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Does Okun's Law and its Coefficient value, β exist? Evidence from Sixteenth South and Southeast Asian Countries during 1991-2020

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ABSTRACT

Purpose: This paper retested the Okun's Law established in the 1960s and the subsequent research on Okun's findings that a 1% increase in unemployment would lead to a 3 % decrease in GDP), i.e. Okun's coefficient (β)= -3 in diverse economies of sixteen South and Southeast Asia, sixteen countries.

Design/methodology/approach: Using panel data in two models, the first difference model: $(Y_t - Y_{t-1}) = \alpha - \beta(U_t - U_{t-1})$ and the gap model: $(Y_t - \hat{Y}_t) = \alpha - \beta(U_t - \hat{U}_t)$ were estimated.

Findings: Results of pool ordinary least square (POLS), Fixed Effect Model (FEM), and Random Effects Model (REM) supports Okun's Law and shows that the coefficient, β , is (-4.4) suggesting that every 1 percent unemployment rate leads to 4.4 decrease in GDP. The Okun's coefficient varies with country. The validity of Okun's coefficient, β = -2 percent, is found only in four. Findings of negative coefficient and its significance provides important policy prescriptions for nine countries.

Research limitations/implications: This paper suffers from limitations. First data limitation. This paper used annual data of 30 years. Future research may include quarterly data or annual data with more observations. Second, as Hodrick and Prescott [1997] filtering approach suffers from criticism, Cobb-Douglas production function estimate may be applied for estimating full-employment GDP and natural rate of unemployment.

Originality/value: All studies of Okun's law studies derived its coefficient focused on the economically developed countries, this study is an exception. The survey of literature shows that there is no research of Okun's for sixteen South and Southeast Asian countries with diverse level of economic growth. So, the result of this study is an important contribution in the literature of Okun's law. Second, as the policy makers of these countries are facing mounting pressure of unemployment, finding the value of Okun's coefficient is a contribution of this paper for them.

Keywords: Okun's Law, Panel Estimates, Fixed Effect Model, South and Southeast Asia

I. Introduction

Sixteen countries of the South and Southeast Asia, Bangladesh, Brunei, Burman, Cambodia, China, Hongkong, India, Indonesia, Malaysia, Nepal, Pakistan,

Singapore, South Korea, Sri Lanka, Thailand, and Philippine are examined in testing Okun's Law that GDP and unemployment is negative related and its empirical findings that the coefficient, $\beta=0.3$. Studying is important for many reasons. The macroeconomic policy implication is one of the most important reasons.

While assessing the healthiness of an economy, there are two statistics that are most talked about, Gross Domestic Product and Unemployment Rate.

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These metrics are so important as a high GDP indicates a healthy and prosperous economy and a low unemployment rate indicates that the nation is using adequately all the sources available to them. With the understanding of how important these statistics are in measuring an economy's health, it can be easily inferred that the finding of a correlation between these two pieces of data is also very crucial in understanding the health of a country's economy. This is precisely what Arthur Melvin Okun set out to do in 1962 when he discovered Okun's Law which in its most simple form states that a two percent increase in output corresponds to a one percent decline in the rate of cyclical unemployment (Okun). If these findings are still valid given more recent statistics from the South and Southeast Asia, they will be highly indicative for seeing the healthiness of those nation's economies.

The validity of Okun's relation could potentially be very useful for the governments of each nation in order to make policies that can further stimulate growth in their individual economies. For example, if Okun's Law remains viable in South and Southeast Asia, the governments of those nations can understand that if they would like to increase their GDPs, policies or programs focused on reducing unemployment have the potential of producing something of economies of scale, meaning that the effort they input can result in an output worth double the original effort.

Unemployment is an important issue in the world, and it is certainly a major issue in the countries under study. High unemployment rate means that labor resources are not fully and efficiently utilized. It means many high school and college graduates remain unemployed. It leads to loss of output and hence loss of consumption and standard of living. Their unemployment creates added social unrest and law order issues.

The high unemployment rate in developing countries is a big challenge and has a great impact on the sociopolitical life of countries. Every year thousands of college and university graduates are unemployed. Because they are not employed, crime is common. Maintaining law and political stability have become

a major challenge in countries of high unemployment rate.

Full employment is a major macroeconomic goal of any government because it maximizes output. Government must provide employment to every citizen who looks for a job and certainly to high school and college graduates. Failing to provide jobs is threatening the stability of government in most of the South and Southeast Asian countries. Political unrest becomes a norm due to the high unemployment rate.

Output gap play has an important policy implication Jahan and Mahmud (2013). If the output gap is negative, output level is below the full-employment output, unemployment increases. It is a major concern for the policy makers of a country.

Finally, the understanding of Okun's Law that an increase economic growth by 1 percent reduces unemployment by $\frac{1}{2}$ percent and testing the law is important because it is both interesting and helpful as it gives an important choice to policy makers in understanding correlations that occur among statistics. Although correlation does not always indicate causation, correlation in the case of Okun's Law can be used to help predict other variables. For example, if a nation's GDP growth was down a certain percentage, Okun's Law can be used as a rough estimate on how much unemployment rates may have grown and vice versa. The understanding that the increase in economic growth reduces unemployment is essential for the conduct of monetary and fiscal policy success.

The South and Southeast Asia countries are chosen because they are the best testing grounds/ countries. The stages of economic development in these countries are not uniform. Some countries are high income nations like Singapore, Malaysia, and Brunei. The per capita income of these countries is highest in the region. On the other hand, Bangladesh, Bhutan, Pakistan, India, Sri Lanka, and Thailand are countries of low income striving for achieving a higher standard of living. The per capita income is not as high as that of Singapore and Malaysia. Conducting the empirical test of the validity of Okun's law and its coefficient, $\beta = 3$, is interesting testing countries

because of their socio-economic diversity. Given the validity of Okun's law, it will be an interesting finding. It will provide universal validity to Okun's law; it is a contribution in the literature of Okun's law.

The most important policy implication of Okun's findings is that it has profound implications on policy making that the increase in economic growth and lowering unemployment rate is crucial for pursuing better economic performance and essential for enacting successful fiscal and monetary policy.

This paper is organized as: Importance of study, the characteristics feature of unemployment of nine countries of southeast Asia is presented in Introduction. Survey of literature is provided in section 2. Data and methodology are discussed in section 4. Empirical results are presented and analyzed in section 5. Conclusions and policy implications are presented in section 6.

II. Literature Survey

Since Okun's publication in 1962, it opened the gates of numerous studies on the various fronts of Okun's coefficient relating to estimating and testing his coefficient, factors affecting *coefficient* and its stability, and lastly the existence of Okun's Law. Early research by Weber (1984), and Smith (1974). Smith (1975), Gordon (1984), Knoester (1986), Kaufman (1988), Prachowny (1993) focused on these issues and found mixed results.

Using post-war US data, Weber (1995) examined the validity of Okun's law and found the coefficient was close to -0.25. Perman et. al. (2014) conducted research in finding the "true value" of the Okun's law coefficient using a sample of 269 estimates. They found the impact of unemployment rate on GDP in -1.02 points. This value is far away from the three points - coefficient and make obvious that the period and countries selected matters. Lee (2000) found qualitative but not quantitative validity of Okun's law. He selected 16 OECD countries to observe if

the so - called rule of thumb holds. He found that, although all countries present a negative relationship between GDP and unemployment, the coefficient that relates these variables varies significantly across countries. Moosa (1997), examined Okun's Law in G-7 countries found that the Okun's coefficient was not uniform, highest in the US and lowest in Japan.

Daly and Hobijn (2010) examined the relationship using US data and found a deviation of Okun's findings and the strong productivity growth was the main driver of the departure from Okun's law in 2009. Using two sets of US data and a gap model, Prachowny (1993) examined the link between employment and output in greater detail. When the output gaps were estimated for the U.S. economy with a production-function approach, he found that a 1point reduction in unemployment increases GDP gap by only 2/3%. Villaverde and Maza (2008) examined Okun's law and its coefficient in Spanish regions during the period 1980-2004. Using "gap" specification, they found the validity of Okun's law i.e.an inverse relationship between unemployment for most of the regions and for the whole country. However, they have different values of Okun's Coefficients. Freeman (2000) empirically tested Okun's coefficient for the 1959-98 period and found that the value of Okun's coefficient was remarkably stable at about 1.9 to 2.0 for the overall economy whereas values for the regions vary from 1.8 to 3.6.

Adanu (2005) examined Okun's coefficients for ten Canadian provinces and found an average estimated coefficient of -1.58 under the Hodrick-Prescott detrending method and -1.32 under the quadratic detrending method. The cost of unemployment is higher in higher industrialized provinces than non-industrialized provinces in Canada. Pereira (2014) examine the strength of Okun law relationship between unemployment and GDP, stability of relationship as well as spillover impacts in Virginia metropolitan statistical areas (MSA) during the Great. Spring and Adam (2019) examined Okun coefficient, i.e., the output-unemployment relationship and spillover effects between neighboring MSAs of Florida. Kennedy, Brian (1989) tested Okun's coefficient for

U.S. State level using data over the period of 1977-1997, and 1997 -2007. found that Okun's coefficient does exist at the state level, and the coefficient is about 1.5 to 1. His pooled data suggested a symmetrical relation and he found no strong evidence of a structural break. Evans (1989) used three legged periods in determining how past variations in Gross National Product (GNP) and unemployment influenced quarterly values of these variables. He applied a bivariate approach and obtained instantaneous causality and a significant long run relationship between GNP and unemployment rate.

III. Data and Methodology.

A. Data

In exploring Okun's Law relationship of the changes of output variation on the unemployment rate requires four macroeconomic data sets: real GDP, potential GDP, unemployment rate and natural rate of unemployment rate.

Data for real GDP and unemployment rate for 16 countries of the south and southeast Asia are annual from 2001-2020. Both GDP and unemployment data are obtained from the International Financial Statistics of the world.

Data for potential GDP (\hat{Y}) and the natural rate of unemployment, (\hat{U}), are not observed. They are latent variables and tricky to estimate. There are several approaches for estimating these two variables. They include the Hodrick-Prescott (1997) approach and the Bandpass filter developed by Baxter and King.

According to Moisa et (2010), the HP filter proposed by Hodrick and Prescott is widely used, even though it is not free from shortcomings. Ting and Ling (2011) examined the existence of Okun's relationship for Malaysia economy applying the first difference and gap model with Hodrick-Prescott filter (HP filter). Similarly, Arshad (2010) used the gap equation and technique of Hodrick-prescott filter (HP) to investigate the presence of Okun's in the Swedish

economy. So, this paper used the Hodrick and Prescott [1997], hereafter HP-filter, prefiltering technique to estimate potential, GDP (\hat{Y}) and natural rate of unemployment (\hat{U}).

The difference between the HP GDP value, (\hat{Y}_t), and the observed value of GDP, Y_t , is the output gap/GDP gap series. The same way, the difference between the HP unemployment rate, \hat{U}_t , and the actual unemployment rate, U_t , is an unemployment gap series. In otherwards, ($Y_t - \hat{Y}_t$) and ($U_t - \hat{U}_t$) are GDP gap and unemployment gap respectively.

As potential GDP (\hat{Y}) and the natural rate of unemployment, (\hat{U}), are not observed, they are estimated/generated by the author using the Hodrick-Prescott (HP) filter detrending technique.

Descriptive statistics of pool data for the GDP gap and unemployment gap is provided in Table 1.

The first important point of Table 1 is the negative relationship between the GDP gap and unemployment gap. The second point is that the p-value of the Jarque-Bera fails to reject normality of the data series.

B. Methodology

First, the unemployment and output gaps are generated using the Hodrick-Prescott (HP) filter detrending technique.

Three models are used in estimating the Okun's original coefficient. They are:

Table 1. Descriptive Statistics of Pool GDP gap and Unemployment gap

Unemployment gap		GDP gap	
Mean	0.01894	Mean	-0.03205
Median	0.000000	Median	0.000373
Maximum	0.591960	Maximum	0.428859
Minimum	-1.286439	Minimum	-0.508080
Std. Dev.	0.114991	Std. Dev.	0.098676
Skewness	-3.023974	Skewness	-0.853119
Kurtosis	44.59239	Kurtosis	10.34714
Jarque-Bera	33931.60	Jarque-Bera	1130.723
Probability	0.000000	probability	0.000000

Model I: the first difference equation model.

$$(Y_t - Y_{t-1}) = \alpha - \beta(U_t - U_{t-1}) + \varepsilon_t \quad (\text{Eq 1})$$

or

$$\Delta y_t = \beta_0 - \beta_1 \Delta u_t + \varepsilon_t \quad (\text{Eq 2})$$

Where $(Y_t - Y_{t-1})$ is the difference/variation of GDP natural logarithm between output in t and $t-1$ period Y_t , and $(U_t - U_{t-1})$ is the difference between unemployment rates in periods t and $t-1$.

1. ε_t in all equation is the white noise/error in estimation

Model II: the gap equation model.

$$\left(\frac{Y - \hat{Y}}{\hat{Y}} \right) = \alpha - \beta(U - \underline{U}) \quad (\text{Eq 3})$$

Where $\left(\frac{Y - \hat{Y}}{\hat{Y}} \right)$ is the gdp gap and it is the difference between actual (Y) and potential (\hat{Y}) GDP expressed in terms of percentage. $(U - \underline{U})$ is the unemployment gap which is the difference between actual (U) and natural rate of unemployment, (\underline{U}).

Postulated relation:

From 1,

$(Y_t - Y_{t-1})$ and $(U_t - U_{t-1})$ are negative. If $(Y_t - Y_{t-1}) > 0$, then $(U_t - U_{t-1}) < 0$ and vice versa. If $(Y_t - Y_{t-1}) = 0$, $Y_t = Y_{t-1}$, it means $U_t = U_{t-1}$

From 3

If $\left(\frac{Y - \hat{Y}}{\hat{Y}} \right) > 0$ then $(U - \underline{U}) < 0$, that is, if actual GDP, (Y) is higher than the potential (\hat{Y}) GDP, actual unemployment (U) is lower than the natural rate of unemployment, (\underline{U}) and vice versa

If $\left(\frac{Y - \hat{Y}}{\hat{Y}} \right) = (U - \underline{U})$, it means there is no GDP and unemployment gap.

Both models are estimated using non-panel and

panel data. Before estimating eq (1) and eq (3) using non-panel data, Augmented Dickey Fuller Test and Phillip Parron test were performed because of Pollossi (1972) publication. Since his publication, it is now admitted that the time series suffers from non-stationarity, this paper applies unit root test before running a meaningful regression. The augmented Dickey-Fuller (ADF) test, Phillip Parron (PP) tests were performed on GDP and unemployment rate, In the following equation, the null hypothesis, $\alpha=0$ is tested against the alternative hypothesis, $\alpha<0$:

$$\Delta y_t = \alpha_0 + \beta_1 + \gamma y_{t-1} + \sum_{i=1}^k \lambda_i \Delta y_{t-1} + \varepsilon_t \quad (1)$$

Schwarz Bayesian Criterion (SBC) will be used to determine the lag length or K . The results of the ADF and PP test are presented in the empirical section.

C. Panel Estimate

As this paper incorporates sixteen countries and thirty years, the panel estimate is also the best candidate for testing the validity of Okun's law and its coefficient value. When entities (countries) are many and year is not a single, there are three types of panel estimates, (i) Pool Ordinary Least Square (POLS), (ii) Fixed Effect Model (FEM), and (iii) Random Effect Model (REM).

This paper used the Fixed effect Model in estimating the eq (1) in determining the Okun's law and its coefficient. The decision to apply the FEM is based on the conclusion of several tests. This paper applies the Breusch-Pagan test, Honda test, King Wu, and Hausman tests in determining the appropriateness of whether to use POLS or FEM.

IV. Empirical Results

A. Non-Panel Estimate Results

Results of ADF and PP tests were provided in

Table 2. The regression results for the estimate of (Eq 1) and (Eq 2) are provided in Table 3 and Table 4 respectively.

Table 2. Results of Unit Root Test of Augment Dicky-Fuller and Phillip Parron

Country	Variables	Augment Dicky Fuller Test		Phillip Parron	
		Level	1st difference	Level	1st difference
Bangladesh	GDP	-1.22	-3.00**	-1.17	-3.59***
	UN	-2.49	-5.56*	-2.44	-5.91*
Bhutan	GDP	-2.51	-7.05*	-1.8	-4.03**
	UN	-1.80	-4.51*	-1.86	-5.06*
Brunei	GDP	-1.57	-4.43*	-1.63	-4.96*
	UN	-4.35**	-7.68*	-3.45**	-8.29*
Burma	GDP	3.67	0.84	0.24	0.98
	UN	-1.89	-0.50	-1.96	-4.49*
Cambodia	GDP	-8.53*	15.25*	-6.68*	-13.85
	UN	-2.12	-6.94*	-2.39	-14.43*
China	GDP	1.19	-149	-042	-3.49***
	UN	-2.57	-3.60**	-1.67	-3.38**
Hongkong	GDP	-1.22	-3.64**	-1.04	-3.69**
	UN	-2.10	-4.57*	-2.10	-4.38*
India	GDP	-1.73	-1.04	-1.04	-2.73
	UN	-2.39	-0.89	-1.01	-0.55
Indonesia	GDP	-2.09	-3.65**	-1.79	-3.47**
	UN	-2.01	-5.15*	-1.63	-5.71*
Malaysia	GDP	-2.21	-4.51*	-2.53	-4.42*
	UN	-2.11	-4.15*	-1.47	-3.87*
Nepal	GDP	-3.15	-3.90***	-2.24	-2.58
	UN	-1.29	-5.51*	-1.36	-5.31*
Pakistan	GDP	-3.15	-2.80	-2.23	3.89***
	UN	-1.29	-.31*	-1.36	-5.31*
Singapore	GDP	-0.74	-4.33*	-0.89	-4.35*
	UN	-3.31***	-6.02*	-3.1***	-6.63*
South Korea	GDP	-3.03	-4.63*	-3.01	-5.60*
	UN	-3.46***	-4.60*	-2.31	-7.60*
Sri Lanka	GDP	-0.87	-3.72***	-1.15	-2.75***
	UN	-0.67	-5.04*	-0.64	-5.03*
Thailand	GDP	-1.94	-3.38***	-2.02	-3.94***
	UN	-2.54	-6.69*	-2.69	-6.72*
Philippine	GDP	-1.82	-1.77	-1.82	3.89***
	UN	-2.49	-3.55**	-2.53	3.52**

*= Significant at 1 percent level, ** = Significant at 5 percent level, and *** = Significant at 10 percent level

Results of ADP and PP test shows all series are stationary at first difference except the GDP of Burma, Philippine, China, Pakistan, Philippine and unemployment for India (GDP UN)

Table 3. Regression Results of Model I and Okun Coefficient, β

Country	Model I: $(Y_t - Y_{t-1}) = \alpha + \beta(U_t - U_{t-1}) + \epsilon$				
	α []	β []	R ²	F-statistic ()	DW
Bangladesh	6.00 [8.4]*	0.08 [0.80]	0.02	0.08 (0.37)	0.43
Brunei	0.01 [3.1]	-0.06 [-0.96]	0.03	1.08 (0.34)	1.29
Burma	0.03 [11.47]*	-0.087 [-3.7]*	0.33	13 (0.0009*)	0.46
Cambodia	0.05 [2.52]**	-0.01 [-0.14]	0.0007	0.01	1.19
China	0.09 [17.65]*	-0.02 [-0.88]	0.02	0.79 (0.38)	0.24
Hongkong	0.03 [8.24]*	-0.02 [-703]*	0.64	49.89 (0.0000)*	1.44
India	0.02 [19.26]*	-0.45 [-8.25]*	0.71	68.07 (0.0000)*	2.00
Indonesia	0.05 [9.68]*	0.000 [0.01]	0.000	0.000 (.98)	1.02
Malaysia	0.05 [11.87]*	-0.28 [-7.45]*	0.76	55.54 (0.000)*	1.65
Nepal	0.04 [10.23]*	-0.003 [-0.79]	0.02	0.65 (0.43)	1.93
Pakistan	0.03 [10.60]*	-0.001 [-0.21]	0.000	0.04 (0.83)	0.91
Singapore	-0.04 [-6.93]*	-0.02 [-2.73]**	0.22	7.45 (0.01)**	1.16
South Korea	0.04 [10.55]*	-0.02 [-5.33]*	0.51	28.89 (0.000)*	0.81
Sri Lanka	0.03 [8.81]*	-0.02 [-3.38]*	0.29	11.4 (0.002)**	1.36
Thailand	0.02 [5.56]*	-0.04 [-4.36]*	0.41	19.00 (0.000)*	1.62
Philippine	0.04 [9.93]*	-0.08 [-6.10]*	0.58	37.78 (0.000)*	1.78

() = prob, [] = t-statistics, * = Level of significance 1%, ** = Level of significance 5%, and *** = Level of significance 10%

Table 4. Regression Results of Model II and Okun Coefficient, β

Country	Model II: $\left(\frac{Y - \hat{Y}}{\hat{Y}}\right) = \alpha - \beta(U - \underline{U}) + \epsilon$				
	α []	β []	R ²	F-statistic ()	DW
Bangladesh	-0.0000 [-0.02]	-0.006 [-2.00]***	0.12	3.99*** (0.05)	1.11
Brunei	-0.0000 [-0.01]	-0.11 [-2.18]**	0.14	4.79** (0.03)	1.19
Burma	0.0000 [0.000]	-0.07 [-2.03]***	0.12	4.15 (0.05)***	0.44

Table 4. Continued

Model II: $\left(\frac{Y - \hat{Y}}{\hat{Y}}\right) = \alpha - \beta(U - \underline{U}) + \epsilon$					
Cambodia	-0.0000 [-0.000]	-0.0001 [-0.002]	0.000	00000 (0.99)	1.40
China	-0.000 [-0.03]	-0.01 [-1.39]	0.06	1.94 (0.17)	0.34
Hongkong	-0.0002 [-0.38]	-0.03 [-8.26]*	0.70	68.24* (0.000)	1.34
India	-0.000 [-0.02]	-0.11 [-8.06]*	0.70	65.9 (0.000)*	1.43
Indonesia	0.21 [0.005]	-0.07 [-0.09]	0.02	0.71 (0.42)	0.08
Malaysia	-0.000 [-0.10]	-0.06 [-6.39]*	0.60	40.92 (0.000)*	0.89
Nepal	-0.000 [-0.006]	0.0006 [1.4]	0.0007	0.02 (0.88)	1.69
Pakistan	-0.02 [-8.77]*	0.0008 [0.35]	0.004	0.12 (0.78)	0.12
Singapore	-0.000 [-0.07]	-0.03 [-3.79]*	0.34	14.90 (0.0000)*	0.84
South Korea	0.31 [39.5]*	-0.02 [-0.52]	0.008	0.25 (0.63)	0.51
Sri Lanka	-0.000 [-0.09]	-0.09 [-4.85]*	0.45	23.87 (0.000)*	0.99
Thailand	-0.0000 [-0.08]	-0.002 [-1.62]	0.08	2.65 (0.11)	0.90
Philippine	-0.000 [-0.22]	-0.01 [-1.2]	0.05	1.55 (0.22)	1.01

() = prob, [] = t-statistics, * = Level of significance 1%, ** = Level of significance 5%, and *** = Level of significance 10%

B. Panel Estimate Results

Results of POLS test, Breusch-Pagan test and Honda test, FEM, REM, and Hausman tests are provided in Tables 5-10 respectively.

The coefficient of the first difference equation, in Table 3, all fifteen counties, except Bangladesh, shows negative signs suggesting that there is a negative relation between the first difference GDP gap and the first difference unemployment gap. However, a significant negative relationship is observed in nine, out of fifteen countries, of south and southeast Asia. They are Burma, Hongkong, India, Malaysia, Singapore, South Korea, Sri Lanka, Thailand, and the Philippines.

The value of β , the coefficient of first difference

GDP gap, is not uniform. The value of the coefficient of the GDP gap ranges from -0.01 to 0.45. The ranges in the value of significant coefficient lies between -0.02 and -0.08 except Malaysia and India where the value of coefficient 0.28 and 0.45.

The validity of Okun' coefficient, β = (-2 percent, is found in four out of nine countries. The coefficient of the GDP gap of four countries, Hongkong, South Korea, Singapore and Sri Lanka, shows that the value of β = -0.02. The -0.02 suggest that for every 1 percent unemployment gap the GDP gap is negative 2 percent.

The value of the coefficient for Thailand and the Philippines is -0.04 and -0.08 respectively suggesting that for every 1 percent unemployment gap the GDP gap is negative 4 percent and 8 percent respectively.

Only in India and Malaysia, the value of coefficients

is -0.45 and -0.28. that is, for every 1 percent unemployment gap the GDP gap is negative 45 percent and 28 percent respectively.

The range of R^2 value for countries that have significant β coefficients lies between 0.22 and 71. The highest value of R^2 is for Malaysia. For Malaysia, the unemployment gap explains 71 percent variation of GDP gap. Singapore has the lowest R^2 value= 0.22.

The low DW (Durbin-Watson) value for all countries that show the significant values of Okun'

coefficient, β , suggest that there is no auto-correlation. The regression does not suffer from auto-correlation problems.

The negative sign of β (coefficient) of model 2,

Table 8. Result of appropriateness of Fixed Effect Model. Test of Cross-section Fixed Effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	6.174	(15,444)	0.0000
Cross-section Chi-square	87.346	15	0.0000

Table 5. Result of Pool Ordinary Least Square

Dependent Variable: GDP				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
UN rate	-0.045	0.007	-6.116	0.000
C	0.021	0.001	24.934	0.000
R-squared	0.75	Mean dependent var		0.021
F-statistic	37.411	Durbin-Watson stat		0.992
Prob(F-statistic)	0.000			

Table 6. Result of appropriateness of POLS Test using

Lagrange Multiplier Tests for Random Effects

Null hypotheses: No effects

Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	132.7653 (0.0000)	63.29860 (0.0000)	196.0639 (0.0000)
Honda	11.52238 (0.0000)	7.956042 (0.0000)	13.77333 (0.0000)
King-Wu	11.52238 (0.0000)	7.956042 (0.0000)	13.99700 (0.0000)

Table 7. Result of Cross-Section Fixed Effect Model

Dependent Variable: GDP				
Method: Panel Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
UN rate	-0.045	0.007	-6.116	0.0000
C	0.021	0.001	24.934	0.0000
R-squared	0.75	Mean dependent var		0.021
F-statistic	37.411	Durbin-Watson stat		0.992
Prob(F-statistic)	0.000000			

Table 9. Result of Panel EGLS (Cross-section Random Effect) Model.

Dependent Variable: GDP				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
UN	-0.045	0.007	-6.640	0.0000
C	0.021	0.002	10.509	0.0000
Effects Specification				
			S.D.	Rho
	Cross-section random		0.007	0.162
	Idiosyncratic random		0.017	0.838
Weighted Statistics				
R-squared	0.88	Mean dependent var		0.008
F-statistic	44.190	Durbin-Watson stat		1.163
Prob(F-statistic)	0.000			
Unweighted Statistics				
R-squared	0.75352	Mean dependent var		0.020784
Sum squared resid	0.148176	Durbin-Watson stat		0.992708

Table 10. Result of Hausman Correlated Random Effect

Test cross-section random effects				
Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.	
Cross-section random	0.065501	1	0.7980	
Cross-section random effects test comparisons:				
Variable	Fixed	Random	Var(Diff.)	Prob.
NEWUN	-0.045164	-0.045073	0.000000	0.7980

in Table 5, supports the validity of Okun's law. Results of the GDP gap and unemployment gap model of this paper show that the coefficient, β , is negative for thirteen out of fifteen countries in southeast Asia. However, the negative coefficient is found significant in eight countries. They are Bangladesh, Brunei, Burma, Hongkong, India, Malaysia, Singapore, and Sri Lanka.

The validity of Okun's law that there is a negative relation between full-employment GDP gap and full-employment unemployment gap is supported by these countries irrespective of the status of economic development. It is valid for the high per capita income countries such as Malaysia and Singapore as well

as less developed countries with rising per capita income such as Burma, India, Thailand, Sri Lanka, and Pakistan.

The coefficient, β , of the GDP gap model shows that the value of coefficient is not uniform. The value of the significant coefficient, β , ranges from (-0.006) to (-0.11). That is, every 1 percent unemployment above the natural rate of unemployment GDP gap ranges from 0.6 percent to 11 percent.

The coefficients of the GDP gap of two countries, Hongkong and Singapore are 0.03, eg, every 1 percent unemployment above the natural rate of unemployment GDP gap -3 percent and it supports Okun's original findings.

The coefficients of two countries, Brunei and India are 0.11, eg, every 1 percent unemployment above the natural rate of unemployment GDP gap -11 percent.

The coefficients of Burma, Malaysia, Sri Lanka, and Bangladesh are -0.07, -0.06, -0.09, and -0.006 respectively.

The Coefficient of Sri Lanka = -0.02 suggests that for every 1 percent unemployment gap the GDP gap is negative 2 percent.

The value of the coefficient for Thailand and the Philippines is -0.04 and -0.08 respectively suggesting that for every 1 percent unemployment gap the GDP gap is negative 4 percent and 8 percent respectively.

Only in India and Malaysia, the value of coefficients is -0.45 and -0.28. that is, for every 1 percent unemployment gap the GDP gap is negative 45 percent and 28 percent respectively.

The signs of coefficient for two countries, Nepal and Pakistan, were positive but significant.

The range of R^2 value for countries that have significant β coefficient ranges between 0.12 and 0.70. The highest value of $R^2 = 0.70$ is found for Hongkong and India. The R^2 for Malaysia is 0.60. The lowest value of $R^2 = 0.12$ is found for Bangladesh.

The low value of the DW (Durbin-Watson) for all countries with the significant values of Okun's coefficient, β , suggest that there is no auto-correlation. The regression does not suffer from auto-correlation problems.

The great variation of impact of the changes of GDP on unemployment can be attributed to various factors. The variation of the total productivity change (technical change—TC, technical efficiency change—TEC and scale change—SC) in countries of the regions are a major contributing factor. The total agricultural productivity declined during 2002-2016 (Lie et. al. 2016) due to the decline in three factors. Among the determinants, human capital, level of urbanization, and development flow to agriculture positively influenced agricultural TFP growth, while the level of economic development and agricultural import were negatively associated with TFP growth. In general, autonomous countries in the regions show great internal differences in the level of economic activity, diverse urbanization

degree and lack of uniformity in the productivity level and productivity growth.

Findings that the coefficient, β , is negative and it is significant have policy prescriptions. Countries that have coefficient, $\beta < 0$ and significance are Burma, Hongkong, India, Malaysia, Singapore, South Korea, Sri Lanka, Thailand, and the Philippines. The significance of negative β , suggests that the policy makers of these countries should resort to accelerate GDP growth to reduce the unemployment problem of these countries.

C. Panel Estimate Results

The pool Ordinary least square (OLS), in Table 5, shows that the p-value (0.0000) of the coefficient of unemployment rate (UN rate) is negative (-0.044) and it is significant. The coefficient value -0.044 suggests that every 1 percent increase in unemployment decreases 4.4 percent GDP in the sixteen South and Southeast Asian countries.

As the p-value of the Breusch-Pagan, Honda, and King Wu is less than 0.05, we reject the H_0 that cross section has no effects i.e. OLS are not appropriate estimates and we go for cross-section Fixed Effect Model (FEM) or Random Effect model (REM).

The results of the estimate of the fixed model and the test of appropriateness are provided in Table 5 and Table 6 respectively. We also estimated the Random Effect model and tested its appropriateness.

Results of the pool cross-sectional fixed model (FEM), in Table 6, shows that the coefficient of UN rate is native. The negative sign supports Okun's law. The value of coefficient is (-0.044) The negative (-0.044) suggests that the every 1 percent increase in unemployment decreases 4.4 percent GDP in the sixteen South and Southeast Asian countries. As the p-value of the coefficient of UN rate is 0.0000, the coefficient is significant.

The $R^2 = 0.75$, it suggests that 75 percent of the GDP is explained by the UN rate. The p-value of the F-statistics suggests that model works well.

As the P-value of the Hausman test is < 0.05 , we

reject H_0 and accept H_a . Meaning that the Fixed Effect is the best appropriate model.

V. Conclusions

This study examinee the Okun's Law and its coefficient, β , value for sixteen south and south Asian countries (Bangladesh, Brunei, Burman, Cambodia, China, Hongkong, India, Indonesia, Malaysia, Nepal, Pakistan, Singapore, South Korea, Sri Lanka, Thailand, and Philippine). Annual data during 2001-2020 are used.

Two models, the first difference equation model $(Y_t - Y_{t-1}) = \alpha - \beta (U_t - U_{t-1}) + \varepsilon_t$ and gap model, $\left(\frac{Y_t - \hat{Y}_t}{\hat{Y}_t} \right) = \alpha - \beta (U_t - \underline{U}) + \varepsilon_t$ used in determining the Okun's law and the value of β . Before running the regression, ADF and PP tests are applied to check the stationarity of series.

As potential GDP and natural rate of unemployment are not observed, for Hodrick-Prescott filter (Hodrick, 1997) is applied in obtaining potential GDP (\hat{Y}) and natural rate of unemployment (\underline{U}).

The paper applied two types of estimates in estimating the Okun's law and its coefficient value. Panel estimate and the country specific estimate.

Results of all three Panel estimates clearly support the Okun's law of negative relation. All three models, POLS model, FEM, and REM shows that the value of coefficient, β , is (-0.0444) suggesting that every 1 percent increase in unemployment rate leads to 4.44 percent decrease in GDP. The result of this coefficient value is significant.

Results of country specific estimates of both models support Okun's law, i.e. negative relationship between GDP gap and unemployment gap.

With regards to the value of coefficient, β , results of country specific models (non-panel) find that the value of coefficient, β , is not uniform. The value of the coefficient of the first difference GDP gap model ranges from -0.01 to 0.45. The value of

significant coefficient lies between -0.02 and -0.08 except Malaysia and India where the value of coefficient 0.28 and 0.45.

The validity of Okun's coefficient, β (-2 percent, is found in four out of nine countries. The coefficient of the GDP gap of four countries, Hongkong, South Korea, Singapore and Sri Lanka, shows that the value of β = -0.02. The -0.02 suggest that for every 1 percent unemployment gap the GDP gap is negative 2 percent.

The value of the coefficient for Thailand and the Philippines is -0.04 and -0.08 respectively suggesting that for every 1 percent unemployment gap the GDP gap is negative 4 percent and 8 percent respectively.

Only India and Malaysia, the value of coefficients is -0.45 and -0.28, that is, for every 1 percent unemployment gap the GDP gap is negative 45 percent and 28 percent respectively.

The coefficient of the GDP gap model shows similar results, i.e. the value of coefficient is not uniform. The value of the coefficient, β , ranges from (-0.006) to (-0.11). That is, every 1 percent unemployment above the natural rate of unemployment GDP gap ranges from 0.6 percent to 11 percent.

The finding of the negative coefficient of this paper has important policy prescriptions. Government policy focusing on increasing economic growth above the potential GDP will help reduce countries' unemployment rate below its natural rate of unemployment.

The paper suffers from some limitation. One of the important limitations is the use of Hodrick-Prescott (HP) in estimating natural rate of unemployment and potential GDP. Although the method is used by many, there are critiques against the use of this method. It is susceptible to end-point bias caused by the asymmetry inherent in the filter at the extreme points of a time series, Cobb-Douglas production is widely used without any controversy. Future study may apply it.

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Appendix

The general equation for Hodrick-Prescott filter (Hodrick, 1997):

$$\text{Min} \left(\sum_{t=1}^T (y_t - \tau_t)^2 \right) + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2$$

There are usually two terms in this filter.

1st term: sum of squared deviations that penalizes the cyclical movement and secondly the multiple λ which penalizes the rate of the trend component.