Economic Growth and Unemployment Nexus in USA

Asoke Howlader, Sidhartha Sankar Laha, Arindam Modak

Abstract: ***Empirical relationship between unemployment and growth is not pronounced as we investigate the economic scenario of the nations. Author attempted to relate US unemployment rate to the growth during 1948-2016 by using bivariate and log regression models, Bai-Perron Model, Granger Causality test, Johansen cointegration test, vector auto regression and vector error correction models. Even, author also verified relationship between unemployment gap, output gap and growth in USA during the same period. Data on US unemployment rate, GDP and growth rate have been taken from Bureau of US census during 1948-2016. Data on US natural rate of unemployment was taken from Fed Bank of St.Louis from 1949 to 2016.The paper concludes that US unemployment rate is increasing at the rate of 0.507 per cent per annum and it has upward structural break in 1971.The nexus follows the Okun's law in USA. US unemployment is negatively related with growth rate during 1948-2016.Their relationships are causal and cointegrated. VAR model is stable and stationary. Residual test showed non-normality and autocorrelations.Moreover, author showed negative relation between growth and unemployment gap in USA during 1949-2016.They have no causality and cointegration. Their VAR model is stable and stationary. The residual test proved non-normality and auto-correlation problems. Perceptible output gap influences unemployment gap negatively during 1949-2016 .It has significant bi-directional causality and one cointegrating equation. In Vector error correction model, error corrections are significant with high speed having stability, autocorrelation and non-normality. The rate of decline in unemployment rate due to increased growth rate in USA during 1948-2016 was marginal.***

Keywords: Output Gap, Unemployment Gap, Cointegration, Vector Error Correction

I. INTRODUCTION

Classists thought that unemployment is the excess supply of labor resulting from the intersection of the labor supply and labour demand at a given real wage. Classical theory was based on Say's Law (1821) followed by Marshall (1890) and Pigou(1914) who thought that unemployment appears because the real wage is above the competitive level, where labor supply and labor demand cross out. Pigou (1914) believed that full employment prevails automatically in the labour market when the demand for labor equals supply of Labor. Marshall (1890) and Pigou (1914) explained that output and employment are determined by the interactions among labour, output and money markets. There exists a built-in equilibrium mechanism in each market to ensure full employment in the economy. On the contrary, Keynes (1936) argued that wages are often inflexible i.e. sticky downwards. To Keynes aggregate demand in the market is the benchmark. Workers resist nominal wage cuts through minimum wage laws and trade union legislation. That's why involuntary unemployment appears.

Negative output gap occurs when unemployment rate is higher than natural unemployment rate (NAIRU), and real GDP is below the potential rate. Opposite is also true. During the long period, it certainly moves around. Yet economists differ on the importance of NAIRU. The concept of natural rate was accepted by the Classical school because the economy automatically reaches stable equilibrium system. The dynamic nature of the economies was explained by John Maynard Keynes (1936) and Joseph Schumpeter (1936).The concept of Robinson (1937) on NAIRU was similar with earlier concept, since there must be a level of employment given labor market condition at which money wage will increase. But Keynesian theory of unemployment is related with the interaction among aggregate demand and aggregate supply given income distribution with fixed price level.

Okun (1962) believed that if unemployment rate is higher than NAIRU then real GDP will be less than the potential GDP which implies that the output and employment is positively related. He verified that if the economy wanted to reduce unemployment rate by 1% then real GDP should grow by 2% that must be higher than potential rate. In other words if the potential rate of GDP grows by 2%, GDP must expand by 4% to achieve 1% decrease in unemployment rate. Afterwards, long run relation between growth and employment had been glorified by Hicks (1950) who showed cyclical patterns of upswings and downswings of national income with the impact on employment in different ceilings, especially on full employment.

The quantitative relationship among unemployment, inflation and growth was analyzed by Phillips (1958) in a macro-dynamic and non-optimal disequilibrium way where role of the policy makers are important. Besides, inflation expectation is difficult to assume so that target rates of inflation, unemployment and output to the government became crucial. Modified Phillips model now describes the relationship among the output gap, unemployment gap and inflation expectation. It is analyzed that recession leads to a large negative output gap with high unemployment and inflation although empirical evidences are not identical to all economies. To avoid cyclical behavior, economists should treat them as instrumental variables along with anti-cyclical monetary and fiscal policies.

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II. REVIEW OF LITERATURE

There are innumerable economic literatures on the econometric analysis of growth-unemployment nexus.Some studies have been reviewed here. Abaidoo (2012) found that both GDP growth and corporate profit growth are significant to potentialize for lower unemployment rate in USA during 1960-2011 where author used marginal effect of Probit estimates. Knotek (2017) studied that Okun's law was unstable over time during recessions and expansions. During 1947-1960 in USA, when output was 1% below potential rate, then unemployment rate varied from 0.3 per cent to 0.75 per cent above its full employment rate. On the other hand, during 1961-2007, USA expects 0.5 % unemployment rate above the full employment rate for a 1 % fall of output from potential rate. Perhaps in the gap version of Okun's law, there was instability of the derivation of H.P.Filter in the trends of unemployment and output series. Kitov & Kitov (2011) estimated Okun's law in USA during 1951-2010 and found two structural breaks in 1975 and 1995 respectively. He fitted Okun's law as $\Delta U=1.113-0.406\Delta lnG$ during 1951-1979 and $\Delta U=0.866-0.465\Delta lnG$ during 1979-2010 respectively. Unemployment rate will be constant if threshold growth rate is calculated as (0.866/0.465) =0.89 per year. US unemployment rate starts to fall when ΔlnG is larger than the threshold rate. Owyang,Vermann & Sakhposyan (2013) tested Okun's coefficients in several data sets in USA . Firstly, they found that one per cent increase in real GDP growth led to 0.3% decrease in unemployment during 1947-1960. Secondly, they calculated the coefficient as 0.28 during 1948-2013Q1.In both the cases, using data of Bureau of Economic Analysis and Bureau of Labour Statistics, they suggested that Okun's coefficient should be smaller in magnitude during recession and expansion. NBER analysed that coefficients were 0.16 and 0.17 during expansion and recession respectively in USA. Ayoyinka & Stephen (2017) fitted Okun's law in Nigeria during 1970-2009. They found a long run negative relationship between unemployment and output where Okun's coefficient was 1.75% which was significant but unstable.In applying Okun's law, Gocer & Erdal (2015) analysed the relationship between youth unemployment and economic growth in EU through cointegration test using new generation panel data.Their findings showed that 1% increase in economic growth led to 1.13% decrease in youth unemployment in EU-18 during 2006-2012 and 2.06% decrease in EU-28 during 1996-2012 assuming there were 50-60 per cent youth unemployment rate. Cashell (2006) studied that 1% change in growth rate led to 0.3% change in unemployment in USA during 1950-2005.But to maintain a stable unemployment rate with sufficient growth rate of 3.4%, an additional 1% increase in the growth rate requires to decrease unemployment rate by 0.3 % per year. Similarly, if growth rate drops to 2.4%, then unemployment rate must increase by 0.3 % per year. It was found that during 1949-2005,NAIRU ranges between 5-6 per cent ,inflation and unemployment follow Phillips curve norm with ranging inflation from 3% to 4% during 1970-1982.It is similar with expert opinions where near 3% growth rate and 5% to 6 % unemployment rate would be consistent with stable rate of inflation. Using NBER statistical analysis, Federal Reserve Bank of Cleveland (2012) studied that in USA during 1990-2011, output growth increased by 1.6% while unemployment rate declined more than 0.9 %. It also calculated Okun's equations during 1948-2011 and 1970Q1-2011Q4 and found significant inverse relationship. Using employment-population ratio as a measure of the extent of employment generation, Swane & Vistrand (2006) examined the nexus between GDP-unemployment growths in Sweden. Authors observed a significant positive relationship between them**.** Madito & Humalog (2014) analyzed the growth-unemployment relationship during 1967-2013 in South Africa with the help of cointegration test and VECM and observed significant negative relation along with 62% error corrections. Abdul-Khaliq,Soufan& Abu-Sahib (2014) studied growth-unemployment relationship in nine Arab countries during 1994-2010 and obtained significant negative relation and showed that 1% increase in economic growth led to 0.16 % decrease in unemployment rate . Khan, Saboor, Mian &Anwar (2013) examined that 1% rise in unemployment rate led to 0.36% decrease in growth rate in Pakistan during 1976-2010 which is significant with the Okun's law. Mihaela & Mihaela (2013) studied growth-unemployment relationship in Romania during 2000-2011 and observed the significant negative coefficient of -0.753. Pinar,Serkan, Deniz & Murat(2014) examined econometric relationship between growth and unemployment in EU in 2013 and Turkey during 2001-2011 and found significant positive long run and negative short run relationships . In EU, a 1% increase in unemployment led to 0.35 % increase in growth rate in the long run and in Turkey it led to a 0.26% decrease in growth rate in the short term respectively. In studying historical relationship between growth and unemployment, Levine (2013) concluded that the negative relationship was changed in different economic structures of the countries.

III. OBJECTIVE

In this paper author attempted to verify the relationship between growth and unemployment rates in USA during 1948-2016.This study is extended to analyze the association between unemployment gap and growth and the nexus between output gap and unemployment gap in USA during the same period. Besides, the trend and structural break of unemployment rate of USA

were also examined. Econometric tools like Bai-Perron model, Granger Causality Test, Johansen Cointegration Test, Vector Auto Regression model,Vector Error Correction model and simple regression model have been taken for analysis of aforesaid relationships.

IV. RESEARCH METHODOLOGY AND DATA

Author has used bivariate simple regression, log regression models and Bai-Perron model (2003). Also author used Granger Causality test (1969), Johansen (1988,1996) unrestricted cointegration test ,Vector Auto Regression Model and Vector Error Correction Model to find relationship between growth rate and unemployment rate in USA during 1948-2016. Residual tests for autocorrelation and normality (Hansen & Doornik,1994) have been also done. Author calculated Impulse Response Functions for testing stationary. Unit circle was plotted to check stability of the VEC/VAR. Even, author tested above econometric models to find out the relation between unemployment gap, output gap and growth in USA during the specified period. Output gap (which is a difference between actual and potential rate of growth) is measured by deducting Hodrick Prescott (1997) filtered trend value from the actual output. Unemployment gap is a difference between natural growth rate of unemployment and the actual unemployment rate. Moreover, natural rate of unemployment is treated as NAIRU i.e. Non Accelerating Inflation Rate of Unemployment. Following Ball & Mankiw (2002), NAIRU is calculated from the regression of change in inflation on unemployment during the specified period where unemployment gap is the difference between unemployment rate and the coefficient of unemployment rate of the regression equation. The data on US unemployment rate, GDP and growth rate have been taken from the Bureau of US census during 1948-2016.Data on US natural rate of unemployment was taken from Fed Bank of St.Louis during 1949-2016.

V. ECONOMETRIC OBSERVATIONS AND ANALYSIS

1. GROWTH-UNEMPLOYMENT IN USA

In USA, unemployment growth rate has been stepping up at the rate of 0.507% per annum during 1948-2016 .It is significant at 5% level and the estimated equation is given below,

Log(U)=1.545167+0.005070t

(24.40)* (3.22)*

R^2=0.134,F=10.40* , DW=0.56,U=unemployment rate of USA,t=year,*=significant at 5% level.

On the other hand, GDP growth rate of USA during 1948-2016 has been increasing at the rate of 0.407% per annum which is insignificant at 5% level and is shown below.

Log(G)=-0.012008+0.004074t

(-0.017) (0.24)

R^2=0.00086,F=0.058 ,DW=1.87 , G= GDP growth rate of USA,

The unemployment rate of USA during 1948-2016 is showing one upward structural break in 1971 which is estimated by Bai-Perron model(2003) using HAC standard errors and covariance with maximum 5 breaks. The estimated values are given in Table 1.

Table 1:Structural break of US unemployment rate

Variable	Coefficient	Standard Error	T statistic	Probability
		1948-1970…23obs		
C	1.520289	0.072049	21.10087	0.00
		1971-2016…46obs		
C	1.823794	0.055187	33.04749	0.00

Source-Author, R2=0.269,F=24.75,DW=0.66,

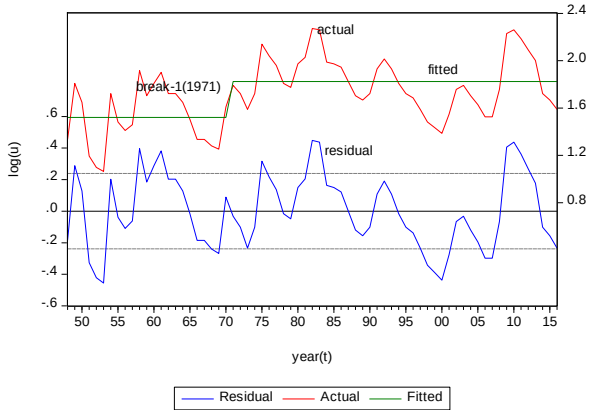

Figure 1: Structural break in US unemployment

Source- Plotted by author

This structural break in 1971 is plotted in Figure 1. In the following regression equation, Okun's law is verified in USA during 1948-2016.It is statistically significant at 5% level.

ΔU=0.014156-0.136661Δlog(G)

(0.118) (-4.409)*

R^2=0.227 , F=19.443* , DW=1.516 , G=GDP growth rate , U=unemployment rate,*=significant at 5% level.

The estimated equation suggests that 0.1366 per cent decrease in the change of unemployment rate in USA is significantly associated with one percent increase in GDP growth in USA during 1948-2016.This relationship defers from the original work of Okun (1962) for USA. But it is similar with empirical evidence in Trinidad and Tobago during 1980-2012 where it was found that 1% percent decrease in real GDP led to 0.16% increase in unemployment significantly (Blackman & Salazni, 2014).

Growth-unemployment relationship is negative in USA during 1948-2016 which has been found by regression equation and is statistically significant at 5% level. It states that one per cent increase in GDP growth rate per year during 1948-2016 in USA led to 0.034 per cent decrease in

unemployment rate per year. This relationship is shown below.

Log(U)=1.727-0.03448log(G)

(54.61* (-3.008)*

R^2=0.118, F=9.049*, DW=0.421 , U=unemployment rate (% of labour force),G= GDP growth rate of USA% per year, *=significant at 5% level.

In the following Figure 2, the fitted line of this relation is plotted clearly.

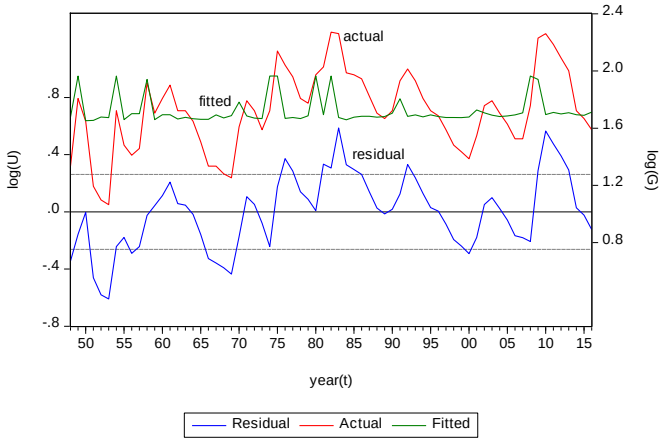

Figure2:TheEsimated line

Source-Plotted by author

The non-linear relationship of this study is similar to the findings of Basu & Foley (2011) who verified that over three business cycles in unemployment and GDP relation during 1948-2010 in US Economy clearly showed a breakdown of Okun's Law with structural changes.

Economic growth and unemployment rate in USA has no bi-directional causality which has been found out by Granger Causality test whose results are given below in the Table 2.

Table 2: Granger Causality Test between growth and unemployment

Null hypothesis	Observations	F statistic	Probability
logG does not Granger cause logU	68	4.9443	0.0297
logU does not Granger cause logG		4.98843	0.0290

Source-Calculated by author

In USA, growth rate (in terms of log G)and unemployment rate (in terms of log U) is not cointegrated in the order one which was calculated by Johansen unrestricted rank test between them during 1948-2016 where both Trace Statistic and Max Eigen Statistic have two cointegrating equations each which are significant at 5% level.It is shown below.

Table 3: Johansen Cointegration Test

Hypothesised no of CEs	Eigen Value	Trace Statistic	0.05 level Critical Value	Probability**
None*	0.305091	31.59861	15.2646	0.000
At most 1*	0.108449	7.576343	3.8414	0.005
		Max Eigen Statistic		
None*	0.305091	24.02227	14.2646	0.0011
At most 1*	0.108449	7.576343	3.8414	0.005

Source-Calculated by author,*=significant at 5% level, ** denotes Mckinnon-Haug-Michelis(1999)p value.

Since growth rate and unemployment in USA are not cointegrated with each other then estimate of Vector Auto Regression is needed to verify the relationship. The estimated equations of VAR are given below:

$logG_t$=-4.80584+0.16045$logG_{t-1}$+2.83968$logU_{t-1}$

(-2.16)* (1.26) (2.23)*

R^2=0.07,F=2.63 , SC=4.98, AIC=4.88

$logU_t$=0.55847-0.018365$logG_{t-1}$+0.679683$logU_{t-1}$

(3.86)* (-2.22)* (8.21)*

R^2=0.59 , F=48.24* , SC=-0.479 , AIC=-0.57,*=significant at 5% level

The equation log U_t is a good fit where $logU_t$ is significantly related with $logU_{t-1}$ and $logG_{t-1}$ while the equation $logG_t$ is not a good fit due to low R^2 and F but it relates to $logU_{t-1}$ significantly. Moreover, the VAR is stable because all roots (0.543553, 0.296581) reside inside the unit circle which is plotted in Figure 3.

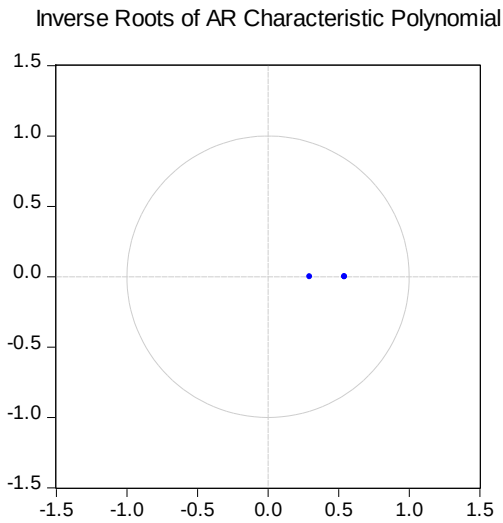

Figure 3: Stable VAR

Source-Plotted by author

VAR residuals test for autocorrelations showed existence of autocorrelation functions which are clearly shown in Figure 4.

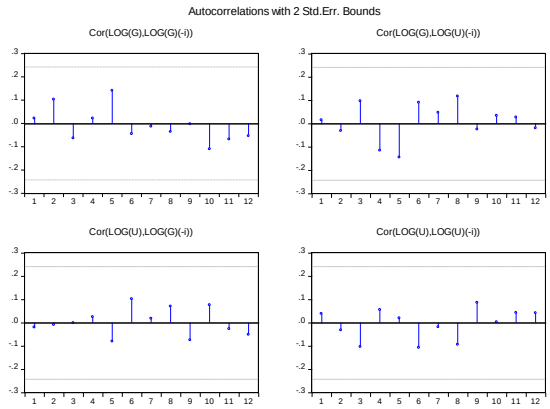

Figure 4: Autocorrelations

Source-Calculated by author

VAR residual normality test through Hansen-Doornik model assures no normality because some components of Chi-square distribution of Skewness and Kurtosis and some components of Jarque-Bera are not significant at 5% level.All the values are arranged in the Table 4.

Table 4 :Normality test

Component	Skewness	Chi-square	Degree of freedom	Probability
1	-1.907526	25.40046	1	0.00
2	-0.298609	1.161799	1	0.28
Joint		26.56225	2	0.000
Component	Kurtosis	Chi-square	Degree of freedom	Probability
1	6.138645	65.90618	1	0.00
2	3.91562	3.732249	1	0.053
Joint		69.63843	2	0.000
Component	Jarque-Bera	Degree of freedom	Probability	
1	91.30664	2	0.00	
2	4.894048	2	0.086	
Joint	96.20069	4	0.00	

Source-Calculated by author

The Impulse Response Functions of VAR model are converging to equilibrium which means that the VAR model is stationary.It is plotted in Figure 5.

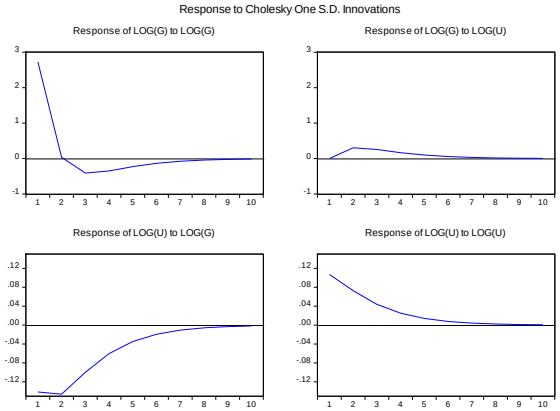

Figure 5 :Impulse Response Functions of VAR

Source- Plotted by author.

2. UNEMPLOYMENT GAP AND GROWTH IN USA

Unemployment gap and growth in USA from 1949 to 2016 are inversely related significantly at 5% level. In spite of low R^2, the coefficient of G and F value are statistically significant. The regression equation is given below.

U_1=1.218003-0.282592G

(4.22)* (-3.88)*

R^2=0.18 , F=15.06* ,DW=0.55 , *=significant at 5% level,U_1=unemployment gap of USA.

In Figure 6, the estimated regression equation between unemployment gap and growth is plotted clearly.

It is observed that there is unidirectional causality between unemployment gap and growth rate of USA during 1948-2016 which was verified by Granger Causality test that is visible in Table 5.

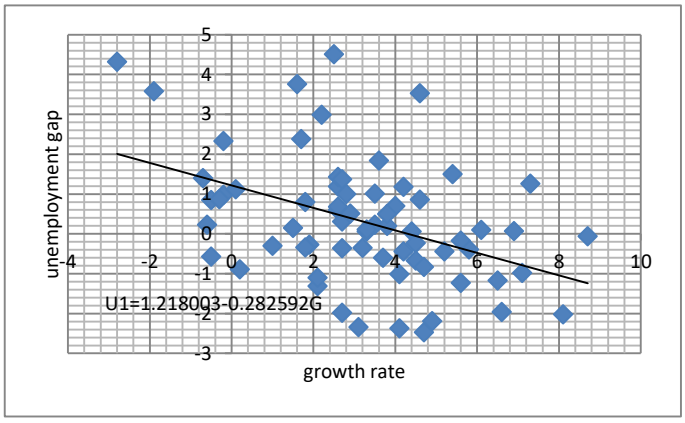

Figure 6*: Fitted line*

Source-Plotted by author

Table 5: Granger Causality test

Null Hypothesis	Observation	F-statistic	Probability
G does not Granger cause U_1	67	17.5946	9.E-05
U_1 does not Granger cause G		3.40688	0.0696

Source-Calculated by author

Even, the unemployment gap and growth rate during 1951-2016 in USA are not cointegrated which was found by Johansen cointegration rank test where both Trace Statistic and Max Eigen statistic contain two cointegrating equations which are significant at 5% level.

Table 6:Johansen Cointegration Test

Hypothesised no of CEs	Eigen Value	Trace Statistic	0.05 Critical Value	Probability**
None*	0.360094	37.57562	15.4947	0.00
At most 1*	0.115642	8.110969	3.8414	0.00
		Max Eigen Statistic		
None*	0.360094	29.46465	14.2646	0.00
At most 1*	0.115642	8.110969	3.8414	0.00

*denotes rejection of null hypotheses at 5% level,** denotes Mckinnon-Haug-Michelis(1999)p value.

Source-Calculated by author

Since there is no cointegration between unemployment gap and growth in USA during 1948-2016, the Vector Auto-Regression model is to be tested. The estimated equations of the VAR between unemployment gap and GDP growth rate are given below.

U_{1t}=0.88373-0.233497G_{1t-1}+0.6345U_{1t-1}

(3.875)* (-4.14)* (8.12)*

R^2=0.66 , F=64.87* ,AIC=2.70 , SC=2.80

G_t=2.3454+0.26989G_{1t-1}+0.33883U_{1t-1}

(4.50)* (2.09)* (1.90)*

R^2=0.08 , F=2.88 , AIC=4.35 , SC=4.44 , *=significant at 5% level

In the equation U_{1t},high value of R^2,significant F and low values of SC and AIC are preferable for good fit but in the equation G_t ,low value of R^2,insignificant F and high

values of AIC and SC are not good symptoms of good fit yet both G_t and U_{1t} are significantly related with their previous period. The t values of the coefficients of G_{t-1} and U_{1t-1} are significant. This VAR is also a stable model since all roots (0.4522±0.214204i) lie inside the unit circle which is shown in the Figure 7.

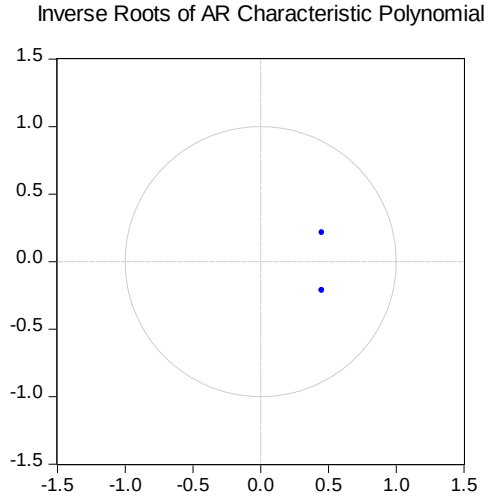

Figure 7*:* Unit Circle of roots of VAR model

Source-Plotted by author

Residual test confirmed that the VAR model suffers from autocorrelations problems. The correlogram are plotted in Figure 8.

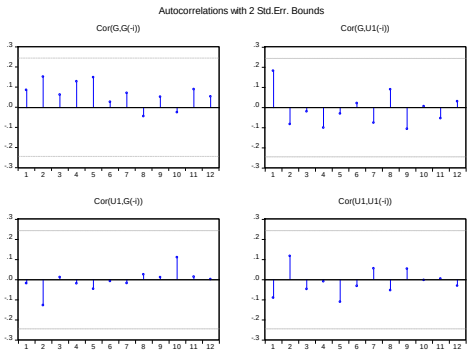

Figure 8*:* Autocorrelations of residuals

Source-Plotted by author

The Residuals of the estimated VAR rejected its normality which was found by Hansen-Doornik test that is seen in Table 7 where the values of Jarque-Bera and Chi-square values of Skewness and Kurtosis are insignificant in some components.

Table 7: Normality test of residuals of VAR

Component	Skewness	Chi-square	Degree of freedom	Probability
1	0.356669	1.615677	1	0.2.37
2	1.168418	12.84428	1	0.0003
Joint		14.45995	2	0.000
Component	Kurtosis	Chi-square	Degree of freedom	Probability
1	3.003423	0.004447	1	0.946
2	3.494706	0.09244	1	0.761
Joint		0.096899	2	0.952
Component	Jarque-Bera	Degree of freedom	Probability	
1	1.620124	2	0.4448	
2	12.93672	2	0.0016	
Joint		4	0.0057	

Source-Calculated by author

The Impulse Response Functions are showing convergence so that the VAR model is said to be stationary.

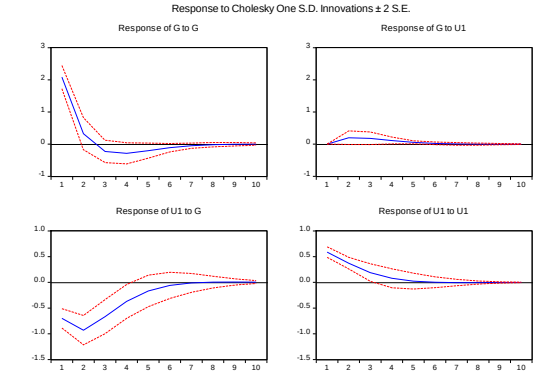

Figure 9*:* Impulse Response Functions of VAR (U and G)

Source-Plotted by author

3. UNEMPLOYMENT GAP AND OUTPUT GAP IN USA

In spite of many differences of opinions about NAIRU, it is fact that if unemployment rate is greater than the natural unemployment rate and if the real GDP is lower than the potential GDP, then output gap is negative and the converse is also true. Following Okun's law it can be said that there is negative relation between output gap and the unemployment gap.

Empirical evidence showed that unemployment gap in USA from 1949 to 2016 has negative impact from output gap which is estimated as given below.

Y_1=0.331870-9.770739x_1

(1.90) (-3.49)*

R^2=0.15 , F=12.21* , DW=0.39 ,AIC=3.59 , SC=3.66 ,

*=significant at 5% level, x_1=output gap and

Y_1=Unemployment gap

The fitted line is plotted in Figure 10 distinctly.

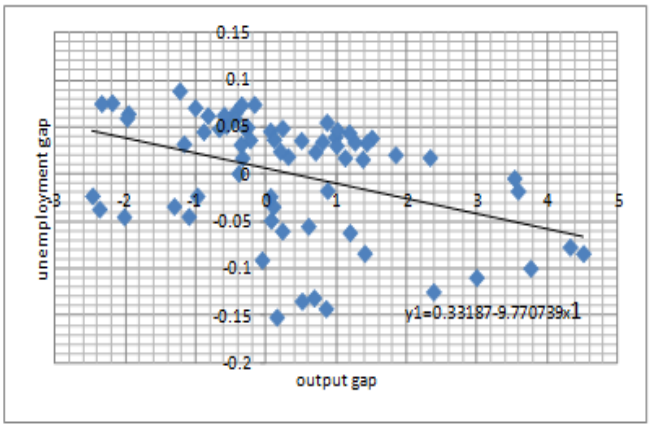

Figure10: Unemployment and output gap

Source-Plotted by author

Output gap Granger causes unemployment gap in USA during 1948-2016 and converse is also true which are verified by

Granger causality test. The results have been shown in Table 8.

Table 8: Causality Test

Null Hypothesis	Observations	F Statistic	Probability
X_1 does not Granger cause y_1	67	1.19150	0.2791
Y_1 does not Granger cause x_1		0.27668	0.6007

Source-Calculated by author

Johansen unrestricted rank test suggests that unemployment gap and output gap in USA during 1948-2016 are cointegrated.Trace Statistic confirms one cointegrating equation and Max Eigen Statistic also confirms one cointegrating equation.In Table 9,Eigen value,Trace Statistic,Max-Eigen Statistic,critical values and probabilities have been shown.

Table 9:Cointegration between output gap and unemployment gap

Hypothesised no of CEs	Eigen Value	Trace Statistic	0.05 Critical Value	Probability**
None*	0.389677	32.98494	15.4947	0
At most 1	0.005987	0.396331	3.8414	0.52
Max Eigen Statistic				
None*	0.389677	32.58861	14.2646	0
At most 1	0.005987	0.396331	3.8414	0.52

Source-Calculated by author,*=significant at 5% level, ** denotes Mckinnon-Haug-Michelis(1999)p value.

It is found that unemployment gap and output gap are cointegrated. Therefore**,** the estimated equations of VECM along with error correction coefficients are stated below.

Δx_{1t}=-0.000956+0.898668Δx_{1t-1}+0.014095Δy_{1t-1}-0.02198EC

(-0.40) (4.65)* (3.63)* (-2.54)*

R^2=0.27 , F=7.71 , SC=-4.86 , AIC=-5.0

Δy_{1t}=0.00599-37.125Δx_{1t-1}-0.316259Δy_{1t-1}+2.08263EC

(0.05) (-4.23)* (-1.79)* (5.31)*

R^2=0.33,F=12.59 , AIC=2.62 , SC=2.75 , *=significant at 5% level

Both the equations in VECM are not very good fit**.** In equation Δx_{1t} ,the t values of coefficients of Δx_{1t-1} ,Δy_{1t-1} and Error Correction are significant with low R^2 and F. Moreover, in equation Δy_{1t} ,the t values of coefficients of Δx_{1t-1} ,Δy_{1t-1} and Error Correction are significant with low R^2 and F. The speed of error correction is slow in equation Δx_{1t} and is very fast in equation Δy_{1t}. Therefore, there is a tendency towards equilibrium. This VECM is a stable model where all roots (1.0,0.801049, 0.196761±0.509653i) are situated inside the unit circle which is plotted in Figure 11.

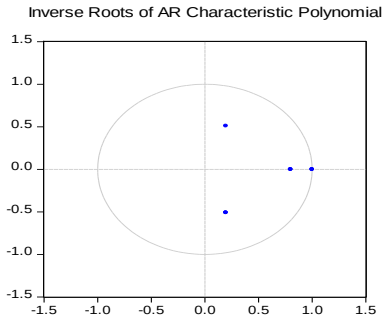

Figure 11: Unit Circle of roots

Source-Plotted by author

In Figure 12,the first Impulse Response Function is diverging but the second Impulse Response Function is converging.Therefore, there is a tendency towards equilibrium although VECM is nonstationary.

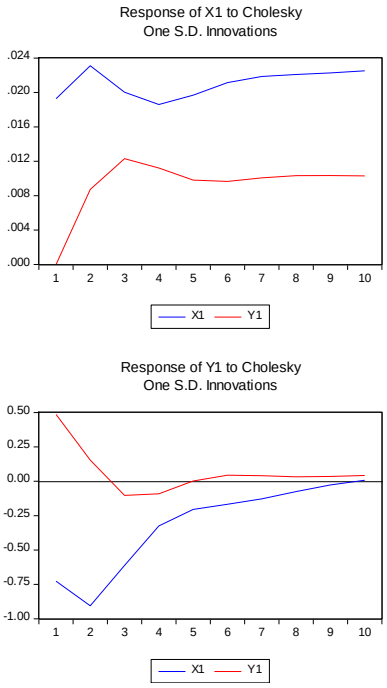

Figure 12: Impulse Response Functions of VECM

Source-Plotted by author

But the residuals of VECM have problems of autocorrelations too which are plotted in Figure 13 through correlogram.

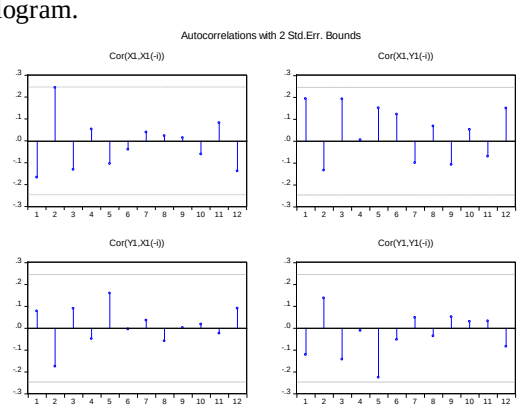

Figure 13: Correlogram of Residuals

Source-Plotted by author

And the residuals of VECM are rejected for normality which was verified by Hansen-Doornik normality test. The values of Chi-square of Skewness and Kurtosis and the values of Jarque-Bera are insignificant at 5% level in some components which have been arranged in Table 10.

Table10: Normality test of residuals of VECM

Component	Skewness	Chi-square	Degree of freedom	Probability
1	-0.446445	2.44138	1	0.11
2	0.882136	8.158359	1	0
Joint		10.59974	2	0
Component	Kurtosis	Chi-square	Degree of freedom	Probability
1	2.405252	3.132394	1	0.07
2	4.161769	0.176513	1	0.67
Joint		3.308907	2	0.19
Component	Jarque-Bera	Degree of freedom	Probability	
1	5.573774	2	0.06	
2	8.334872	2	0.01	
Joint	13.90865	4	0	

Source-Calculated by author

VI. LIMITATIONS AND FUTURE SCOPE OF RESEARCH

Non-linearity between growth and unemployment in USA in the long period is the most feasible estimate which was not explained here through econometric model**.** There are some different critical views regarding computation of output gap and unemployment gap respectively because there are various views and axioms on these gaps especially on NAIRU. Secondly, Okun's coefficients can be estimated in expansionary and recessionary phases of cycles which are not computed here. It is left for future research. Recommended policy implications based on these observations of the models are excluded here. These crucial works on U.S. macroeconomic stability are of great possibility of research in the offing.

VII. CONCLUSIONS

The paper concludes that US unemployment is stipulating at the rate of 0.507 per cent per year from 1948 to 2016.The series of unemployment rate has one upward structural break in 1971.US unemployment rate is negatively related with growth rate significantly during 1948-2016. There is no causality between the two and even they are not cointegrated in the order one .Vector Auto Regression model is statistically significant**,** stable and stationary. Non-normal distribution and autocorrelation are confirmed by Residual tests. Moreover, relation between growth and unemployment gap in USA during 1949-2016 suggests that the relation is negative and significant at 5% level. They have no cointegration but have unidirectional causality. Their VAR model is stable and stationary. The residual test showed non-normality and auto-correlation problems. Output gap is negatively related with unemployment gap significantly during 1949-2016.Both have significant bi-directional causality and one cointegrating equation. In Vector Error Correction model, error corrections are significant having stability, autocorrelation and non-normality. The paper also concludes that the reduction of unemployment rate is marginal as a result of increased growth rate in USA during 1948-2016. Last but not the least, US government can fix threshold level of NAIRU or inflation rate to get desired level of growth rate. Anti-cyclical fiscal and monetary policies can minimize output and unemployment gaps in USA. Even, sound macro-economic fundamentals are necessary to adjust with the long run growth-unemployment relationship.

REFERENCE

1. Abaidoo,Rexford.(2012,July).Corporate Profit Growth and Variability in US Unemployment Rate,International Journal of Economics and Finance,4(7),3-14.
2. Abdul-Khaliq,Shatha.,Soufan,Thikraiat.,& Abu-Sahib,Ruba. (2014). The Relationship between Unemployment and Economic Growth Rate in Arab Country,Journal of Economics and Sustainable Development,5(9), Retrieved from www.iiste.org.
3. Abu,N.(2017). Does Okun's Law Exist in Nigeria? Evidence from the ARDL Bounds Testing Approach , Contemporary Economics, 11(2),131-144.
4. Arewa,A., & Nwakanma,P.C.(2012,May).Potential-real GDP relationship and growth process of Nigeria economy:An empirical re-evaluation of Okun's Law, European Scientific Journal , 8(9),25-53.
5. Ayoyinka, Sodipe Oluyomi., & Isaiah,Ogunrinola Ohuranti.(2011,June). Employment and Economic Growth Nexus in Nigeria, International Journal of Business and Social Science , 2(11),232-239.
6. Ayoyinka,Sodipe Oluyomi.,& Stephen,Oluwatobi.(2017,November 27).Output and Unemployment Relationship :How Applicable is the Okun's Law to Nigeria? Retrieved from www.academia.edu
7. Bai,Jushan., & Perron,P.(2003).Critical values for Multiple Structural Change Tests, Econometrics Journal ,6,72-78.
8. Ball,Laurence.,& Mankiw,N.G.(2002).The NAIRU in theory and practice,Journal of Economic Perspectives,16(4),fall,115-136.
9. Basu,D.,& Foley,D.K.(2011).Dynamics of output and employment in the US Economy,Working Paper-111,University of Massachusetts Amherst.
10. Blackman,Valerie Mercer.,& Salazni, Mariana.(2014,August).Unemployment and Growth :Does Okun's Law Apply to Trinidad and Tobago? Policy Brief No-IDB-PB-229,Inter-American Development Bank.
11. Cashell,Brian W.(2006,November 20).Economic Growth,Inflation and Unemployment:Limits to Economic policy,CRS Report for Congress,The Library Congress.
12. Cusbert,Tom.(2017,June).Estimating the NAIRU and the Unemployment Gap, Bulletin,1-21.
13. Diwani,Geetanjali.(2017,January).Nexus between Population, Income, Output and Employment: Econometric Evidence from India, International Journal of Multidisciplinary and Current Research,5,96-103.
14. Federal Reserve Bank of Cleveland.(2012,May 4).An Elusive Relation between unemployment and GDP growth:Okun's Law.
15. Gocer,Ismat., & Erdal,Leman.(2015).The relationship between youth unemployment and economic growth in Central and Eastern European Countries:An Empirical Analysis,Journal of The Faculty of Economics and Administrative Sciences,5(1),173-188.
16. Granger, C.W.J.(1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods, Econometrica, 37(3), 424-438.
17. Hansen,H.,& Doornik,J.A.(1994).An omnibus test for univariate and multivariate normality, Discussion Paper ,Nuffield College, Oxford University.

18. Hicks,J.R.(1950).A Contribution to the Theory of the Trade Cycle,Oxford:Clarendon Press.
19. Hodrick,Robert., & Prescott,Edward C.(1997).Post War USBusiness Cycles:An Empirical Investigation, Journal of Money,Credit and Banking,29(1),1-16.
20. Jelilov,Gylych.,Obasa,Olanrewaju Joseph., & Isik,Abdurahman.(2016). Impact of Inflation and Unemployment on Economic Growth in Ten (10) Selected Member's States of Economic Community of West Africa States (ECOWAS) (2001-2014), Advances in Economics and Business ,4(5), 222-244.
21. Johansen,S.(1988).Statistical Analysis of Co-integrating Vectors. Journal of Economic Dynamics and Control, 12,231-254.
22. Johansen,S.(1996). Likelihood-Based Inference in Co-integrated Vector Autoregressive Models, 2nd Edition,Oxford University Press.
23. Keynes,J.M.(1936).The General Theory of Employment,Interest and Money,London:Macmillan.
24. Khan,Muhammad Amir.,Saboor,Abdul.,Mian, Sarfraz Ahmad., &Anwar,Aftab.(2013). Modeling the relationship between GDP and unemployment for Okun's law specific to Pakistan during 1976-2010, Theoretical and Applied Economics,20(10),71-78.
25. Kitov,Ivan.,& Kitov,Oleg.(2011).Employment,Unemployment and real economic growth , Retrieved from www.ssrn.com
26. Knotek,Edward S.(2017).How useful is Okun's Law?Retrieved from www.kansasCityFed.org
27. Kreishan,Faud M.(2011). Economic Growth and Unemployment: An Empirical Analysis**,** Journal of Social Sciences ,7 (2), 228-231.
28. Levine,Linda.(2013,January).Economic growth and the unemployment rate, Congressional Research Service,7-5700,R42063.
29. Madito,Oatlhotse., & Khumalo,John.(2014,September). Economic Growth - Unemployment Nexus in South Africa: VECM Approach, Mediterranean Journal of Social Sciences,5(20),79-84.
30. Marshall,A.(1890).Principles of Economics,Reprinted by Palgrave Macmillan in 2013.
31. Mihaela,Savu., & Mihaela,Bursugiu.(2013).Correlation between economic growth and unemployment, Annals of the Constantin Brâncuşi University of Târgu Jiu, Economy Series, 3,195-198.
32. Neto,Antonio., & Silva,Sandra T.(2013,July). Growth and Unemployment:A bibliometric analysis on mechanisms and methods, FEP Working Paper-498,University Of Porto.
33. Okun,A.M.(1962). Potential GNP & Its Measurement and Significance, American Statistical Association, Proceedings of the Business and Economics Statistics Section, 98-104.
34. Owyang,M.T.,Vermann,E.K.,& Sekhposyan,T.(2013,October).Output and Unemployment :How Do they Relate Today? Federal Reserve Bank of St.Louis.
35. Phillips,A.W.(1958).The relation between unemployment and the rate of change of money wage rate in United Kingdom,1861-1957,Economica,25(100),283-299.
36. Pigou,A.C.(1914).Unemployment,London:William and Norgate.
37. Pinar,Eryigit.,Serkan,Cura.,Deniz,Zungun., & Murat,Ortanca.(2014).Econometric evaluation of the relationship economic growth and unemployment in EU & Turkey, Annals of the University of Oradea, Economic Science Series , 23(1),452-461.
38. Robinson,Joan.(1937).Introduction to the Theory of Employment, Macmillan.
39. Say,J.B.(1821).A Treatise on Political Economy,NewYork:Sentry Press.
40. Schumpeter, Joseph A. (1936,December). Book Review [The General Theory of Employment, Interest and Money by J.M.Keynes], Journal of the American Statistical Association,31 (196), 757–820.
41. Swane,A.,& Vistrand,H.(2006).Jobless Growth in Sweden? A Descriptive Study,Master's Thesis in International Economics and Business at Stockholm School of Economics.
42. Umair,Muhammad., & Ullah,Raza.(2013,June). Impact of GDP and Inflation on Unemployment Rate: A Study of Pakistan Economy in 2000-2010, International Review of Management and Business Research,2(2),388-400.

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