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THE VALIDITY OF OKUN'S LAW IN SRI LANKA

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Abstract

Our research aims to find a relationship between the unemployment rate and the GDP growth rate in Sri Lanka according to Okun's law and whether it can still be used as the best rule of thumb. This empirical analysis has employed the difference model, dynamic model, Error Correction Model (ECM) and Vector Error Correction Model (VECM) to validate the relationship between the unemployment rate and economic growth suggested by Okun's Law. The study is based on Quarterly data from 2004 Q1 to 2019 Q4. The study was used different econometric methods, likethe ordinary least square (OLS), Engel-Granger approach, and cointegration test. The study finds that Okun's law is supported only by the cointegration analysis as expected by Okun's law in Sri Lanka. However, all other versions were reported negative Okun's law coefficient signs while these results are not statistically significant. Overall, this study cannot find enough evidence to prove the negative relationship between the short run's unemployment rate and economic growth rate. Further, Okun'slaw can still be used as the best rule of thumb to describe the relationship between unemployment and GDP growth in the long term in Sri Lanka.

Keywords: Economic Growth, Engel-Granger Approach, Unemployment, VECM

1.0 Introduction

The concepts of economic growth and unemployment are at the beginning the most significant variables in the sense that all economies are choosing and implementing economic policies (Soylu et al., 2018). Empirical relationships regarding unemployment have long fascinated economists. For instance, the Phillips curve started life as a simply observed trade-off between unemployment and inflation. But as the theory caught up with the evidence, the Phillips curve emerged as the most significant relationship in the way economists viewed the supply-side of the economy and is embedded in all the key macroeconomic models driving policy today (Chamberlin, 2011). Another relationship of interest to economists is that between output and unemployment. Generally, economic growth and low unemployment rate are critical macroeconomic policy goals for developing countries like Sri Lanka. Significantly, the association between the actual output and the unemployment rate iscrucial in economic recession and recovery. Therefore the main objective of this research project is to find such an association between the actual output and unemployment according to Okun's law and to know whether it can still be used as the best rule of thumb.

The rest of the paper is structured into four more sections. Section 2 describes various theoretical aspects and empirical evidence on the relationship between unemployment and economic growth. Section 3 provides the

data and methodology, while the principal analysis and interpretations of results are presented in the following section. Finally, section 5 summarizes the main findings and conclusions of the analysis.

2.0 Literature Review

2.1. Economic Growth and Unemployment

Economic growth is a constant debate among economists, which the most important indicators of the increase in the level of economic and social welfare of a country. Growth theories explain the factors that determine the rate of economic growth of a nation. On the other hand, growth theories explain the reasons for differences in income and growth rates among countries. Economists use the gross domestic product (GDP) as the primary measurement of economic growth, which means the market value of final goods and services produced in an economy, stated in theprices over a given period. When people make and selltheir goods through the market, they earn income, so when the economy is growing. The "public expense"is put into consideration to investigate the importance of economic growth and shadow economy as well(Luong et al., 2020). And also, the strengthening of global technical revolution processes brought into focus the search problem of new models, resources, and factors of economic growth (Nurlanova et al., 2020).

Unemployment refers tothose willing to work from the current wage and cannot find a job. Types of unemployment can bedefined as voluntary unemployment, involuntary unemployment, frictional unemployment, cyclical unemployment, seasonal unemployment, technological unemployment, structural unemployment, and hidden unemployment. Initially, economists and society still did not view unemployment as a social problem. It was an individual problem. Unemployment occurs when people are looking for a job and cannot find one. This wasn't a problem in preindustrial farming societies because farmers received net revenue (the income left after all costs have beenpaid) instead of a wage. The industrial revolution changed the nature of work, and unemployment became a problem for society. The Industrial Revolution was accompanied by a shift to wage labor and a division of responsibilities. In this period, some capitalists took ownership of production and hired others to work for them, paying them a wage per hour. These practices marked a significant change in the unemployment problem.

Solow (1956) assumed that employment is anindigenous factor of production. When talking about unemployment, economists usually refer to the "unemployment rate." The unemployment rate is the percentage of willing and able to work but are not working in the economy. Otherwise, the unemployment rate is determined by dividing the number of unemployed individuals by the number of people in the labor force. The unemployment rate gives a good insight into how much labor is available to increase production and how fast the economy could grow. Generally, the economy is growing due to improved productivity or rise in the number of people select to work. Economists translate the target of unemployment rate and target capacity utilization rate (the rate at which factories and machines are operating compared to the maximum sustainable rate at which they could use, indicating how much capital is available for economic growth) into the target level of potential output.

To explore what changes in the unemployment rate will have on output, we use Okun's rule of thumb (Colander, 2001). Okun summarized the inverse relationship with a regression that related change in the unemployment rate to changes in real output growth. This negative relationship, called Okun's Law, appears in forecasting models used by central banks, governments, and the private sector (Mary et al., 2015). Wulandari et al. (2019) stated that the labor force women and children tend to show a higher unemployment rate than older

men. Then, when inflation is at a particular level, unemployment is higher.

Sri Lanka has witnessed a considerable reduction in its unemployment rate over the past decades. Annualaverage GDP growth in the range of 5 percent has helped to generate employment in Sri Lanka. However, employment growth is explained more by changing public-sector jobs and informal types of work than informal and private-sector employment. Furthermore, unemployment remains high for females, youth, and the educated (Dushni&Nisha, 2011).

2.2. Okun's Rule of Thumb

Okun's (1962) seminal paper regarding the unemployment-output relationship considers the measurement of potential output. Okun believed that the potential output should not be defined as the maximum output the economy could (unconditionally) produce. Instead, he argued that the potential should be measured at full employment. He believed that a four percent unemployment rate is a reasonable target to achieve full employment without inflationary pressure or the level of the non-accelerating rate of unemployment (NAIRU). Subsequently, at the business cycle recurrence, the deviations of joblessness from a class, for example, the NAIRU, could correspond with the variations of yield from its pattern (Owyang&Tatevik, 2012).

Okun (1962) empirically proved the inverse relationship between the unemployment rate and the potential output, depending on the participation in the workforce, the duration of work, and the change in productivity. This rule of thumb is based on the fact that the increased force must produce more goods and services. According to this fact, the unemployment rate declined when the actual growth rate was high, whereas the unemployment rate increased in the years when the actual growth rate remained low or even harmful. Okun's rule of thumb states that a one percentage point change in the unemployment rate will cause the output to change in the opposite direction by 2 percent. Also, he presented two empirical relationships between the unemployment rate and the actual production, namely, the different approach and the gap approach.

2.2.1. The Difference/Changes Version

This version captures how changes in the real output affect the unemployment rate. The theoretical underpinning of Okun's Law in this section comes from production theory. It is straightforward to map changes inthe unemployment rate to changes in the inputs used by firms relatively directly in labor and indirectly for other inputs (Mary et al., 2011). Arthur Okun noted in this version that quarterly changes in the unemployment rate were related to quarterly growth in the real gross national product (Chamberlin, 2011). The Okun's difference version equation is given below,

$$\Delta u_t = \alpha + \beta \, \Delta \, GNP_t \qquad (01)$$

In the above equation (01), Δ sign denotes the time difference operator, ut is percentage changes in the unemployment rate, GNP is percentage changes in real GNP, α is constant that shows a mean change in the unemployment rate when the economy does not grow. The coefficient β is Okun's law coefficient (OLC).

2.2.2. The Gap Version

Another main version used by Okun is the gap version approach. In this version, deviations in the unemployment rate were related to deviations in GDP from its potential. Especially in this approach, certain

exponential paths of potential output are chosen based on the agreement that this potential GNP should be equal to actual GNP when the unemployment rate is four percent in the economy. The gap version regression equation is given below,

u_t = a + b *(gap between actual output and potential output) (02)

2.2.3. Other Versions of Okun's Law

Besides, we consider an extension of the original Okun'sLaw that allows the current and past output growth values to affect the unemployment rate changes differently. The dynamic version of Okun'sLaw included the present and past values of economic growth rate and past changes in the unemployment rate into the model as given below,

$$\Delta u_t = \alpha_l + \beta l\ \Delta y_t + \beta_{l1}\ \Delta y_{t-1} + \beta_{l2}\ \Delta y_{t-2} + \Upsilon_{l1}\ \Delta u_{t-1} + \Upsilon_{l2}\ \Delta\ u_{t-2} + e_{lt} \quad (03)$$

The dynamic version is the distributed lag version of the standard difference specification in equation (01). We refer to this formulation of Okun'sLaw as a "Dynamic" specification. In this case, the change in the unemployment rate is determined jointly with lags of it and lagged and current changes in output growth. Otherwise, the production function approach explains the effects of a combination of technology, labor, and capital in the production of output. The production function version can be expressed as follow,

$$Y = \alpha\ (k + c) + \beta\ (\Upsilon n + \delta h) + \tau \quad (04)$$

Y is economic growth or output, k is the capital input, and c is its utilization rate, n represents thenumber of workers, h is the number of hours worked, α. B are output elasticities, and Υ and δ are the combinations of workers and weekly hours to the total labor input and τ is a disembodied technology factor. The major drawback of this method is thatthe measurement of both capital and technology is complicated.

2.3. Related Literature

In 1962, Arthur Melvin Okun posited an empirical relationship between the change in the unemployment rate and real output growth. Since then, the media, policymakers, pundits, and intermediate macroeconomics students have used the so-called Okun'sLaw as a rule of thumb to relate changes in unemployment to changes in output growth. However, some studies have suggested that the relationship has not been stable over time. Furthermore, the slow recovery of U.S unemployment relative to output after the Great Recession has led some to question whether Okun'sLaw has changed permanently (Owyang&Tatevik, 2012). As many of the reduced-form relationships build strictly on associations and not causation, Okun's law appears to vary depending on the sample period studied, and Okuns Law rarely appears in modern macro studies. However, after 1962, economists and researchers investigated Okun'sLaw to confirm the relationship between unemployment and output for various periods for multiple countries. Some of the studies explaining the relationship between growth and unemployment rates are presented below in chronological order.

Arthur Okun (1962) was the first economist who developed an economic model to explain the empirical relationship between unemployment and economic growth. He used quarterly data from 1947 to 1960 and utilized OLS as a critical methodology to prove the inverse relationship between unemployment and economic growth. This inverse relationship between the two significant economic variables is famously known as

Okun'sLaw and since then, it has been used as the best rule of thumb. (Barreto& Howland, 1993) stated that the coefficients accepted in Okun's are not valid for the Japanese economy. They analyzed the 1953-1982 period in Japan with regression estimation. Also,Moosa (1997) found the lowest Okun's coefficient for Japan and the highest coefficient for North America for 1960-1995.
In Europe's experience, Zonzilos (2000) found that if Greece output increases by 1percent, unemployment will decrease by 0.28 percent. His estimation is covered the period from 1965 to 1999. However, Zagler (2003) stated that there is a cointegration between economic growth and unemployment in the long run. There is a positive relationship between these variables in European economies, including France, Germany, Italy, and the UK. Zagler investigated Okun's Law using VECM as a key methodology. (Harris & Silverstone, 2001) have analyzed unemployment and output levels of relation.

Empirical evidence shows that there is no long-run relationship between the two variables. Muscatelli and Tirelli (2001) also examined the unemployment and economic growth for the OECD countries over 1955-1990 using the structural VAR model and found a negative relationship between these variables.
Knotek (2007); Knotek II (2007) tested the validity of Okun'sLaw in the United States from 1948 to 2007 with Cointegration Analysis and argues Okun'sLaw can be used as a simple rule of thumb to determine how much unemployment would induce output growth. He estimated the unemployment rate every quarter. He introduced the past level of output, the current level of output, and the past level of employment to analyze the effects of economic growth on unemployment in the gap version. He found a negative correlation between GDP growth and unemployment.

Lal et al., (2010) have shown long-term and short-term relationships between economic growth and unemployment in Bangladesh, China, India, Pakistan, and Sri Lankan economies in the the1980-2006 periods. And also, Balakrishnan et al. (2010) in turn, used Okun'sLaw as an organizing framework to explain unemployment dynamics for a group of advanced countries during the latest recession. Lee (2000) tested Okun's Law in Some Asian Countries with Cointegration Approach. They have used time series annual data from 1980 to 2006 and usedthe Engle-Granger cointegration technique to find the long-run relationship between variable and error correction mechanism for short-run dynamic. They concluded that Okun'sLaw interpretation might not be applicable in some Asian developing countries.

The relationship between changes in output andthe unemployment rate is of significant interest around times of recession and economic recovery (Chamberlin, 2011c). He examined various aspects of this relationship over time, across multiple constituents of the labor market for different countries. He also explores the interactions between changes in the unemployment rate with the household population, economic activity rate, average hours, and labor productivity in accounting for recent output movements in the UK economy and how these compare to previous recessions and recoveries. He estimated Okun'sLaw by gender and age structure as well. Unlike usual estimation techniques, Islas-Camargo and Cortez (2011) follow Clark (1989) to evaluate the correlation between the transitory components of unemployment and output as part of a system of correlations between the permanent and transitory features both series. This model provides a better estimate of Okun's Law and found that the Okun's coefficient for the Mexican economy is significantly lower than previous estimations and unbiased and efficient estimations.

Over the years, Okun's Law has been predominantly used as a rule of thumb to predict how changes in output will feed through to the labor market. Conventional wisdom said 'that for every 2 percent drop in the real gross domestic product (GDP) below trend leads to a one percentage point rise in the unemployment rate'. However, this relationship has proved to be unstable over time. Although the breakdown in the Phillips curve during the

stagflation of the 1970s lead to the advancement of its hypothetical supporting, the equivalent didn't occur for Okun's Law (Chamberlin, 2011d).

Abdullah and Anees (2014) find a relationship between the unemployment rate and the GDP growth rate as proposed by Okun. The paper also focuses on the short-run and long-run relationship between these two variables.

Time-series econometric analysis is applied toall periods. To findout an association between the unemployment rate and GDP growth rate, including Augmented Dickey-Fuller (ADF) test to check for stationary. Engle-Granger test and Johansen test for cointegration analysis and Vector autoregressive model (VAR) and vector error correction model (VECM) for finding interdependencies between variables. Finally, they estimated a different version of Okun'sLaw regression equation. But no contemporary impact on the unemployment rate by the GDP growth rate.

Laurence et al. (2017) investigated how well Okun's Law fits short-run unemployment movements in the United States since 1948 and in 20 advanced economies since 1980. They estimated Okun'sLaw with annual and quarterly data and found that Okun's Law is a strong relationship in most countries and relatively stable over time. They used the term "potential output" for long-run output and the "natural rate" for long-run unemployment. The economy's productive capacity determines potential output and grows over time due to technological change and factor accumulation. The long-run employment and natural unemployment rate are determined by the size of the labor force and frictions in the labor market. When the output is at its long-run level, employment and unemployment are also at their long-run levels. Soylu et al. (2018) investigate the relationship between economic growth and unemployment in Eastern European Countries for 1992-2014 within the panel data framework. In this paper, this relationship has been examined in the context of Okun's Law. Panel Unit Root, Pooled Panel OLS, and Panel Johansen Co-integration tests are applied, respectively. The results showed that the economic growth and unemployment series are stationary at the first level; unemployment is affected positively by economic growth in the long run. In other words,a 1percent risein GDP will fall the unemployment rate by 0.08 percent based on Okun's coefficient for Eastern European Countries.

Prabagar (2015) investigated the equilibrium relationship between the unemployment rate and economic growth in the context of the Sri Lankan economy from quarter 1, 2003 to quarter 1, 2015. He employed the difference model, dynamic model, error correction model, and vector error correction model to validate the relationship between the unemployment rate and economic growth suggested by Okun's Law. This empirical study specified a short-run and long-run equilibrium relationship between the Sri Lankan economy's unemployment rate and economic growth. However,the financial crisis impacts labor markets around the world, and Okun'sLaw faced severe challenges. As a result, various studies have shown positive economic growth with no improvement in unemployment, famously known as jobless growth (Abdullah &Anees, 2014).

However, I could not find more literature about analyzing the relationship between the unemployment rate and economic growth in Sri Lanka about Okun's Law. Sri Lanka has witnessed a considerable reduction in its unemployment rate over the past decade. Annual average GDP growth in the range of 5 percent has helped to generate employment. However, unemployment remains high for females, youth, and the educated. The literature confirmed that studies based on economic growth and unemployment in emerging countries like Sri Lanka are limited to recent studies. Hence, this study attempt to find out the relationship between unemployment and economic growth in Sri Lanka based on Okun'sLaw.

3.0 Methodology

3.1. Data

Our analysis relies on revised data observed at a quarterly frequency. The variables are seasonally adjusted and standardized in percentage points. The sample period includes 2004Q1- 2019Q4. Economic growth is estimated as the quarterly growth rate of realGDP. Data from the Macroeconomic Chart Pack of the central bank of Sri Lanka and international financial statistics are used for real GDP growth and the civilian unemployment rate, respectively. Due to the tsunami and other reasons, the labor force survey was not implemented in 2005 every quarter and 2011Q4 and 2012Q1 as scheduled. Hence we got Interpolate data series for quarterly unemployment rate series to test the validity of the rule of thumb.

3.2. Model Specifications

Our empirical analysis has employed the difference model, dynamic model and error correction model, and vector error correction model to validate the relationship between the unemployment rate and economic growth suggested by Okun. Difference version estimation is most suitable for this empirical analysis. The expected model of different version of Okun'sLaw is given below,

$$\Delta u_t = \alpha + \beta \Delta GDP_t + \varepsilon_t \qquad (05)$$

Where Δut is the change in the unemployment rate, ΔGDP is the change in the GDP growth rate, β is the Okun's Law Coefficient (OLC), α is the unemployment rate when the economy does not grow (constant), and εt represents the error term where $\varepsilon t \sim N(0, \sigma 2)$ and t = 1.....T. To estimate the different versions of Okun'sLaw, we used the Ordinary Least Square method (OLS).

Equation (05) implies that some relevant variables have been omitted from the right side of the equation. Therefore, we used a dynamic version of Okun'sLaw in estimating the relationship between GDP growth rate and unemployment rate. The active version includes more explanatory variables such as lagged variables of the unemployment rate and GDP growth. The dynamic version empirical model can be expressed as follows:

$$\Delta ut = \alpha + \beta 1 \Delta GDPt + \beta 2 \Delta GDPt\text{-}1 + \beta 3 \Delta ut\text{-}1 + et \qquad (06)$$

Where Δ GDP-1 and Δ ut-1 have lagged values of economic growth and unemployment rate, respectively, to eliminate serial correlation, we use the past value of unemployment change as an independent variable.

3.3. Varies Time Series Procedures

The stationary concept is important in the time-series analysis because if a time series is non-stationary, then all typical results of classical regression analysis are not valid. Therefore, the regression would be a false or fake regression(Gujarati, 2003). Both equations 05 and 06 assumes that the variables are unit root level or non-stationary at level form while stationary at first difference. Hence, both regression models may be spurious. To avoid spurious regression, this paper also used another model, which is called Error Correction Method (ECM), for estimating the coefficient of Okun using the procedure of Engle-Granger. Engle-Granger proposed a residual-based cointegration test. If residual series is stationary at its level, both variables are cointegrated and have a long-run relationship between themselves. The ECM model is described as follows,

$$\Delta GDP_t = \alpha + \beta 1\ \Delta U_t + \beta 2\ R_{t-1} + e_t \qquad (07)$$

Δ GDPt and Δ u_1 are economic growth and unemployment in the first difference, α is the intercept, β_1 is the short-run coefficient, and R_{t-1} is the error correction term, negative after estimation.

Finally, this paper used the Vector Error Correction Model (VECM) for testing the long-run causality and the short-run causality between the GDP growth rate and unemployment rate case of Sri Lanka. VECM is commonly used with Johansen multivariate cointegration test. For cointegration analysis, both variables should be integrated in the same order. Hence, identification of integration is base for cointegration analysis. Otherwise, all the variables should be integrated with order one or should be stationary at first difference. Thus, before estimate the VECM, we employed the unit root test to get information about the stationary of each time series. Our analysis consists of two-time series economicgrowth and unemployment to get two estimations similarly in VECM. The expected VECM equations are as follows,

$$GDP_t = \beta_0 + \beta_i \sum_{i=1}^{k} \boldsymbol{U}_{t-i} + \Upsilon_i \sum_{i=1}^{k} \boldsymbol{GDP}_{t-i} + e_{1t} \quad (08)$$

$$U_t = \alpha_0 + \alpha_i \sum_{i=1}^{k} \boldsymbol{U}_{t-i} + \delta_i \sum_{i=1}^{k} \boldsymbol{GDP}_{t-i} + e_{2t} \quad (09)$$

GDPt and ut are economic growth and unemployment, β_0 and α_0 are the intercepts, GDP_{t-1} and U_{t-1}arelagged values of both variables, and e1t and e2t are random error terms with zero means.

Furthermore, this paper used some sophisticated time-series tests, namely, causality test and Impulse Response Function,to test the models' time-series property and imposed some critical violations test.

4. Results and Discussions

Our analysis begins with the unit root test. Table 1 explains the result of Augmented Dickey-Fuller (ADF) stationary tests of the GDP growth rate and unemployment rate. Unit root test based on Search info criterion and does not consider Trent or constant. Here our decision is based on alpha value and probability value. If the alpha values smaller than the probability value at 1 percent, 5 percent, or 10 percent significance level, then the null hypothesis is accepted—[H0: series has a unit root or the series is not stationary at itslevel].

Table 1: Unit root test Results

Variable	At level	At 1st difference
	P-value	P – value
Economic growth rate (GDP growth rate)	0.190	0.000*
Unemployment rate	0.087	0.000*

Note: The superscript * denotes rejection of null hypothesis at 1% significant level.

The results show that the p-value of both variables ismore excellent than the 5percent significant level at its natural level form. This can be concluded that both variables are non-stationary at level form. However, the p-value of both variables is smaller than 5percent significant at the first difference. It depicts that the GDP growth and unemployment rate become stationary after the first difference. Also, this result concludes that the long-run

monetary model is to uses cointegration procedures. Our empirical analysis consists of four different estimations of Okun'slaw.

The difference model and dynamic model are estimated in the OLS method. The estimation of different Versions (equation 05) of Okun's Law is shown in Table 2.

Table 2: The estimation of different Version of Okun's Law

Variable	Coefficient	t-Statistic	Prob.
D(GDP_Growth Rate)	-0.018	-0.939	0.351
Constant	-0.058	-1.194	0.236
R-squared		AIC	0.972
Prob (F-statistic)		D-W	2.280

Based on these results, there is a negative relationship between the GDP growth rate and the unemployment rate because GDP coefficient has a negative sign. However, this Okun's coefficient is insignificant at 5percent level. Thus, the different versions of Okun's model are insignificant at the 5percent level. Secondly, we estimated the Dynamic version of Okun'slaw and explained Okun's coefficient. The results of the Dynamic version are shown in Table 3.

Table 3: Estimation of Dynamic version of Okun's Law

Variable	Coeff.	t-Stat	Prob.
GDP growth rate	-0.044	-1.565	0.123
GDP growth rate (-1)	0.006	0.234	0.815
Unemployment Rate (-1)	0.934	21.653	0.000*
C	0.474	1.981	0.052***
R-squared		AIC	1.030
Prob (F-statistic)		DW-stat	2.424

Note: The superscripts * and *** denote the significance of the variables at 1% and 10%, respectively.

This estimation concluded that the GDP coefficient has a negative sign but it is not significant. GDP lagged variable also has an insignificant relationship with unemployment. This signifies no significant relationship between unemployment and GDP growth rate based on the dynamic version of Okun's law. Although, there is a positive relationship between the Unemployment rate and its lagged value at 1percent level, while the overall model significant at one percent level. The constant value of 0.474964 shows the mean change in the unemployment rate when the economy does not grow.

The third part of the empirical analysis of this study is estimating the Error Correction Model (ECM) based on Engel- Granger approach. Engle and Granger (1987) recommend a two-step procedure for cointegration analysis. A test of cointegration is a test of whether residual series is stationary. ADF tests determine this on the residuals. The stationary test of residual of equation (05) is as follows; see Table 4.

Table 4: the result of Unit root test for residual series

Null Hypothesis: Residual series has a unit root Exogenous: Constant Lag Length: 0 (Automatic – based on SIC)			
ADF test statistic		t-Statistic	Prob.*
		-9.995	0.000*
Test critical values:	1% level	-3.540	
	5% level	-2.909	
	10% level	-2.592	

Note: The superscript * denotes rejection of null hypothesis at 1% significant level.

According to this result, the residual of difference version equation is stationary at its level form and identified that GDP growth and unemployment rate are cointegrated and they have a long-run relationship. Thisresidual unit root test allows re-estimating the difference version equation with an error correction mechanism. The results of the error correction model are shown in Table 5.

Table 5: Estimation of the error correction model

Method: Least Squares (Engel-Granger method)			
Variable	Coefficient	t-Statistic	Prob.
DEG	-0.015	-0.758	0.451
ect (-1)	-0.070	-2.006	0.049**
C	-0.057	-1.205	0.232
Prob(F-statistic)		DW- stat	2.260

Note: The superscript ** denotes the significance of the variable at 5% significant level.

Based on Engel Granger's approach, the short-run coefficient value became negative (-0.01551), but it is not significant. This concludes that the GDP growth rate has no short-run equilibrium relationship with the unemployment rate. However, the error correction term (ECT) has become negative and significant at a 5percent significance level. That means the error term corrects its previous period disequilibrium at the speed of 0.07 percent quarterly. Here we can consider the ECT as Okun's coefficient. Hence ECM concluded that there is no short-run equilibrium relationship between GDP growth and the unemployment rate. At the same time, both variables have a long-run equilibrium relationship. There is another way to confirm the long-run relationship is VECM with cointegration analysis.

Finally, we analyzed GDP growth and unemployment rate with VECM, which explains both the short-run and long-run relationships. For Vector Error Correction Model, we choose one lag based on the Likelihood ratio, final prediction error, Akaikeinfo criterion, and Hannan-Quinn criterion.while, we found cointegration between the unemployment rate and GDP growth rate through the Johansen cointegration procedure. Both trace test and the max-eigenvalue test indicates twocointegrating equations at the 0.05 level. This estimation confirmed a long-run relationship between the unemployment rate and economic growth in Sri Lanka. According to Johansen's cointegration procedureand VECM estimates, the long-term cointegrating equation is as follows.

Unemployment ratet = 9.167928 – 0.719975 GDP growth ratet

The t-statistics of Okun'slaw coefficient is [3.07005] indicated that the GDP growth rate has a significant inverse relationship with the unemployment rate inthe long run in Sri Lanka. According to the cointegration equation, a

one percent increase in the GDP growth rate causes 0.72 percentage declines in the unemployment rate in the long run. Furthermore, VECM estimations confirmed the validity of Okun'slaw in Sri Lanka when the Okun'law coefficient becomes statistically significant with a negative sign. VECM explains the short-run dynamics as well. The estimations of VECM equations (04) and (05) are below,

GDPt = - 0.10915 -0.586 $\sum_{i=1}^{2} U$t-i + -0.3059 $\sum_{i=1}^{2} GDP$t-i* - 0.218862
Ut = 0.08433 – 0.26378 $\sum_{i=1}^{2} U$t-i ** - 0.0866 $\sum_{i=1}^{2} GDP$t-i -0.06287*

(Note: The superscripts * and ** denote the significance of the variables at 1% and 5% respectively, and the error correction terms are provided in bold letters)

Based on these equations, it is confirmed that there is an inverse relationship between the unemployment rate and GDP growth in both equations. This means one percentage increase unemployment rate leads to a 0.586 percentage decrease in Sri Lanka's GDP growth. Similarly, a one percent increase in Sri Lanka's GDP growth leads to a 0.08663 percentage decrease in the unemployment rate in the short run. Error correction term inthe second equation has become statistically significant with a negative sign. According to the ECT coefficient of -0.062873, around 6% of dis equilibriumin's unemployment rate in the short-term is corrected quarterly. To be more specific, it takes more than four years to correct short-term disequilibrium and to restorethe long-term equilibrium of the unemployment rate in Sri Lanka. Furthermore, this paper analyzed the causal relationship and impulse response function for the unemployment rate and GDP growth series. The granger causality test clarified how these variables affect (drive) each other. The VEC Granger Causality/Block Exogeneity Wald Tests results are shown in Table 6.

Table 6: Summary of causality test

Null hypothesis (H0)	P-value	Decision
GDP growth does not Granger cause the unemployment rate	0.338	H0 Accepted
the unemployment rate does not Granger Cause GDP growth rate	0.450	H0 Accepted

There was no causal relationship between the unemployment rate and GDP growth rate in Sri Lanka from these results. However, the Impulse response function is supported to prove the inverse relationship between the unemployment rate and GDP growth in Sri Lanka, as shown in Figure 1.

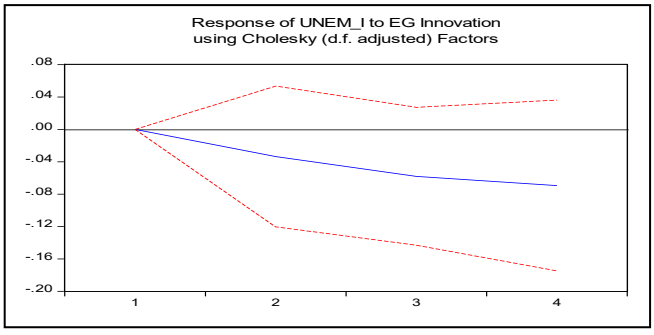

Figure 1: Impulse Response Function

Based on Impulse Response Function, it is clear that there is a significant inverse relationship between the unemployment rate and GDP growth rate from the beginning. This means a one unit standard deviation shock of GDP growth made an inverse impact on the unemployment rate in the long term, and It will take a long period to reach the equilibrium level.
The following Table 7 is summarizing some of the significant residual-based Diagnostic test results for each model.

Table 7: Summary of the Diagnostics Tests

Diagnostic test (p-value) Models	Normality test	AC-LM test	Het. Tests
Difference version	0.612	0.186	0.985
Dynamic Version	0.162	0.005	0.953
ECM	0.038	0.083	0.811
VECM	0.023	0.563	0.075

Basing on the table above, it is now clear that the Difference version estimation is stable. It is normally distributed, serial uncorrelated with equal variance, and the parameters are stable. Dynamic version estimations satisfy the normality test and Heteroscedasticity test while suffering from serial correlation. Finally, ECM and VECM are not suffering from serial correlation and Heteroscedasticity problems,however;, residuals of both models are not multivariate normal. These pieces of evidence are not enough to validate the presence of Okun's law in Sri Lanka.

5.0 Conclusion

The concepts of economic growth and unemployment are most important because all economies are choosing and implementing economic policies. Thus, when an economy is growing, unemployment is usually falling; when an economy is in recession, unemployment is generally rising. Arthur Melvin Okun (1962) summarized the inverse relationship from changes in the unemployment rate to changes in real output growth by using regression.

Sri Lanka has witnessed a considerable reduction in its unemployment rate over the past decade. The literature confirmed that studies based on economic growth and unemployment in emerging countries like Sri Lanka are limited to recent studies. Hence, this study attempts to find out the relationship between unemployment and economic growth and test the validity of Okun'slaw in Sri Lanka. This empirical analysis has employed the difference model, dynamic model, Error Correction Model (ECM), and Vector Error Correction Model (VECM) to validate the relationship between the unemployment rate and economic growth suggested by Okun's Law. For this purpose, quarterly data from 2004Q1 to 2019Q4 are used in this empirical analysis. This study is structured as four different models and five equations to prove the inverse relationship between the unemployment rate and economic growth rate and check the validity of Okun'slaw in Sri Lanka.

All the models provedan inverse relationship between unemployment and GDP growth in Sri Lanka, as we assumed by Okun's Law. Significantly, the different version and dynamic version of Okun'slaw shows a negative relationship, but the result is notsignificant at 5percent significant level. This study analyzed both the short-run and long-run relationship between unemployment and economic growth rates through the Engel-Granger approach and Vector Error Correction Model. These two models found long-term cointegration between the

unemployment rate and economic growth rate in Sri Lanka.

VECM proved the statistically significant negative relationship, while Engel Granger's approach reported an insignificant negative relationship between unemployment and GDP growth rates in Sri Lanka.However, the error correction term in both these models said the correct sign and became statistically significant. Furthermore, the Impulse Response Function also satisfied the negative relationship between the unemployment and economic growth suggested by Okun in Sri Lanka. Overall this study implies that Okun's Law can still be used as the best rule of thumb to describe the relationship between unemployment and GDP growth only in the long term in Sri Lanka.

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