Journal of Contemporary Macroeconomic Issues *ISSN (Print) 2708-4973*
December, 2025, Vol. 6, No.2 [1-17] *ISSN (Online) 2709-0469*

DOI: 10.5281/zenodo.17646527

Journal of Contemporary Macroeconomic Issues
www.scekr.org

The Empirics of Okun's Law Using Augmented ARDL: The Case of Pakistan

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PAPER INFO

Information:
Received: 10 October, 2025
Revised: 11 November, 2025
Published: December, 2025

Keywords:
Okun's law, Gap version, Difference version, Dynamic version, Unemployment, Potential Output, Augmented ARDL, and Hodrick Prescott (HP) filter

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ABSTRACT

From time series data covering 1972 to 2024, the objective of the study is to investigate the Okun's coefficient for Pakistan. The coefficient of Okun's law is determined using the Augmented ARDL econometric technique to estimate the long-run elasticities and short-run dynamics while sidestepping degenerate cases. Four variations of the Okun's law – the gap, difference, dynamic version, and augmented production function versions – are applied to estimate the Okun's coefficient. In order to measure output and unemployment gap, Hodrick-Prescott (HP) filter is also used. The empirical results demonstrated that in case of Pakistan the law doesn't hold as evidenced by the comparatively low coefficients obtained applying all four versions.

1 Introduction and Literature Review

Okun's law is the name given to the empirical relationship between variations in GDP and variations in the unemployment rate. It shows that unemployment falls when GDP rises and vice versa. The law's name comes from economist Arthur Okun, who established the connection in the 1960s (Okun, A. (1962). Okun's law states that for every 1% change in GDP, the unemployment rate varies by three percentage points. Although the precise relationship varies by country and with time, it is anticipated that a 1% growth in GDP will cause the jobless rate to fall by between 0.5 and 3%.

Stable Okun's law provides guidelines to make decisions. As this law helps provide stimulus to both monetary and fiscal policy, through which the organizations can enhance hiring, which will result in decreasing unemployment. This way, the output changes due to changes in aggregate demand in the economy. But the effective tool in this regard is not the aggregate demand; rather, it is the labor policies. Which includes training related to skill development and for job training. Okun's law has recently motivated the interest of many economists, as the rate of job recovery in major economies following the recent financial crisis and covid-19 pandemic showed to be slow (Woo, 2023).

A lot of empirical studies support Okun's law's projected unemployment-output tradeoff. However, whether the coefficient of the output-unemployment trade-off is consistent with Okun's hypothesis is controversial. Numerous empirical studies have demonstrated that the computed Okun's coefficient does not match Okun's forecast within 3%, but that it varies among nations and time periods. Okun's law predictions have been challenged by many, including Ball et al. (2019), An et al. (2019), and Ball (2017).

Okun's Law research in Pakistan has shown conflicting results. The structural peculiarities of the economy of Pakistan could explain the conflicting results of the studies. Pakistan's economy is primarily agricultural, with a modest industrial sector. Because the economy is so reliant on agriculture, it is sensitive to external shocks such as fluctuations in global commodity prices, weather-related disasters, and other environmental issues. These external factors can have a considerable impact on both GDP growth and the unemployment rate, thereby confounding their relationship. Some researchers (Some studies should be cited here) have come up with inverse relation of GDP growth and unemployment, which is consistent with Okun's Law. For example, Khan and Qayyum (2012) conducted a study from 1980 to 2011 and discovered a significant inverse link between unemployment gap and GDP gap. This relationship was consistent with Hussain and Malik (2013), for example, evaluated Pakistan's output growth and unemployment from 1980 to 2012. Furthermore, the study's findings indicated significant inverse link between output growth and unemployment, according to the Law. Authors claim that the correlation was stronger in times of economic expansion and weaker in times of economic decline. while others found no significant relationship, such as (Khan & Qayyum, 2007) observed the tradeoff between unemployment and growth rate in Pakistan. It concluded with a weak and insignificant connection between output growth and unemployment from 1972 to 2005 period).

The relevancy of Okun’s law was studied by (Batavia AR et al. 2011) for Pakistani economy and reached to the conclusion that the law is not relevant. In their concluding remarks, authors maintain that in the case of Pakistan, unemployment does not significantly affect output. These results contrast with research findings from more developed nations, and changes in economic structure may be the cause of this discrepancy. Akram and Misbah et al. (2014) studied the relevancy of the law for Pakistani economy. Applying the gap form, dynamic and difference form of Okun’s law and using the OLS method the findings show that the law doesn’t hold for Pakistani economy. All the above-mentioned forms came up with low coefficients. Similarly, Ahmad et al. (2015) also favors the above results that for Pakistani economy that Okun’s law doesn’t seem valid. Abbas (2014) negated any short run link between unemployment and growth in Pakistan. The parameters estimated for short run were also insignificant, although there is an inverse and significant long run relation between the two.

According to (Khan et al., 2015) a long run relationship exists between unemployment and GDP while they found no evidence of short run relationship. The long run coefficient of Okun's Law was larger, suggesting that unemployment's influence on GDP growth is more important. Hussain and Malik (2016) used yearly time series data for the period 1980-2014 for Pakistani economy and discovered that the law was hold good in short run but there was no signal for a long-run relationship. The short run coefficient of Okun's Law was lower, indicating that the influence of unemployment on real GDP growth was less substantial. Ali and Ahmed (2017) found no strong relationship between Pakistan's output growth and unemployment from 1981 to 2014. This could be due to the informal nature of the economy, and lack of formal labor market structures. Similarly, Khan et al. (2020) conducted a more recent study that looked at the link of unemployment and growth for Pakistani economy from 1981 to 2017. They discovered that Okun’s law is true for long run but not for short run. The coefficients in the long run of Okun's Law were larger, indicating that the influence of unemployment on real GDP growth was more important. Shah et al. (2022) has examined the effect of unemployment on

economic growth using ARDL model for Pakistan through a period of 1974 to 2020. The study found inverse relation between the variables under study.

The study aims to understand the relationship between unemployment and growth rate in Pakistan using Okun's law in four forms: gap, difference, dynamic, and Cobb-Douglas production function versions. It employs augmented ARDL econometric techniques to avoid degenerate cases and find the short and long run relation between economic growth and unemployment. The extensive time period used in the research fills the research gap by examining the four forms of Okun's law available in the literature. The rest of the study is ordered as follows: The research methodology and data specifications are covered in section two, the findings and discussion are covered in section three, and the study is concluded in section four.

2 Research Method and Data Specification

2.1 Introduction

This study uses time series data consisting of different variables, including Pakistan's real GDP, unemployment rate, Gross Fixed Capital Formation is used to represent the physical stock of capital, a weighted index of enrollment at different levels of education shows the human capital stock and labor force. All variables are represented in natural-log form. The data for the current study range for the period of 1972-2024. The data on the aforementioned variables are taken from the World Development Indicator (WDI) and the State Bank of Pakistan (SBP).

The key factors in this relation include unemployment (UE) and GDP. To apply the gap form potential production, the natural rate of unemployment is needed. The literature has suggested a number of methods to calculate potential output and unemployment, which include Kalman filter, Baxter King filter developed by (Freeman 2001) and Hodrick Prescott (HP) filter developed by (Ball et al., 2017). The HP filter was used in this study. Other studies have also utilized this technique including Alamro and Aldalaien (2014), Ting and Ling (2011), Hodrick and Prescott (1997) under the following equation:

$$min_{\varphi} \sum_{t=1}^{T} (\gamma_T - \varphi_t)^2 + \psi \sum_{t=2}^{T} [(\varphi_{t+1} - \varphi_t) - (\tau\varphi_t - \varphi_{t-1})]^2$$

The cyclical component is penalized by the sum of squared deviations in the first half of this equation, while the structural (trend) component is penalized by the multiple λ (ψ) in the second half. A ψ of 100 is used in this paper because the data is annual.

2.2 Potential Endogeneity Problems

Endogeneity occurs when a model has omitted variable bias, leaving a crucial variable out of the model, or when independent and dependent variables affect each other, raising complications; the independent variable is not totally exogenous mostly linked with the disturbance term (Stock & Watson, 2015; Lynch & Brown, 2011. Endogeneity concerns are common, and caution is needed when presenting conclusions with endogeneity, as biases may cause estimations to be incorrect. Numerous studies have explored endogeneity and methods to prevent. The study of (Barreto & Hovland's 1993) demonstrates that output and unemployment gap are endogenous, emphasizing the significance of selecting the appropriate dependent variable based on the study type. Okun's law endogeneity problem is addressed using an instrumental variable when endogenous variables are present.

Clemens et al. (2012) found that using lags and first difference in independent variables helps avoid simultaneous and reverse causality. Huang et al. (2019) tested the reliability of the link between output and unemployment rate using international oil price shocks and rigorous testing. When adjusting for endogeneity problem in regressor, that produce discrepancies in Okun's coefficient, still the law remains valid. To reduce the potential of endogeneity issues, we use lags in regressor rather

than an instrumental variable (IV). It eliminates the risk of a bad choice of IV and provides a more apparent method of tackling any biases (Clemens et al., 2012).

3 Data

Data of unemployment (Um), Gross Domestic Product (Ou) and GDP deflator are obtained from WDI. For potential output Out*, HP filter, which eliminates the time trend from the data to smooth it out leaving us with output and unemployment gap. In equation (1) output gap variable is the difference between real GDP and potential GDP ($RGDP_t$ - $RGDP_t$*) and unemployment gap (Um_t - Um_t*) is difference between the observed and natural rate of unemployment.

Theoretical Framework

Various Forms of the Law

Okun's law has several variations. Specifications and attributes of each form of this law differ. Each form is made up of a distinct model, and each form uses a distinctive method for calculating the value of coefficient for this law.

This study used the following forms of the law.

- The Gap form
- The Difference form
- The Dynamic form
- The production function form

The Gap Form

Okun's rule in its gap form describes unemployment as the difference between actual and potential unemployment. Okun (1962) presented two equations that have been frequently utilized in the empirical literature, which link the output to unemployment. To enhance statistical fit and offer further understanding of the conceptual underpinnings, these equations have been developed and altered in a number of diverse ways (Perman et al., 2015). The changes in the unemployment gap alter the output gap. The functional form of the gap version of Okun's law can be represented as follows:

$$Ou_t - Ou_t^* = \alpha + \beta_1 (UE_t - UE_t^*) + \epsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where, Ou_t represents the Actual output, Ou_t^* represents Potential output, UE_t shows Actual unemployment rate, UE_t^* represents a potential rate of unemployment, ϵ_t shows Disturbance term in current period, and β_1 is Okun's Coefficient.

The above gap statement states that the unemployment gap decreases (and vice versa) when actual production surpasses potential. It emphasizes how short-term changes in aggregate demand may have an influence on output and, consequently, unemployment. The error term (ϵ_t) accounts for variables that may alter how output and unemployment are correlated. The above-mentioned factors experience unexpected variations in productivity and employment rate hence the Okun's law will be good fit if the error term has minimum value.

The Difference Form

This form shows the variation of unemployment over different periods of time. This version of the law can be expressed as:

$$Ou_t - Ou_{t-1} = \alpha_o + \alpha_1 (UE_t - UE_{t-1}) + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In the above equation, Ou_t and Ou_{t-1} show GDP growth in the current and previous periods respectively. UE_t and UE_t show Unemployment rate in the current and previous periods respectively.

While e_t represents Error term in current time period, α_1 represents Okun's coefficient, α_o represents the Intercept term.

It makes the assumption that the potential output will always be constant rather than requiring an estimate of it. The above equation shows the relationship between GDP growth and unemployment rate. Okun expects a negative relationship between the two. This equation has the advantage of not depending on invisible variables, unlike the gap form. It helps provide a procedure to check the stationarity of variables. The basic issue lies in the co-integration of unemployment and output; if so then this equation may not give valid results.

The Dynamic Form

The unemployment rate in the current time period is affected by the current and previous level of output, according to Arthur Okun, who claimed that the difference form is deficient in some way. Recent studies (Ball et al., 2017, Owyang & Sekhposyan, 2012 and Knotek & Edward, 2007) have highlighted the possibility of current and historical dynamic relations of unemployment and output. The static relationship as emphasized by Okun (1962) takes into account the fact that it can take time for unemployment to react to an external shock to output. Further it is stated that labor behaves as a quasi-fixed part of the relation. In order to deal with short-term output changes, businesses may change efforts of employees and sometimes the hours of working by the labor; these can change the productivity in a pro-cyclical way, because adjusting employment is costly. As a result, the link being just contemporaneous is not theoretically feasible. Furthermore, it may be empirically mis-specified due to the omission of considerable temporal lags. Hence a dynamic form has been added to the model which is provided as follows:

$$Ou_t - Ou_t^* = \beta_0 + \beta_1 (UE_t - UE_t^*) + \beta_2 (Ou_{t-1} - Ou^*_{t-1}) + \beta_3 (Ou_{t-2} - Ou^*_{t-2}) + \delta_1(UE_{t-1} - UE^*_{t-1}) + \delta_2 (UE_{t-2} - UE^*_{t-2}) + \epsilon_t \quad \ldots\ldots 3$$

Ou_t represents GDP growth in current time period, Ou_t^* represents Potential output, UE_t represents Unemployment rate in current period, UE^*_t represents potential rate of unemployment, ϵ_t represents Error term in the current period, Ou_{t-1} represents Output level in previous period, UE_{t-1} represents Unemployment in previous period, Ou_{t-2} represents Output level in previous two lag period, Ou_{t-2} represents Unemployment at period t-2, B_1 represents Okun's coefficient, and B_0 represents Intercept term.

Given that it is an autoregressive distributed lagged (ARDL) specification of the difference and output gap models, the dynamic specification serves as an expansion of those models. In this way, the dynamic model links current and historical changes in output/output gap to current and previous unemployment rate changes.

The above equation 3 shows ARDL model of the gap form of the law as defined in equation no.1. This form removes the serial correlation, if exists in error terms which is frequently present in the original difference and gap models. It may also alleviate endogeneity difficulties in the model's contemporaneous part. According to (Meyer & Tasci 2012), incorporating lags may help to overcome the OL instability problem over time. The dynamic link is therefore more flexible and can accommodate changes in unemployment rate and growth rate of actual output. Indirectly controlling for asymmetries and probable misspecification due to missing factors that explain variations in the rate of unemployment. The fundamental explanation of OL's form, on the other hand, becomes more complicated.

The ARDL methodology also seeks to identify potential long and short-term relationships between output growth and unemployment rate. The ARDL approach was chosen because it consistently yields normal long-run coefficient estimates irrespective of if the latent regressors are stationary or non-stationary. Additionally, as the ARDL format does not need lag length symmetry, it is possible

for each variable to have a varying number of lag terms when estimating co-integrating relationships (Pesaran et al., 2001).

The Production Function Form

Because there is not a one-to-one relationship between variations in output and variations in labor, capital, and technology, Okun recognized the limitations of his proposed association. "The unemployment rate at best acts as "a proxy variable for all the ways that idle resources affect output." (Perman et al., 2015). Okun's law gap form and production function forms are frequently combined. The Cobb-Douglas production function is taken, to be the theoretical production function. As a result, the model's hybrid specification is:

$\ln (Out - Out^*) = \beta_0 + \beta_1 K_t + \beta_2 L_t + \beta_3 HC_t + \beta_4 (UE_t - UE_t^*)$ ---------- (4)

Ou_t = Actual output, Ou_t^* = Potential output, K_t = Physical Capital Stock, L_t = Labor force

HC_t = Human capital stock, UE_t = Actual unemployment, UE_t^* = Natural unemployment

ln = Natural logarithm, β_0, β_1, β_2, β_3 and β_4 are the elasticity parameters to be estimated.

4 Results and Discussion

4.1 Stationarity Test

The factors were checked to verify if they were stationary, even though this was not necessary when using the ARDL approach (Alamro & Al-Dalaien, 2014). The ADF and PP tests assume the null hypothesis of a variable to have a unit root. Here both the tests suggest that the included variables, UEG, K, and L, are stationary at the level hence the presence of unit root as assumed by null hypothesis is rejected. GDP growth (GDPG) and human capital (HC), on the other hand, shows integration of order 1 in the presence of both with intercept and trend as well.

Table 1

Stationarity Test Results

	At Level		**At 1st Diff**		
	Intrcpt	**Trnd & Intrcpt**	**Intrcpt**	**Trnd & Intrcpt**	**Decision**
Augmented Dick-Fuller (ADF) Test					
GPGC	-1.92	-1.89	-5.39**	-7.16**	I (1)
UEG	-3.91**	-4.28**	…	…	I (0)
K	-3.44**	-3.46*	…	…	I (0)
L	-14.3**	-16.5**	…	…	I (0)
HC	-0.93**	-1.74	-6.19	-6.16**	I (1)
Philips Perron (PP) Test					
GPGC	-1.96	-1.83	-5.13	-7.14**	I (1)
UEG	-3.91**	-4.33**	…	…	I (0)
K	-3.97**	-3.72*	…	…	I (0)
L	-9.19**	-13.7**	…	…	I (0)
HC	-0.92	-1.74	-6.17	-6.14**	I (1)

Calculated by the authors. ** and * mean significance at 1% and 5% respectively.

4.2 Gap Form

Table 2

ARDL Bounds Test Results

F Bounds Test		**H_0: No level relationship**		
		Significance.	**I(0)**	**I(1)**
F Statistic	8.929473	10%	3.02	3.51
		5%	3.62	4.16
		1%	4.94	5.58

Because the estimated F-statistic value of 8.93 is larger than the upper bound critical value of 5.58, we don't reject the null hypothesis of cointegration and conclude that the variables are in steady state equilibrium.

Table 3

ARDL Long-Run Coefficients

ARDL Long Run **Dependent Varble: D(LOGGDPGAP)** **Selected Model: ARDL (5, 2)**				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
UEGGAP	-0.001501	0.000926	-1.621017	0.1137
C	-7.97E-05	0.000291	-0.274224	0.7855

Table 4

Diagnostic Results for the Gap Form

Nature of the problem	**Test-statistics**	**p-value**
Specification (Ramsey RESET Test)	1.466325	0.245
Normality (Jarque-Bera)	0.393047	0.821
Heteroskedasticity	9.513	0.950
Autocorrelation	0.950600	0.396

Charts of the dynamic stability of all four versions of the law are given in the appendices as Appendix 2.

Table 5

ARDL Short Run Coefficients

Variable		**Standard Error**	**t-Statistic**	**Prob.**
Δ (LGDPGAP(-1))	1.075836	.300379	3.581600	0.0010
Δ (LGDPGAP(-2))	.733425	.258041	2.842286	0.0073
Δ (LGDPGAP(-3))	.464172	.219022	2.119298	0.0410
Δ (LGDPGAP(-4))	.354749	.156478	2.267078	0.0295
Δ (UEGGAP)	-.000761	.000677	-1.124386	0.2683
Δ (UEGGAP(-1))	.001834	.000748	2.452155	0.0192
ECM(-1)*	-.912619	.359678	-5.317581	0.0000
Goodness of Fit				
R^2	0.559249	Durbin-Watson stat		2.061707
Adjusted R^2	0.489657	S.D. dependent var		0.005826

The gap form is first used to examine for the law. The discovery of a very small and statistically negligible Okun's law coefficient (-0.001501) shows that the law does not apply to the economy of Pakistan. However, Okun's law makes a strong case for the existence of a three-to-one ratio. The

computed coefficient should therefore range between 2 and 3. As a result, in the instance of Pakistan, empirical data conflicts with theory. Since its introduction, Pakistan's economy has continued to be in shambles; therefore, empirical evidence from the gap form did not indicate the existence of this law. No period of time has ever seen a decline in unemployment. Our labor force is of very low caliber; neither is it well educated nor qualified. Okun's law does not exist since increases in RGDP only result in a very minor decrease in unemployment. Okun's law does not apply to Arab nations as well. This claim is corroborated by researchers Zidong An, T. Ghazi, and N. Prieto (2017), who found no evidence of the law in the countries of South Asia, as well as Lal et al. (2010). In the short-run results, the error correction term is significant and equal to -0.91 which indicates a long-term link among the factors. Additionally, this analysis demonstrates that the annual correction towards equilibrium is 91.3% in the long run.

4.3 Difference Form

Table 6

ARDL bounds test results.

F Bounds Test		**H_0: No level relationship**		
		Significant.	**I(0)**	**I(1)**
F-stat	139.6600	10%	3.02	3.51
		5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58

Table 7

ARDL Long Run Coefficients

ARDL Long Run Form **Depndt Variable: D(LLGDP)** **Selected Model: ARDL(1, 1)**				
Variable		**Standard Error**	**t-Stat**	**P-value.**
LUEG	0.013994	0.116011	0.120629	0.9045
C	8.466627	1.083042	7.817448	0.0000

Table 8

Diagnostic Checking for the Difference Form

Nature of the problem	**Test-stat**	**p-value**
Specification (Ramsey RESET Test)	0.134	0.715
Normality (Jarque-Bera)	0.856	0.651
Heteroskedasticity	0.348	0.950
Autocorrelation	0.525	0.594

Table 9

ARDL Short Run Coefficients

ARDL Error Correction **Dependent Variable: D(LLOGGDP)** **Selected Model: ARDL(1, 1)**				
Variable		**Standard Error**	**t-Stat**	**P-Value.**
Δ (LUEG)	-.001695	.000838	-2.023134	0.0493
ECM(-1)*	-.010949	.000523	-20.93962	0.0000
Goodness of Fit				

R^2	0.233010	S.D. dependent var	0.007821
Adjusted R^2	0.215966	DW	1.734161

Following the estimates of the gap form, the difference form is utilized for obtaining Okun's coefficient. The empirical results of the gap form also reveal that this law does not exist in Pakistan. Both GDP and the unemployment rate are positively insignificantly correlated. This coefficient, however, is less than the needed value and statistically insignificant. The estimated value is substantially lower than Okun's originally calculated coefficient. As a result, this implies the irrelevance of Okun's law for the Pakistani economy. (Ahmed et al., 2011; Akram et al., 2014; and Zidong., 2017) Back up these findings. They also discovered no evidence of Okun's law in Pakistan's economy.

The ECM is significant and equal to -0.0109. This indicates a long-term link among the factors. Additionally, this analysis demonstrates that the annual correction towards equilibrium is 1.095% in the long run.

4.4 Dynamic Form

Table 10

ARDL Bounds Test Results

F Bounds Test		**H_0: No level relationship**		
		Significance.	**I(0)**	**I(1)**
F-stat	5.04207	10%	2.08	3
		5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Table 11

ARDL Long-run Coefficients

ARDL Long Run Form **Dependent Variable: D(LGDPGAP)** **Selected Model: ARDL(3, 0, 0, 0, 0, 0)**				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
UEGGAP	-0.000014	1.83E-05	0.767812	0.4475
LGDPGAP	1.308311	0.023867	54.81758	0.0000
L2GGDPGAP	-0.291823	0.017329	-16.83975	0.0000
LUEGGAP	-6.65E-06	1.34E-05	-0.496245	0.6227
L2UEGGAP	1.64E-05	1.55E-05	1.055477	0.2981
C	5.46E-06	8.42E-06	0.648482	0.5207

Diagnostic Checking for The Dynamic Form

Nature of the problem	**Test-statistics**	**p-value**
Specification (Ramsey RESET Test)	1.010	0.319
Normality (Jarque-Bera)	0.348	0.840
Heteroskedasticity	6.319	0.610
Autocorrelation	1.292	0.287

Table 12

ARDL Short-Run Coefficients

ARDL ECM **Dependent Variable: D(LGDPGAP)** **Selected Model: ARDL(3, 0, 0, 0, 0, 0)**				
Variable		**Standard Error**	**t-Stat**	**P-value.**
Δ (LGDPGAP(-1))	20.6861	3.270561	6.324966	0.0000
Δ (LGDPGAP(-2))	0.257529	0.138962	1.853229	0.0718
ECM(-1)*	-0.34186	10.82700	6.404529	0.0000
Goodness of Fit				
R^2	0.546010	S.D. dependent var		0.005794
Adjusted R^2	0.524894	DW		2.045211

The results of the dynamic form used to determine whether Okun's law is in effect in Pakistan are shown in the above table. Okun's law coefficient is 0.000014. The value of, in Okun's estimation, should be between 2 and 3. However, the calculated coefficient in this case is 0.000014, which implies that the results estimated using the gap, difference, and dynamic forms are the same. The existence of Okun's law in Pakistan was also not discovered in this form. Because the calculated coefficient is too much lower, insignificant, and positive than the original Okun's coefficient, this form demonstrates the nonexistence of Okun's law for Pakistan.

The short-run coefficient on the error correction term is significant and holds a value of -0.34. This indicates a long-term link among the factors. Additionally, this analysis demonstrates that the annual correction towards equilibrium is 34.186% in the long run.

4.5 The Production Function Form

Table 13

ARDL Bounds Test Results

F Bounds Test		**H_0: No level relationship**		
		Significance.	**I(0)**	**I(1)**
F-stat	6.91	10%	2.2	3.09
		5%	2.56	3.49
		1%	3.29	4.37

Table 14

ARDL Long-Run Coefficients

ARDL Long Run Form **Dependent Variable: D(LGDPGAP)** **Selected Model: ARDL(5, 5, 1, 5, 5)**				
Variable		**Standard Error**	**t-Stat**	**P-Value.**
UEGGAP	-0.004136	0.001695	-2.439747	0.0247
L	0.033687	0.009925	3.394277	0.0030
K	0.003734	0.003254	-1.147682	0.2653
HC	0.013374	0.007933	-1.685718	0.1082
C	-0.153396	0.060070	-2.553602	0.0194

Table 15

Diagnostic Checking for the Production Function Form

Nature of the problem	Test-statistics	p-value
Specification (Ramsey RESET Test)	0.006	0.938
Normality (Jarque-Bera)	0.835	0.658
Heteroskedasticity	27.083	0.819
Autocorrelation	0.006	0.927

Table 16

ARDL Short-Run Coefficients

ECM **Dependent Variable: D(LGDPGAP)** **Selected Model: ARDL (4, 4, 1, 4, 4)**				
Variable		**Standard Error**	**t-Stat**	**P-value**
ΔLDPGAP(-1))	2.097802	0.363479	5.771449	.0000
Δ(LGDPGAP(-2))	1.812606	0.316633	5.724636	.0000
Δ (LGDPGAP(-3))	1.339436	0.253471	5.284373	.0000
Δ (LGDPGAP(-4))	0.694277	0.163623	4.243146	.0004
Δ (UEGGAP)	0.001119	0.000773	1.448755	.1637
Δ (UEGGAP(-1))	0.013449	0.001946	6.912305	.0000
Δ (UEGGAP(-2))	0.009894	0.001524	6.491745	.0000
Δ (UEGGAP(-3))	0.005315	0.000970	5.480553	.0000
Δ (UEGGAP(-4))	0.002891	0.000666	4.339218	.0004
Δ (L)	0.430529	0.089221	4.825411	.0001
Δ (K)	-5.53E-05	0.024159	-0.002289	.9982
Δ (K(-1))	-0.056442	0.025050	-2.253174	.0363
Δ (K(-2))	0.060341	0.024866	2.426629	.0254
Δ (K(-3))	0.074969	0.028052	2.672520	.0151
Δ (K(-4))	0.026897	0.020955	1.283570	.2147
Δ (HC)	-0.110180	0.026895	-4.096680	.0006
Δ (HC(-1))	0.099546	0.031746	3.135744	.0054
Δ (HC(-2))	0.110231	0.034370	3.207191	.0046
Δ (HC(-3))	0.000623	0.031574	0.019742	.9845
Δ (HC(-4))	-0.084269	0.034022	-2.476875	.0228
ECM(-1)*	-0.032867	0.418943	-7.239328	.0000
Goodness of Fit				
R^2	0.847743	S.D. dependent var		.005826
Adjusted R^2	0.720863	DW		2.055740

The ARDL model's long-run coefficients show that Pakistan's total labor force has a considerable positive effect on GDP growth, while physical capital and human capital have a positive but insignificant impact on output. The long-run link of unemployment gap and GDP gap is -0.004136, which is significant, negative, but negligible. This demonstrates the irrelevance of Okun's law for the Pakistani economy.

The short-run coefficient on the error correction term is statistically significant with a value of -0.0328. This indicates a long-term link among the factors. Additionally, this analysis demonstrates that the annual correction towards equilibrium is 3.287% in the long run. Misbah et al. (2014), Lal et al. (2010), and Batavia et al. (2001) have arrived at the same conclusions. There can be various reasons for this, such as:

Informal sector: Pakistan has a sizable informal sector (Mughal et al., 2018; and Kiani et al., 2015) that is underrepresented in official employment and GDP statistics. Many workers are in low-wage, low-productivity jobs that are not reflected in official employment statistics. According to the labor force survey of Pakistan 2020-21 informal sector accounts for more than 70% of non-agricultural employment, more in rural (76.2%) than urban areas (68.5%). As a result, shocks in the rate of unemployment may not show variations in economic activity in the country accurately.

Underemployment: Underemployment is common in Pakistan, as many employees work part-time or in positions that do not fully utilize their talents and credentials. Even though they are not fully engaged in productive activities, some people may not be formally classed as unemployed. As a result, fluctuations in the unemployment rate may not accurately reflect the extent of untapped labor resources.

Labor market mismatch: Pakistan confronts labor market mismatch difficulties, in which the workforce's skills and qualifications may not match the demands of existing job opportunities. This results in structural unemployment, in which individuals may remain unemployed even when the economy is growing. According to Estevao and Tsounta (2011), the responsiveness of labor markets may be affected by skill mismatch (Ball et al., 2016).

Population growth: Pakistan's population is quickly increasing, putting strain on the labor market. The annual population growth rate, according to World Bank indicators, is 1.8 %. The rate of job creation may fall short of the rate of population growth, resulting in persistent unemployment even during periods of economic expansion.

5 Conclusion

The Okun's coefficient for Pakistan is calculated in this article using annual time series data spanning 1972-2023 from reliable sources, including the WDI and SBP. Different versions of the law, such as the gap, difference, dynamic, and production function forms, were used to derive the coefficient. The empirical analysis shows that Okun's law does not apply to the economy of Pakistan. The Okun's law coefficients for all four variations are negligible, suggesting that the Pakistani economy does not follow this law well. Although all economies, including Pakistan's, should have had Okun's law being operational, most of the research suggests that this is not the case (Boussemart et al., 2012).

Okun's legislation is only partially or not applicable in Pakistan for a number of reasons. First, Pakistan's economy is less formal, with agriculture accounting for 18.1% of GDP and employing 42.3% of the labor force. However, as a result of its decreasing contribution to GDP, incomes are no longer sufficient to ensure basic food security and coping mechanisms. Second, unstable weather patterns and global commodity prices affect developing nations with an emphasis on agriculture, like Pakistan, resulting in trade shocks and transient unemployment. As a result, there are large economic losses, transient job losses, and company disruptions. Third, Pakistan also has an incredibly low capital-to-labor ratio, which, along with increased labor supply and a lack of investment and capital accumulation, results in worker underutilization and low job quality. Furthermore, Pakistani labor is protected from the effects of macroeconomic policy by its orientation on domestic and even local markets. Fourth, there is a significant amount of educational poverty in Pakistan. The lowest level among South Asian economies in fiscal year 2021 was the state's investment in education, which was only 2.5% of GDP. Last but not least, certain sources dispute Pakistan's unemployment estimate. Since 1986, it has consistently ranged between 5 and 6 percent (Siddiqui, 2019). If the unemployment rate were so low, almost every entrant to the job market would have been able to find employment in Pakistan. Since 4% unemployment has been deemed to be full employment, this should bring the populace great joy and satisfaction, and there shouldn't be any such thing as unemployment in Pakistan. As a result, political factors are present in Pakistan's economic metrics (Siddiqui, 2019).

Data Limitations

Accurately measuring unemployment and GDP in a poor nation such as Pakistan can be difficult. Data collection and reporting procedures may be insufficient, affecting the accuracy of measuring the relationship between changes in GDP and unemployment.

5.1 Policy Recommendations

Okun's legislation is only partially or not applicable in Pakistan for a number of reasons. First, Pakistan's economy is less formal, with agriculture accounting for 18.1% of GDP and employing 42.3% of the labor force. However, because of its decreasing contribution to GDP, incomes are no longer sufficient to ensure basic food security and coping mechanisms. Second, unstable weather patterns and global commodity prices affect developing nations with an emphasis on agriculture, like Pakistan, resulting in trade shocks and transient unemployment. As a result, there are large economic losses, transient job losses, and company disruptions. Third, Pakistan also has an incredibly low capital-to-labor ratio, which, along with increased labor supply and a lack of investment and capital accumulation, results in worker underutilization and low job quality. Furthermore, Pakistani labor is protected from the effects of macroeconomic policy by its orientation on domestic and even local markets. Fourth, there is a significant amount of educational poverty in Pakistan. The lowest level among South Asian economies in fiscal year 2021 was the state's investment in education, which was only 2.5% of GDP. Last but not least, certain sources dispute Pakistan's unemployment estimate. Since 1986, it has consistently ranged between 5 and 6 percent (Siddiqui, 2019). If the unemployment rate were so low, practically every entrant to the job market would have been able to find employment in Pakistan. Since 4% unemployment has been deemed to be full employment, this should bring the populace great joy and satisfaction, and there shouldn't be any such thing as unemployment in Pakistan. As a result, political factors are present in Pakistan's economic metrics (Siddiqui, 2019).

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Appendices

Appendix 1

Augmented ARDL Bound Test for the Gap form

Exogenous F-Bounds Test			**Null Hypothesis: No exo. levels relationship**		
F-statistic = 18.284			t-statistic= -5.168032		
10%	2.87	5.30	10%	-2.57	-2.91
5%	4.11	7.33	5%	-2.86	-3.22
1%	7.41	12.13	1%	-3.43	-3.82

Augmented ARDL Bound Test for the Difference form

Exogenous F-Bounds Test			**Null Hypothesis: No exo. levels relationship**		
F-statistic = 14.020780			t-statistic= -5.784473		
10%	2.87	5.30	10%	-2.57	-2.91
5%	4.11	7.33	5%	-2.86	-3.22
1%	7.41	12.13	2.5%	-3.13	-3.5
			1%	-3.43	-3.82

Augmented ARDL Bound Test for the Dynamic form

Exogenous F-Bounds Test	**Null Hypothesis: No exo. levels relationship**

F-statistic = 7.292491			t-statistic= -5.073265		
10%	2.00	3.57	10%	-2.57	-3.86
5%	2.45	4.25	5%	-2.86	-4.19
1%	3.46	5.81	1%	-3.43	-4.79

Augmented ARDL Bound Test for the Production form

Exogenous F-Bounds Test			**Null Hypothesis: No exo. levels relationship**		
F-statistic = 6.265647			t-statistic= -6.085517		
10%	2.08	3.76	10%	-2.57	-3.66
5%	2.60	4.55	5%	-2.86	-3.99
1%	3.80	6.33	1%	-3.43	-4.6

All the forms of the model show that there is no degenerate case and therefore a cointegration relationship exists.

Appendix 2

CUSUM and CUSUM Squares Charts

Chart 1: dynamic stability of the Gap form model parameters

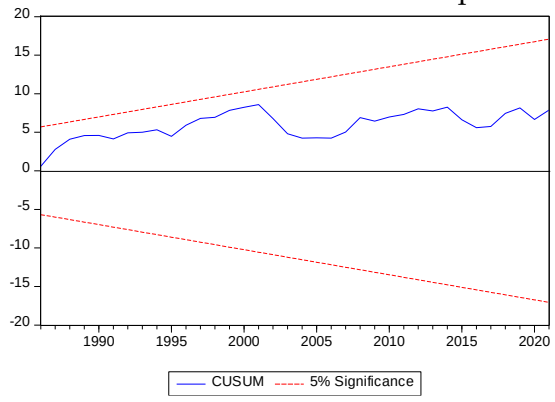

Chart 2: dynamic stability of the Gap form model parameters

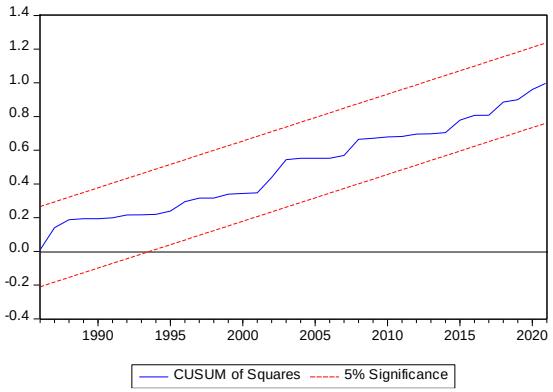

Chart 3: Dynamic stability of the difference form of the model parameters

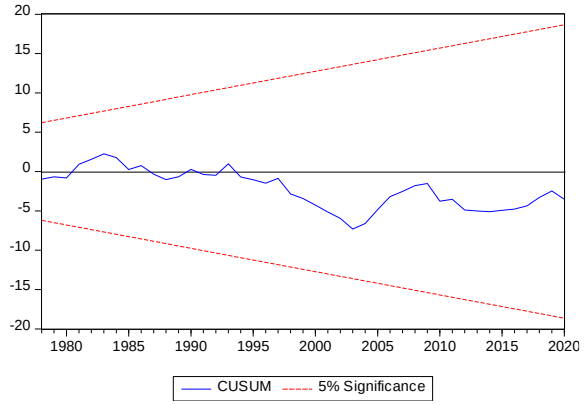

Chart 4: Dynamic stability of the difference form of the model parameters

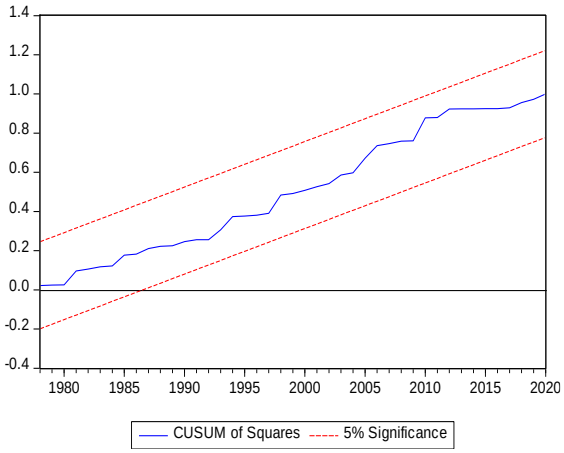

Chart 5: Dynamic stability of the dynamic form of the model parameters

Chart 6: Dynamic stability of the dynamic form of the model parameters

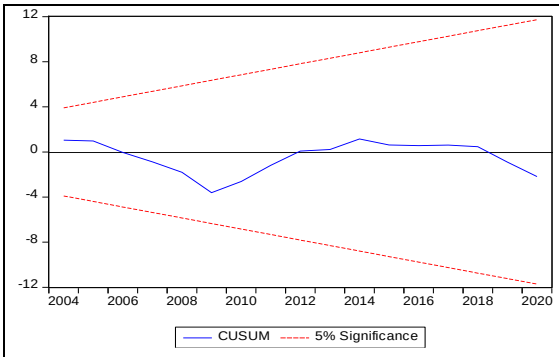

Chart 7: Dynamic stability of the production function form of the model parameters

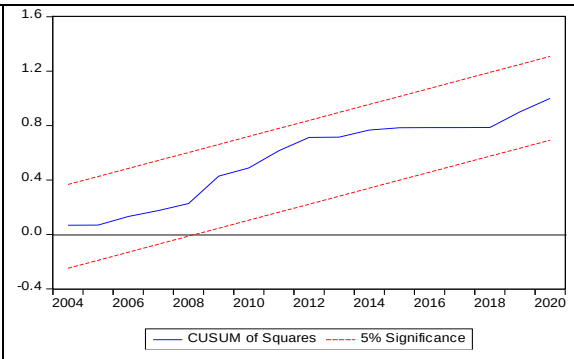

Chart 8: Dynamic stability of the production function form of the model parameters