and Method**

We use a first difference version of Okun’s law to check its validity for BRICS countries. Okun (1962) estimates empirical model in gap version and difference version. Since unemployment and output gap are unobservable in long run and must be estimated, which creates uncertainty in estimating Okun’s law in gap version (Andonova & Petrovska, 2018). Because of this weakness, we only estimate difference version of Okun’s law. The change/first difference version of Okun’s Law can be presented in Equation 1:

\[
U_{it} - U_{it-1} = \alpha + \beta(GDP_{it} - GDP_{it-1}) + \omega_t
\]  

(1)

where \(U_{it}\) represents current unemployment rate and \(U_{it-1}\) is the lagged unemployment rate. Similarly, \(GDP_{it}\) represents real GDP in a current time period and \(GDP_{it-1}\) is its first lag. Subscript \(i\) and \(t\) show cross-section and time dimension of the data series. Okun law, that is, estimated in first difference assuming no change in natural rate of unemployment and constant growth in potential GDP. The difference version of Okun’s Law given in Equation 1 can also be written in the following form:

\[
\Delta U_{it} = \alpha + \beta \Delta GDP_{it} + \omega_t
\]  

(2)

where \(\Delta\) is the first difference operator. \(\beta\) represents the response of changes in the unemployment rate to changes in GDP. This coefficient is our prime interest as it helps us decide the validity and relevance of Okun’s law for a particular economy or region. The coefficient is expected to be negatively signed showing an inverse relationship between output changes and changes in the unemployment rate. However, Equations (1) and (2) are in aggregate form as they show the overall effect of changes in GDP on changes in the unemployment rate. To check disaggregated effects of different components of GDP on unemployment rate, we follow Anderton et al. (2014) and augment Okun relationship by decomposing changes in aggregate GDP into its expenditure components \(GDP_{it}\): consumption \((C)\), government expenditures \((G)\), investment \((I)\), exports \((X)\), and imports \((M)\):

\[
\Delta Y_{it} = \Delta \sum GDP_{it} \approx \sum g \left( \frac{GDP_{it}}{\sum g GDP_{it}} \right) \\
\Delta GDP_{it} = \sum g \Delta GDP_{it}
\]  

(3)
\[ \Delta U_t = \alpha + \sum_g \beta_g \lambda_{g t} \Delta GDP_{g, t} + \omega_t. \tag{4} \]

Instead of calculating a single Okun coefficient; that is, \( \beta \), we estimate a separate \( \beta_g \) for each of the components. Thus, Equation 4 is augmented by substituting in it expenditure components of GDP and is:

\[ \Delta U_t = \alpha + \beta_1 \lambda_{g1t} \Delta C_{g, t} + \beta_2 \lambda_{g2t} \Delta I_{g, t} + \beta_3 \lambda_{g3t} \Delta G_{g, t} \]
\[ + \beta_4 \lambda_{g4t} \Delta X_{g, t} + \beta_5 \lambda_{g5t} \Delta M_{g, t} + \omega_t. \tag{5} \]

where \( \beta_s \) from 1 to 5 show individual Okun’s Coefficients for consumption, investment, government expenditures, exports, and imports which measure differential response of unemployment to each component of aggregate demand. All \( \beta_s \) are expected to be negative except \( \beta_5 \) which is expected to be positive. \( \lambda_{g t} \) subscripts show that weight attached to each component of GDP varies over a time and across the panel.

First, we estimate Equation 2 to evaluate impact of changes in GDP on changes in unemployment rate for BRICS. We use three different econometric methods for estimating Okun law in aggregated and disaggregated form and are common constant method—CCM (also known as pooled ordinary least square method), FEM, and PMG.

The common constant method assumes homogeneity across panels—that there are no differences across sample countries [(Wooldridge, 2001, 2009); Verbeek (2004); and Asteriou and Hall (2006)]. This study focuses on BRICS and common constant method will be appropriate if they have similar economic structure. However, the assumption of homogeneity or common constant is highly restrictive as there is always some heterogeneity or individuality across each panel, that is, country. The sample countries despite being merged into single group differ from each other in many respects. The data analyzed in this article display heterogeneity across the panel countries. For example, unemployment rate and GDP growth rates data show how different BRICS are from each other. For instance, unemployment rate in China during the sample period averaged 3.4% compared with around 28.10% for South Africa and 10.62% for the sample countries. To account for unobserved cross-country individuality and heterogeneity, FEM and random effects method are applied. We follow Fouquau (2008), Anderton et al. (2014), and Garavan (2017) and apply country-specific FEM. Contrary to CCM, FEM allows differences in intercepts across the sample countries. In other words, FEM generates as many intercepts as there are countries or cross sections in the panel.

We also apply PMG as suggested by Pesaran et al. (1999) for checking the robustness of results obtained from CCM and FEM. The PMG has certain advantages over mean group (MG) as used by Anderton et al. (2014). These advantages are: First, it restricts long-run parameters to be identical but allows intercepts, short-run coefficients, and error variances to vary across panels. This contradicts the MG method which does not impose cross-country parameter restrictions. In other words, PMG estimates long run as well short run relationships of dependent variable with its covariates. Second, it does not require to check panel unit roots of the variables as it is applicable to both stationary and nonstationary data. Finally, contrary to MG, PMG estimates are more efficient and consistent in the presence of cross-section homogeneity (Huang & Yeh, 2013).

Data and Empirical Results

Data, Trends, and Time-Series Properties

Annual data from 1991 to 2018 are used for investigating the responsiveness of changes in unemployment rate to changes in GDP for BRICS. The data on all variables except total investment are taken from World Bank World Development Indicators. Total investment is taken from International Monetary Fund World Economic Outlook 2020. The data on expenditure components of GDP are in current U.S. dollars. Availability of data for all variables for all countries determined the choice of sample period. This resulted in balanced panel data for analysis as recommended by Hansen (1999), which suggests the use of balanced panel data for panel regression. Balanced panel data refer to that data in which each cross-section unit has an observable data for the same time period. Standard panel regression methods like FEMs can be applied to balanced panel data without any concern whereas applying same methods to the unbalanced data panels warrants careful investigation into the process, which generates missing data for some cross-sections, Wooldridge (2009). Further, we divide our sample into two subsamples to check difference if any in response to changes in the unemployment rate to changes in GDP and its expenditure components before and after the global financial crisis (2007–2008).

Figure 1 shows unemployment and GDP growth rates for BRICS from 1991 to 2018. The figure shows a negative association between the unemployment rate and the GDP growth rate. The negative association between the variables is due to the fact that an increase in economic activity creates employment opportunities and thus has a negative effect on the country’s unemployment rate. Moreover, Figure 2 shows annual changes in GDP growth and its expenditure components, that is, consumption, investment, government expenditure, exports, and imports as percentage of GDP for the same time period for the BRICS.

Descriptive statistics of the data series are given in Table 1. It shows that GDP has the highest average followed by total investment. Standard deviation estimate indicates that
unemployment has large variability followed by total investment. Jarque Berra test statistic indicates that apart from consumption, none of the variables has normal distribution.

Before checking panel unit root and estimating the model, it is important to assess the presence of cross-section dependency in panel data disturbance. It is assumed that disturbances in panel data models with large cross-section are independent of each other. However, there is considerable empirical evidence about violation of this assumption in panel regression models, which distorts the size of panel unit root tests (Olanipekun et al., 2019). It is, therefore, necessary to check the presence of cross-section among the panels before estimating the model. To do so, we employ Pesaran (2004) cross-section dependency test in the following form:

\[ CD = \left[ \frac{TN(N-1)}{2} \right]^{1/2} \tilde{\rho}, \]

where

\[ \tilde{\rho} = \frac{2}{N(N-1)} \sum_{i=1}^{N} \sum_{j=i+1}^{N} \hat{\rho}_{ij}. \]

Here \( N \) = panel size, \( T \) = sample size and \( \hat{\rho}_{ij} \) = residuals’ pair-wise cross-sectional correlation. Thus, the null and alternative hypothesis tested is:

\[ H_0 : \rho_{ij} = \rho_{ji} = \text{cor}(u_{it}, u_{jt}) = 0 \text{ for } i \neq j \]

\[ H_1 : \rho_{ij} = \rho_{ji} = \text{cor}(u_{it}, u_{jt}) \neq 0 \text{ for } i \neq j. \]

Cross-section dependence test results are given in Table 2. Outcome of the test for full sample indicates that null of no cross-sectional dependency can be rejected for all variables except unemployment rate. As far as subsample results are concerned, we can reject null of no cross-sectional dependency for all variables except unemployment rate in the first subsample (1991–2008) and government expenditures, imports, and unemployment rate in the second subsample (2009–2018).

We conduct Im et al. (2003) cross-sectionally augmented unit root test for checking stationarity of the variables. This test is employed because it is reliable and robust to cross-sectional dependence and/or slope heterogeneity. The unit root test is conducted in level and first difference with intercept and intercept and trend specification. The results given in table 3 show that null hypothesis that panels contain individual unit root in levels but in first difference for all variables in both specifications is rejected for entire sample period. The first subsample (1991–2008) results also confirm nonstationarity of all variables in level and stationarity at first difference in at least one specification. The second subsample results reveal nonstationarity of all variables in levels.

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**Figure 1.** Gross domestic product growth and unemployment rate of Brazil, Russia, India, China, and South Africa.
and weak evidence for rejecting null hypothesis in the first difference with constant specification which may be due to small sample size.

**Model Estimation and Results**

First, we present the results from our aggregate approach to Okun’s law by estimating Equation 2. Table 4 contains estimated Okun’s coefficients for BRICS for three as discussed in the preceding sections. They are full sample (1991–2018), pre-crisis sample (1991–2008), and post-crisis sample (2009–2018). Okun’s coefficient estimates for full sample from the CCM and the FEM are −0.22 and −0.21, respectively. They are statistically significant at 1% significance level. The sign and significance suggest that Okun’s law holds for BRICS despite its magnitude is fairly lower than the one suggested by Okun (1962). However, the estimation of Okun’s coefficient from the PMG specification is −1.72, which is fairly close to the

![Figure 2. Changes in gross domestic product growth and its expenditure components.](image)

**Table 1.** Descriptive Statistics of the Variables.

| Variable             | M     | Median | Maximum | Minimum | SD   | JB    |
|----------------------|-------|--------|---------|---------|------|-------|
| GDP                  | 111.798 | 11.655 | 13.143  | 11.050  | 0.508 | 12.001|
| Unemployment rate    | 10.863 | 6.420  | 33.473  | 2.060   | 9.315 | 37.584|
| Consumption          | 11.762 | 11.715 | 12.884  | 10.963  | 0.446 | 3.745 |
| Investment           | 11.887 | 11.212 | 15.617  | 10.274  | 1.572 | 39.150|
| Government Expenditure | 10.961 | 11.126 | 12.312  | 9.314   | 0.729 | 6.621 |
| Exports              | 11.196 | 11.103 | 12.391  | 10.362  | 0.510 | 7.063 |
| Imports              | 11.180 | 11.077 | 12.406  | 10.322  | 0.512 | 6.507 |

*Note. Data on all variables except unemployment is log-transformed. JB = Jarque Bera.*
The value of the coefficient is in line with several similar studies. For example, Tatoglu (2011) and Dogru (2013), while discussing the magnitude of Okun’s coefficient, argue that though Okun (1962) himself found the coefficient to be between −2 and −3 in the United States, but the later empirical studies found this coefficient to be lower than 2 [Attfield and Silverstone (1997), Prachowny (1993), Weber and West (1996), Freeman (2001), Silvapulle et al. (2004)]. Particularly, Izyumov and Vahaly (2002), Christopoulos (2004), and Adanu (2005) found Okun’s coefficient to be −1.70, −1.32, and −1.50 in their respective studies.

The precrisis results from all specifications show that Okun’s coefficient is slightly less than the full sample coefficient, which implies in the precrisis sample period, changes in the unemployment rate were less sensitive to changes in GDP. However, the response of changes in the unemployment rate to changes in GDP is stronger after the financial crisis of 2007–2008. In addition, FEM shows that the postcrisis response of unemployment to GDP changes is more

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### Table 2. Cross-Sectional Dependence Test Results.

| Variable                | 1991–2018 | 1991–2008 | 2009–2018 |
|-------------------------|-----------|-----------|-----------|
|                         | Statistic | p-value   | Statistic | p-value   | Statistic | p-value   |
| Consumption             | 15.143*   | .00       | 9.472*    | .00       | 3.546*    | .00       |
| Exports                 | 16.389*   | .00       | 13.081*   | .00       | 4.016*    | .00       |
| Government expenditure  | 6.191*    | .00       | 1.324     | .186      | 0.741     | .460      |
| GDP                     | 15.621*   | .00       | 11.689*   | .00       | 7.739*    | .00       |
| Imports                 | 15.495*   | .00       | 11.722*   | .00       | 0.962     | .336      |
| Investment              | 14.690*   | .00       | 9.537*    | .00       | 3.366*    | .00       |
| Unemployment Rate       | 1.353     | .176      | 4.046*    | .00       | −1.701    | .089      |

*aShows significance of estimate parameters at 1% level.

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### Table 3. Cross-Sectionally Augmented Unit Root Test Results With Intercept and Intercept and Trend.

| Variable                | Level                  | First difference          |
|-------------------------|------------------------|---------------------------|
|                         | Intercept              | Intercept and trend       | Intercept | Intercept and trend |
|                         | Test statistic         | Probability | Test statistic | Probability | Test statistic | Probability |
| Full sample (1991–2018) |                        |                         |           |               |               |
| Consumption             | 2.229                  | 0.987                   | −1.707    | 0.044        | −3.570        | 0.00        | −5.093      | 0.00       |
| Exports                 | 1.276                  | 0.899                   | 0.129     | 0.551        | −4.060        | 0.00        | −4.700      | 0.00       |
| Government expenditure  | 0.292                  | 0.615                   | 0.591     | 0.723        | −3.403        | 0.00        | −3.286      | 0.00       |
| GDP                     | 9.528                  | 1.00                    | 2.249     | 0.99         | −1.469        | 0.067       | −2.778      | 0.003      |
| Imports                 | 0.958                  | 0.831                   | 0.084     | 0.533        | −4.241        | 0.00        | −5.493      | 0.00       |
| Investment              | 1.629                  | 0.984                   | 0.091     | 0.536        | −4.028        | 0.00        | −5.600      | 0.00       |
| Unemployment rate       | 1.629                  | 0.102                   | −1.787    | 0.037        | −3.342        | 0.00        | −4.440      | 0.00       |
| Subsample I (1991–2008) |                        |                         |           |               |               |
| Consumption             | 2.983                  | 0.998                   | 0.981     | 0.837        | −2.913        | 0.00        | −1.900      | 0.030      |
| Exports                 | 1.623                  | 1.00                    | 1.886     | 0.970        | −1.771        | 0.04        | −2.632      | 0.130      |
| Government expenditure  | 1.734                  | 0.959                   | −0.654    | 0.256        | −3.773        | 0.00        | −6.151      | 0.00       |
| GDP                     | 12.525                 | 1.00                    | 4.535     | 1.00         | −1.888        | 0.03        | −1.424      | 0.077      |
| Imports                 | 3.757                  | 0.999                   | 0.993     | 0.840        | −2.501        | 0.00        | −1.330      | 0.092      |
| Investment              | 2.428                  | 0.992                   | −0.041    | 0.484        | −3.249        | 0.00        | −2.205      | 0.013      |
| Unemployment rate       | 0.363                  | 0.641                   | 2.279     | 1.000        | −1.152        | 0.12        | −1.311      | 0.095      |
| Subsample II (2009–2018) |                        |                         |           |               |               |
| Consumption             | 1.661                  | 0.048                   | 0.018     | 0.510        | −1.373        | 0.084       | −0.980      | 0.540      |
| Exports                 | 2.039                  | 0.020                   | −0.445    | 0.328        | −1.451        | 0.073       | 0.602       | 0.726      |
| Government expenditure  | −0.936                 | 0.175                   | −0.476    | 0.320        | −1.492        | 0.068       | 0.345       | 0.635      |
| GDP                     | 1.406                  | 0.920                   | 0.125     | 0.550        | 0.052         | 0.52        | 0.35        | 0.673      |
| Imports                 | −2.759                 | 0.002                   | −0.073    | 0.471        | −1.240        | 0.107       | 0.623       | 0.733      |
| Investment              | −1.351                 | 0.100                   | −1.116    | 0.132        | −1.332        | 0.091       | 0.0845      | 0.801      |
| Unemployment rate       | 0.941                  | 0.827                   | 0.675     | 0.750        | −1.052        | 0.146       | −0.596      | 0.276      |
Table 4. Okun’s Law for BRICS (Aggregate Approach).

| Variables | CCM | FEM | PMG |
|-----------|-----|-----|-----|
|           | Full sample | Precrisis | Postcrisis | Full sample | Precrisis | Postcrisis | Full sample | Precrisis | Postcrisis |
| ΔGDP      | −0.22** (0.06) | −0.21* (0.07) | −1.31* (0.28) | −0.21** (0.06) | −0.20* (0.07) | −3.07** (0.32) | −1.72* (0.29) | −1.34* (0.34) | −0.84* (0.26) |
| Constant  | 0.04 (0.008) | 0.02 (0.012) | 0.023 (0.006) | 0.04 (0.008) | 0.02 (0.012) | 0.05 (0.005) | 0.17 (0.004) | 0.02 (0.009) | 0.04 (0.005) |
| Observations | 140 | 90 | 50 | 140 | 90 | 50 | 135 | 85 | 45 |
| R²        | .10 | .10 | .31 | .11 | .12 | .71 |

Note. BRICS = Brazil, Russia, India, China, and South Africa; CCM = common constant method (pooled ordinary least square); FEM = fixed effect method; PMG = pooled mean group.

Table 5. Okun’s Law Disaggregated Approach.

| Variables | CCM | FEM | PMG |
|-----------|-----|-----|-----|
|           | Full sample | Precrisis | Postcrisis | Full sample | Precrisis | Postcrisis | Full sample | Precrisis | Postcrisis |
| ΔC        | −3.59** (1.75) | −1.99 (2.26) | −7.21** (3.19) | −3.56** (1.77) | −1.66 (2.25) | −8.82** (3.18) | −3.87 (2.44) | −2.35* (0.72) |
| ΔI        | −4.02 (4.91) | −4.71 (6.38) | −4.32 (11.06) | −7.82 (5.47) | −9.48 (6.83) | −3.19 (13.37) | −0.21 (3.21) | −0.79 (0.97) |
| ΔG        | −1.087 (0.76) | −0.88 (0.83) | −11.85 (23.46) | −1.29*** (0.78) | −1.00 (0.83) | −8.66 (24.40) | −0.38 (1.82) | −1.36 (1.02) |
| ΔX        | −2.62 (5.57) | −5.48 (7.41) | 8.72 (8.78) | 0.02 (5.81) | −4.17 (7.57) | 11.87 (9.45) | −16.87*** (7.30) | −11.39 (2.12) |
| ΔM        | −7.50 (4.80) | −9.46 (6.23) | 1.43 (8.31) | −7.57 (4.85) | −11.10 (6.27) | 0.72 (7.97) | 13.59** (5.90) | 6.71* (1.71) |
| Constant  | 0.26 (0.90) | 0.24 (0.13) | 0.30 (0.11) | 0.26 (0.80) | 0.30 (0.13) | 0.29 (0.11) | 0.04 (0.05) | 0.02 (0.16) |
| Observations | 132 | 82 | 50 | 132 | 82 | 50 | 127 | 77 |
| R²        | .14 | .14 | .22 | .18 | .23 | .36 |

Note. Standard error values are given in parenthesis. Our dependent variable changes in the unemployment rate. Δ represents the first difference operator. Furthermore, C, I, G, X, and M stand for private/household consumption, total investment, government expenditures, exports, and imports respectively. Respective sample periods are: 1991–2018 for full sample, 1992–2008 for precrisis period, and 2009–2018 for postcrisis period. Due to nonpositive integers, we could not estimate PMG for the postcrisis period. The explanatory power of our estimated disaggregated model—Equation 5—has increased significantly as the coefficient of determination (R²) has risen for full sample and first subsample from common constant method and PMG. FEM results further confirm that all expenditure components have expected signs except exports for postcrisis period in common constant method, full and postcrisis period in FEM and imports for full and precrisis period from common constant method and FEM. Our negative and significant estimate of changes in consumption expenditures from common constant method and FEM for full sample and postcrisis period and precrisis period. Other variables from PMG that have a significant effect are changes in exports and imports and their estimates are negative and positive respectively in both sample periods. Hence, based on estimates of Okun’s law from disaggregated data using common constant method, FEM and PMG, we conclude that apart from changes in consumption expenditures, other variables that have relevance in explaining changes in the unemployment rate are changes in government expenditures, exports, and imports. Although changes in government expenditures and changes in imports have negative effect on changes in unemployment rates, changes in the imports are associated with rise in the unemployment rate. As with Anderton et al. (2014), the explanatory power of our estimated disaggregated model—Equation 5—has increased significantly as the coefficient of determination (R²) has risen for full sample and first subsample from common constant method and FEM. However, the postglobal financial crisis period results indicate that explanatory power of the same estimation methods has substantially decreased when the Okun law is estimated using disaggregated data. Results further confirm that all expenditure components have expected signs except exports for postcrisis period in common constant method, full and postcrisis period in FEM and imports for full and precrisis period from common constant method and FEM. Our negative and significant estimate of changes in consumption expenditures from common constant method and FEM for full sample and postcrisis period and precrisis period.
period in PMG is in line with Anderton et al. (2014) and Andonova and Petrovskà (2018). This implies that a rise in consumption expenditure decreases the unemployment rate which means industries catering to consumption needs of the citizens have negative effect on BRICS’ unemployment rate.

**Conclusion**

This article attempts to evaluate the relationship between unemployment rate and economic growth as postulated by Okun (1962) for BRICS for the period from 1991 to 2008. Two different approaches are used to study this relationship. First, the aggregated approach estimates the responsiveness of changes in the unemployment rate to changes in the overall GDP. Second, the disaggregated approach focuses on how changes in the unemployment rate respond to the changes in the expenditure components of GDP. Three different econometric techniques namely CCM, FEM, and PMG are employed for estimating the magnitude of sensitivity of changes in the unemployment rate to changes in GDP and changes in its expenditure components of for full data sample (1991–2018) and two data subsamples—precrisis (1991–2008) and postcrisis (2009-2008). The following interesting findings emerge from the estimation of Okun’s law for BRICS.

First, the results from the aggregate approach lend support to Okun’s law with respect to the BRICS countries. The estimated Okun’s coefficients from all specifications for all samples are statistically significant with the correct signs. The value of Okun’s coefficient estimates, for the full and precrisis period from CCM and FEM models, averages approximately −0.21. This implies that a one percentage change in GDP reduces unemployment by −0.21 percentage points. However, PMG model generates larger coefficients for the same samples; that is, −1.72 and −1.34, respectively. Second, the postcrisis response of unemployment to GDP changes is far greater for all specifications; that is, −1.31, −3.07, and −0.84 for the CCM, FEM, and PMG models, respectively. This suggests that changes in unemployment rate were more responsive to output changes in BRICS countries after the global financial crisis of 2007–2008.

Second, the results from the disaggregated approach are in line with Anderton et al. (2014) who finds the major effect of changes in the expenditure components of GDP on the changes in the unemployment rate. The CCM and FEM results for full sample and postcrisis period confirm negative effect of changes in the consumption expenditures on changes in the unemployment rate.

However, the magnitude of the effect of changes in the consumption expenditure on changes in the unemployment rate is larger in postcrisis period than the full sample from both estimation methods. Changes in consumption expenditure also appear to have significant negative effect on changes in the unemployment rate in precrisis period in PMG estimates. Other variables that have significant effect on changes in the unemployment rate are changes in the government expenditures for full sample period from FEM and imports for full sample period and precrisis period in PMG method.

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**References**

Adanu, K. (2005). A cross-province comparison of Okun’s coefficient for Canada. *Applied Economics, 37*, 561–570.

Aghion, P. V., & Howitt, P. (1992). A model of growth through creative destruction. *Econometrika, 60*, 323–351.

Akram, M., Hussain, S., Raza, S. H., & Masood, S. (2014). An empirical estimation of Okun’s Law in context of Pakistan. *Journal of Finance and Economics, 2*(5), 173–177.

Alamro, H., & Al-Dalaien, Q. (2014). Modeling the relationship between GDP and unemployment for Okun’s Law specific to Jordan (Munich Personal RePEc Archive Paper No. 55302). http://mpra.ub.uni-muenchen.de/55302/

Altunoz, U. (2019). The relationship between real output (real GDP) and unemployment rate: An analysis of Okun’s Law for Eurozone. *Sosyoeconomii*, 27(40), 197–210.

An, Z., Ghazi, T., & Prito, N. G. (2016). Okun’s Law: Unfit for low and lower middle income countries? https://www.imf.org/external/np/seminars/eng/2016/GlobalLaborMarkets/pdf/Ghazi_Session1_paper.pdf

Anderton, R., Aranki, T., Bonthuis, B., & Jarvis, V. (2014). *Disaggregating Okun’s Law: Decomposing the impact of the expenditure components of GDP on Euro area unemployment* (ECB Working Paper No. 1747). https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1747.en.pdf

Andonova, D. U., & Petrovskà, M. (2018). *Disaggregating Okun’s law: A case study for Macedonia* (Working Paper No. 8). https://www.econstor.eu/bitstream/10419/1067687262.pdf

Asteriou, D., & Hall, S. (2006). *Applied econometrics* (Revised ed.). Palgrave Macmillan.

Attfield, C. L. F., & Silverstone, B. (1997). Okun’s coefficient: A comment. *The Review of Economics and Statistics, 79*(2), 326–329.

Baker, D., & Schmidt, J. (1997). The macroeconomic roots of high unemployment: The impact of foreign growth. *WSI Mitteilungen*.

Ball, L. M., Jelles, J. T., & Loungani, P. (2014). *Do forecasters believe in Okun’s Law? An assessment of unemployment and output forecasts* (IMF Working Paper No. WP/1424). https://www.imf.org/external/pubs/ft/wp/2014/wp1424.pdf
Banda, H., Ngirande, H., & Hogwe, F. (2016). The impact of economic growth on unemployment in South Africa: 1994-2012. *Investment Management and Financial Innovations, 13*(2), 246–255.

Barreto, H., & Howland, F. (1993). *There are two Okun’s Law relationships between output and unemployment.* Wabash College.

Bartolucci, F., Marelli, E., Signorelli, M., & Tanverr, M. (2018). GDP dynamics and unemployment changes in developed and developing countries. *Applied Economics, 50,* 3338–3356.

Blinder, A. S. (1997). Is there a core of practical macroeconomics that we should all believe? *American Economic Review Proceedings, 87*(2), 240–243.

Cevik, E. I., Dibooglu, S., & Barisik, S. (2013). Asymmetry in the unemployment–output relationship over the business cycle: Evidence from transition economies. *Comparative Economic Studies, 55,* 557–581.

Christl, M., Turyna, M. K., & Kucsera, D. (2017). Okun’s Law in Austria. *Law and Economics Review, 8*(2), 97–110.

Christopoulos, D. (2004). The relationship between output and unemployment: Evidence from Greek regions. *Regional Science, 83,* 611–620.

Christopoulos, D., McAdam, P., & Tzavalis, E. (2019). Exploring Okun’s Law asymmetry: An endogenous threshold LSTR approach (ECB Working Paper No. 2345). https://www.ecb.europa.eu/pub/pdf/scpwps/ecb_wp2345-70e2259959.en.pdf?b4976fbb6ca04004853e5eb4279579

Coşar, E. E., & Yavuz, A. A. (2019). *Is there asymmetry between GDP and labor market variables in Turkey under Okun’s Law?* (Working Papers 1927). Central Bank of the Republic of Turkey.

Crespo-Cuaresma, J. (2003). Revisiting Okun’s Law: A piecewise-linear approach. *Oxford Bulletin of Economics and Statistics, 65,* 439–451.

Dogru, B. (2013). The link between unemployment rate and real output in Eurozone: A panel error correction approach. *Procedia: Social and Behavioral Sciences, 99,* 94–103.

Dornbusch, R., Fishcher, S., & Startz, R. (2011). A state-level analysis of Okun’s Law. *Economics Bulletin, 15*(23). Federal Reserve Bank of Cleveland.

Hansen, B. E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. *Journal of Econometrics, 93,* 334–368.

Harris, R., & Silverstone, B. (2001). Testing for asymmetry in Okun’s Law: A cross-country comparison. *Economics Bulletin, 5,* 1–13.

Higgins, P. (2011). *GDP growth, the unemployment rate and Okun’s law.* https://www.atlantafed.org/-/media/documents/regional-economy/ecoutsouth/11q3fedatissue.pdf

Holmes, M. J., & Silverstone, B. (2006). Okun’s law, asymmetries and jobless recoveries in the United States: A Markov-switching approach. *Economics Letters, 92,* 293–299.

Huang, H. C., & Chang, Y. K. (2005). Investigating Okun’s Law by the structural break with threshold approach: Evidence from Canada. *Manchester School, 73,* 599–611.

Huang, H. C., & Lin, S. C. (2006). A flexible nonlinear inference to Okun’s relationship. *Applied Economics Letters, 13,* 325–331.

Huang, H. C., & Yeh, C. C. (2013). Okun’s Law in panels of countries and states. *Applied Economics, 45,* 191–199.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics, 115*(1), 53–74.

Izymov, A., & Vahaly, J. (2002). The unemployment-output trade-off in transition economies: Does Okun’s Law apply? *Economics of Planning, 35,* 317–331.

Kallman, R., & Nordell, H. (2012). Estimating Okun’s coefficient in the Swedish Economy. *Students Essay.* https://gupea.ub.gu.se/handle/2077/28996

Khan, M. A., & Saboor, A. (2013). Modeling the relationship between GDP and unemployment for Okun’s law specific to Pakistan during 1976-2010. *Theoretical and Applied Economics, 10*(587), 71–78.

Knotek, E. S., II. (2007). How useful is Okun’s Law? *Economic Review-Federal Reserve Bank of Kansas City, 9*(24), 73–103.

Kreishan, F. M. (2011). Economic growth and unemployment: An empirical analysis. *Journal of Social Sciences, 7*(2), 228–231.

Lal, I., Muhammad, S. D., Jalil, M. A., & Hussain, A. (2010). Test of Okun’s Law in some Asian countries: Cointegration approach. *Journal of Scientific Research, 58*(7), 71–78.

Lee, J. (2000). The robustness of Okun’s Law: Evidence from OECD countries. *Journal of Macroeconomics, 22*(2), 331–356.

Makaringe, S. C., & Khobai, H. (2018). The effect of unemployment on economic growth in South Africa (1994-2016). Munich Personal RePEc Archive.

Mankiw, N. G. (2012). *Principles of macroeconomics* (6th ed.) Cengage Learning.

Meyer, B., & Tasci, M. (2012, June). An unstable Okun’s Law, not the best rule of thumb. *Economic Commentary.* https://www.clevelandfed.org/-/media/content/newsroom%20and%20events/publications/economic%20commentary/2012/ec%20201208%20an%20unstable%20okuns%20law%20not%20the%20best%20rule%20of%20thumb%20pdf.pdf

Michail, N. A. (2019). Examining the stability of Okun’s coefficient. *Bulletin of Economic Research, 71,* 240–256.

Moazzami, B., & Dagostar, B. (2009). Okun’s law revisited: Evidence from OECD countries. *International Business & Economics Research Journal, 8*(8), 21–24.

Moosa, I. A. (1997). A cross-country comparison of Okun’s coefficient. *Journal of Comparative Economics, 24*(3), 335–356. https://doi.org/10.1006/jcec.1997.1433

Moosa, I. A. (2008, March 17–18). Economic growth and unemployment in Arab countries: Is Okun’s Law valid? *Journal of Development and Economic Policies, 10*(2), 5–24.
Okun, A. M. (1962). Potential GNP: Its measurement and significance. In *Proceedings of the Business and Economic Statistics Section of American Statistical Association* (pp. 89–104). https://milescorak.files.wordpress.com/2016/01/okun-potential-gnp-its-measurement-and-significance-p0190.pdf

Olanipekun, I. O., Olashinde-Williams, G., & Güngör, H. (2019). Impact of economic policy uncertainty on exchange market pressure. *SAGE Open*.

Pehlivanglu, F., & Tanga, M. (2016). An analysis on the validity of Okun’s Law: Case of Turkey and BRICS. *International Journal of Economic Studies*, 2(3), 31–44.

Pesaran, M. H. (2004). *General diagnostic tests for cross section dependence in panels* (Cambridge Working Papers in Economics No. 0435). University of Cambridge.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of American Statistical Association*, 94, 621–634.

Phiri, A. (2014). Nonlinear co-integration between unemployment and economic growth in South Africa. *Managing Global Transitions*, 12(4), 303–324.

Prachowny, M. F. J. (1993). Okun’s Law: Theoretical foundations and revised estimates. *Review of Economics and Statistics*, 75, 331–336.

Romer, D. (2012). *Advanced macroeconomics* (4th ed.). McGraw-Hill.

Sadiku, M., Ibraimi, A., & Sadiku, L. (2015). Econometric estimation of the relationship between unemployment rate and economic growth of FYR of Macedonia. *Procedia Economics and Finance*, 19, 69–81.

Siddiqui, K. (2017). Will the growth of BRICs cause a shift in the global balance of economic power in the 21st century. *International Journal of Political Economy*, 45(4), 315–338.

Silvapulle, P., Moosa, I. A., & Silvapulle, M. J. (2004). Asymmetry in Okun’s Law. *Journal of Economics*, 37, 353–374.

Smith, R. (2010). *Okun’s Law: Applied statistics and econometrics*. https://www.economicsnetwork.ac.uk/sites/default/files/Vincent%20Daly/ase09book.pdf

Sögner, L. (2001). Okun’s law does the Austrian unemployment-GDP relationship exhibit structural breaks? *Empirical Economics*, 26(3), 553–564.

Sogner, L., & Stiassny, A. (2002). An analysis on the structural stability of Okun’s Law: A cross-country study. *Applied Economics*, 34(14), 1775–1787.

Sørensen, P. B., & Whitta-Jacobsen, H. J. (2010). *Introducing advanced macroeconomics: Growth and business cycles* (2nd ed.). McGraw-Hill.

Soylu, O. B., Cakmak, I., & Okur, F. (2018). Economic growth and unemployment issue: Panel data analysis in Eastern European countries. *Journal of International Studies*, 1(1), 93–107.

Srinivas, B. (2018). GDP, unemployment and Okun’s Law: Evidence from India. *International Journal of Applied Social Science*, 3(5), 409–419.

Tatoglu, F. Y. (2011). The long and short run effects between unemployment and economic growth in Europe. *Doğuş Üniversitesi Dergisi*, 12, 99–113.

Verbeek, M. (2004). *A guide to modern econometrics* (2nd ed.). John Wiley.

Viren, M. (2001). The Okun curve is non-linear. *Economics Lectures*, 70, 253–257. https://doi.org/10.1016/S0165-1765(00)00370-0

Weber, C. E. (1995). Cyclical output, cyclical unemployment, and Okun’s coefficient: A new approach. *Journal of Applied Econometrics*, 10(4), 433–445. https://doi.org/10.1002/jae.3950100407

Weber, C. E., & West, J. E. (1996). Functional form in regression models of Okun’s Law. *Applied Economics Letters*, 3, 607–609.

Wooldridge, J. M. (2009). *Introductory econometrics: A modern approach* (4th ed.). South-Western/Cengage Learning.

Yildiz, N., Akdugan, U., & Tasdemir, D. (2017). Relationship of the economic growth and unemployment: An empirical assessment of Okun’s Law for Turkey. *Journal of Economics and Sustainable Development*, 25, 61–74.

Zanin, L., & Marra, G. (2012). Rolling regression versus time-varying coefficient modeling: An empirical investigation of the Okun’s Law in some Euro area countries. *Bulletin of Economic Research*, 64(1), 91–108.