

Examining Relationship between Macroeconomic Variables Using Var Approach

**Imran Arshad
IBA Sukkur
Pakistan**

Abstract

This research was aimed to find out the relationship between unemployment, inflation and economic growth of Pakistan. The data was collected for 31 years from 1980-2010. The results showed that there is two-way granger causality exist between these economic variables. These variables have more variance contribution of themselves as compare to other variables in system. Inflation rate has contributed to unemployment variance more as compare to economic growth, unemployment contribute more to economic growth as compared to inflation and unemployment rate has also more variance contribution to inflation as compare to economic growth. Unemployment rate has more variance contribution in both inflation and economic growth rate.

Keywords

Unemployment, economic growth, Inflation

1. Introduction

In recent years the economic growth has a decreasing trend as compare to previous years and an increase in the unemployment rate and inflation rate has been observed. These economic variables moves together and their movement depend on changes in each other as they are related. As suggested by Dunaev (2011) unemployment growth rate of is an increasing function of unemployment rate and thus proportionate to inflation rate. There is tradeoff between unemployment rate and inflation rate, this act as a foundation of business cycle analysis. Ireland (1999) confirmed the existence of the relationship between two important variables inflation and unemployment on the basis of Barro-Gordon type model. This model describes the inability of the central bank to obligate low-inflation policy in consequences of which the unit root of natural unemployment ever translated into rate of inflation.

Philips curve also describes the nature of the relationship of unemployment and inflation in short run as; inverse relationship exists between the inflation and unemployment rate. The study of this relationship is very important with regard to its policy implications. If the relationship in the long run becomes less relevant then it decreases the downward pressure of the unemployment on prices which ultimately make the unemployment more persistent (Blanchard and Wolfers, 2000).

Economic growth and unemployment has negative relationship as proposed by Okun (1962) and known as Okun's law. The search for quantifiable relationship between these two variables identified and claims that cyclical components of output have a negative relationship with unemployment (Okun (1962). Relationship between economic growth, unemployment and inflation based on traditional macro model, as the aggregate supply curve for a country is derived by the combination of both Okun's law and Philips curve. As suggested by Perman and Tavera (2007) this relationship is a significant indicator of interdependence between output and labor movement in long run to capture the effect of higher unemployment.

Dunaev (2011) noted that how the rate of growth associated with wage rates are proportional and also inflation is also a growing function associated with unemployment rate. The increasing unemployment rate also cause increase in inflation rate. The actual maintenance of the higher inflation rate through year upon year using a high unemployment contributes to rising prices that result of a redundant sum of money with inside annual movement also to the actual income growth past the particular equilibrium wage.

Viren (2001) restated the two forms of the theoretical and policy-related advantages for the value of asymmetry suggested by Harris and Silverstone (2001). They proposes in which discovering how the asymmetrical is essential for effectiveness of unemployment policy, and that an asymmetric Okun's relationship would suggest how the concern is very important to macroeconomic relationships such as the Phillips curve. Additionally, Viren suggests one other reason for attempting to detect asymmetry with inside the output-unemployment relationship: it's effects

regarding gathering or amassing. Specifically, Viren unbended the effects aggregation is very important in context of EMU nations around the world, which fluctuate considerably in terms of their own cyclic situation.

This paper aims to investigate the relationship between three macroeconomic variables namely economic growth, GDP and Inflation rate. This paper estimates the short-run as well as long run relationship between these variables. This particular relationship offers important implications regarding economic policy, because the size of the actual OLC (Okun's Law Coefficient) is a crucial indicator of the degree of interdependence of output and labour movements around their particular long-run paths and it is considered to be any standard with regard to policy-makers so that they can look at the cost of increased unemployment rate.

2. Literature Review

Many researchers like Moosa (1997), Sogner and Stiassny (2000) and Lee (2000) examined the stability of the OLC with various statistical methodologies, and empirical results seem to expose powerful proof architectural modify as well as temporal lack of stability of the OLC. The search for the quantifiable relationship between output imbalances and also variations with inside unemployment ideal for coverage examination come about having Okun (1962) and the supposed Okun's Law relationship statements the correlation of the cyclic aspects of result and the unemployment rate will be negative.

Ball and Moffitt (2001) presented evidence the actual influence used by imbalances in productiveness rise in outlining the particular latest conduct of rising inflation rate as well as unemployment. Its value mentioning this link was initially recommended through Grubb (1982) others, who offered any model that aimed to explain the actual witnessed relationship among the productiveness downturn and also the boost in both the inflation rate and unemployment defining the Seventies.

Phelps and Friedman (1968), proposed natural rate of unemployment existence in the long run and negates the existence of tradeoff between unemployment and inflation in the long run. The presence of an adverse short-run relationship involving inflation as well as unemployment can be expected by "natural-rate" theories. According to that financial plan might induce a general change in cyclic unemployment inside reputation of errors regarding the predicted rate of inflation. But, these kinds of versions foresee long-term independence between inflation and unemployment. The propose relationship in the Philips curve can be written as follows:

$$\pi = \pi^e + \lambda(\mu - \mu^*) \dots \dots \dots \text{eq (1)}$$

In macroeconomics, the theoretical Phillips curve, which clearly signifies the dependency associated with changes in the inflation on unemployment rate, is accepted.

$$W_t = W_t - 1(1 - \alpha \rho t) \dots \dots \dots \text{eq (2)}$$

Ireland (1999) highlighted that the Central Bank in 1970's and 1980's was unable to agree to the legitimate low-inflation plan and also targeted at increase in natural-rate of unemployment for expansionary policies. According to the Taylor (1993) rule, the Federal Reserve (FED) is committed to include an overheating economy by increasing inflation through improving interest levels and also advertise development through decreasing interest rate levels. Further this study found that Phillips curve is relatively more stable in Germany as compared to the US. The flattering of the Phillips curve over recent years in UK has additionally been documented (Iakova, 2007).

The basic Okun's Law necessitates the change regarding real output as well as unemployment rates using their semi-permanent or full employment levels. Because of this, it's possible to assume that nationwide economic science buildings (for instance preferences or perhaps work market stiff) cause heterogeneous country-specific amounts of prospective result and also natural unemployment prices, regardless of achievable unity inside size of the actual co-variation between the output gap and also the unemployment gap over the business cycle.

The existence associated with convergence of the Okun's Regulation constant (OLC hereafter). This constitutes one of the many macroeconomic guidelines fundamental the awareness associated rate of unemployment to fluctuations throughout economic activity. When it comes to the United States, Atkeson and Ohanian (2001) showed that in the 1970 and 1999, there's no significant relationship between the inflation and unemployment.

Earlier works (e.g., Tun Wai 1959; Bhatia 1960-61) failed to develop any significant relationship between inflation and economic growth.. Friedman (1968) noted that in the lonr-run there's no link between inflation and quantity demanded.

Bruno and Easterly (1998) analyzed cases of discrete high inflation (40 percent or above) crises and further identified powerful empirical results that economic growth comes dramatically during high inflation crises after that gets back quickly and also recover immediately soon when inflation rate falls.

A typical version of Okun's law is a gap equation of the type:

$$y - y_t^* = \alpha (u_t - u_t^*) + \epsilon_t \quad \alpha < 0 \dots \dots \dots \text{eq (3)}$$

Where, y is log of observed real output, ut is log of observed unemployment, t* and y* are corresponding potential values and "et" is a random error term. Paul et al. (1997) studied the crelationship involving the inflation and

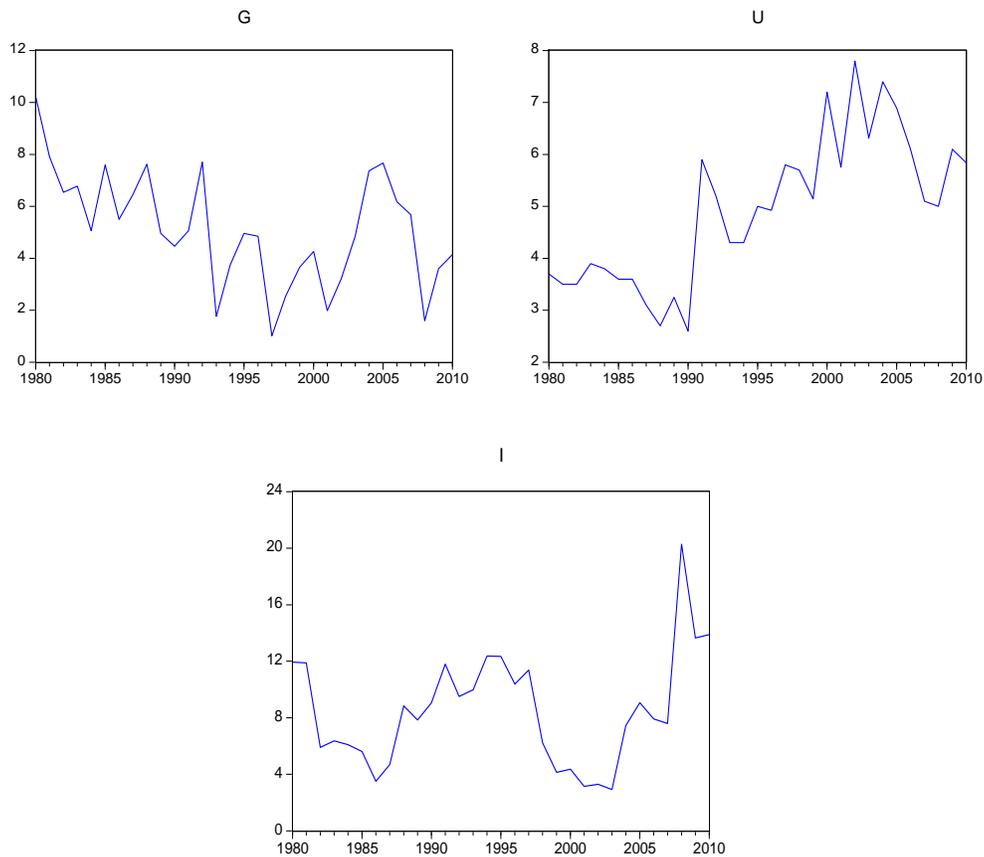
economic growth for the period 1960-1989 seventy countries (out of which 48 are developing economies) and discovered no casual relationship between high inflation rate and economic growth in 40 percent countries; further documented two-way relation within 20 percent countries around the world and also one-way causality (either high inflation rate to economic growth or vice versa) relationships in the rest countries. In many countries very interestingly the relationship was found to be positive in some cases, but decreasing in others.

3. Data and Methodology

3.1 Data

This paper studied the relationship between three economic variables namely economic growth, inflation and unemployment. The data has been collected for a period of 31 years from 1980 to 2010. The growth rate was taken as proxy for economic growth. The data has been taken from World Bank data base. The variables economic growth is represented by (G), unemployment by (U) and inflation by (I). The raw data has been plotted to assess the nature of the data and for possible treatment for assessing its usefulness, as shown in figure-1.

Figure-1

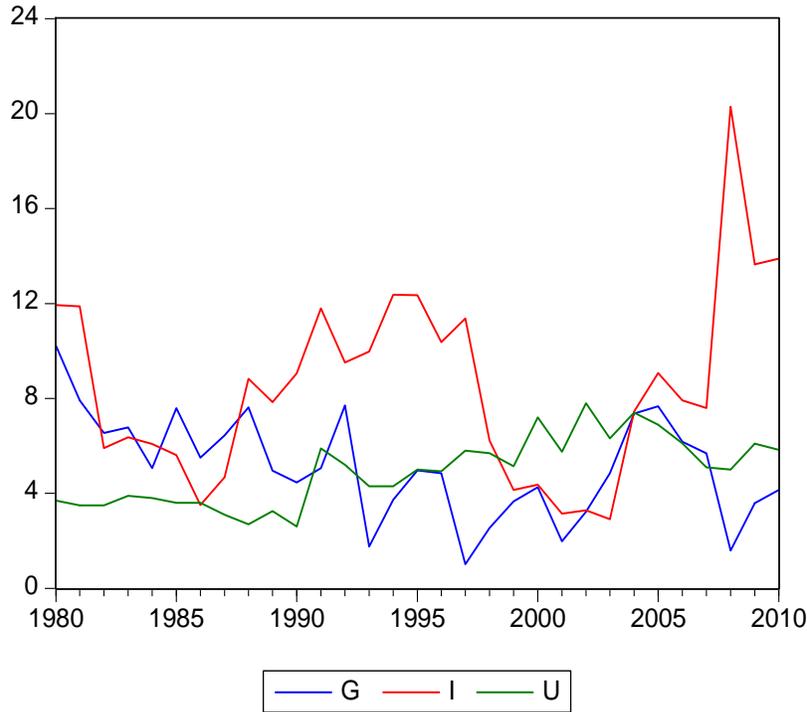


3.2 Methodology

To capture the linear interdependence between these variables, VAR model used, as this model is dynamic multivariate model and treat set of variables equally. The relationship between economic growth, inflation and unemployment can be addressed using VAR model. Papapetrou, (2001) and Li & Liu (2012) also use VAR model to establish the short-run dynamic disequilibrium among these variables. And to develop long term relationship the co-integrating vectors assessed by using Johansen’s co integration technique employed and for long run relationship established using VEC model. Beyer and Farmer (2002), by using co-integration techniques, identify a long-run upward sloping Phillips curve and, as a consequence, pose some “natural rate doubts”. The relationship between these three economic variables is shown in figure-2.

Figure-2
(Relationship between Unemployment,

Inflation and Economic growth)



3.3 VAR Estimation

To capture the linear interdependence between these variables, VAR model estimated, as this model is dynamic multivariate model and treated set of variables equally. The results of the analysis shows that there in negative relationship exist between the previous values of growth rate and unemployment and there is positive relationship between economic growth and inflation rate. The appropriate lag length has been selected by AIC criterion; the appropriate lag length order is lag 1, as the value of the AIC is minimum al lag order 1as indicted in table-1.

Table-1 (VAR Lag Order Selection Criteria)

Endogenous variables: G I U

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-174.3540	NA	63.72686	12.66815	12.81088*	12.71178*
1	-163.6869	18.28645*	56.90253*	12.54907*	13.12001	12.72361
2	-159.1995	6.731192	80.65957	12.87139	13.87055	13.17684

3.4 Unit root test

The data was not stationary for these macro economic variables. To make them stationary and ADF test was used and for appropriate lag selection AIC and SIC criterion was used as suggested by Ivanov & Kilian (2005).The unit root test results for U, G and I are as shown in below table-2. As indicated by respective values of the original series of these variables the hypothesis for unit root has been rejected. The p-values of with 1-st difference for these economic variables are significant at $\alpha < 0.01$ as shown in table-1. The test of the staionarity of the computed by the help of eq(4) and the test statistic used is as defined in eq (5) as suggested by Brooks(2008)

$$\Delta y_t = \phi y_t - 1 + \mu t \dots \dots \dots \text{eq (4)}$$

$$\text{test statistics} = \frac{\phi}{S.E \phi} \dots \dots \dots \text{eq (5)}$$

Table-2 (Unit Root Test)

Difference p-value	UNEMPL	GROW	INFL
Original series	0.7730	0.0072	0.3319

1-st difference	0.0000	0.0000	0.0000
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3.5 Long-term Relationship

As indicated from the result of ADF test the variables were become stationary after taking its first difference. As all the variables are I(1), the Johansen's cointegration technique can be employed to identify the cointegration vectors. As mentioned by Brooks (2008), the Johansen's cointegration test can be affected by the lag length employed in the VECM, so it is useful to select the appropriate lag length optimally as indicated in table-3.

Table-3 (Cointegration test)

Hypothesized No of Coefficient Estimates CE(s)	Eigen values	p-values (rank trace)	p-values (Max-Eigen)
None*	0.623075	0.0000	0.0059
At most 1 *	0.536528	0.0002	0.0030
At most 2 *	0.272787	0.0028	0.0028

The results of the Johansen's cointegration test for depict the all the hypothesis for CE(s) are rejected as p-values are less than $\alpha=0.05$ so all the hypothesis. Tracer and Max-Eigen value both test indicates three (3) cointegration equations at the 0.05 level. The ECM models can be established based on co-integrations matrix as shown in eq(6), eq(7) and eq(8).

$$ECM = G - 0.1389(I) + 0.4205(U) \dots\dots\dots \text{eq (6)}$$

(0.3803) (0.1154)

Log likelihood -63.86952

$$ECM = I - 0.3663(G) + 0.4280(U) \dots\dots\dots \text{eq (7)}$$

(0.3043) (0.6258)

Log likelihood -78.40727

$$ECM = U - 0.1030(G) + 0.0397(I) \dots\dots\dots \text{eq (8)}$$

(0.0581) (0.0931)

Log likelihood -42.77104

It has been noticed that in the long run economic growth is negatively related with inflation and positively related with unemployment rate. When economic growth will increase by 1% the inflation will decrease by 13.89% and unemployment will increase by 42.05% as shown in eq(6). In the long run when inflation rate will increase by 1%, economic growth will decrease by 36.63% and unemployment will increase by 42.80% as shown in eq(7). Further if unemployment will increase or by 1%, then the economic growth will decrease by 10.30% and inflation will increase by 3.397% as shown in eq(8). The results of ADF test for residual of eq(6), eq(7) and eq(8) are stationary, which implies that there is cointegration relationship exist between these three economic variables.

3.6 Short-run relationship

The cointegration between these variables implies that there is long-run relationship exist between these economic variables and short-run disequilibrium also in the dynamic process. Vector error correction (VEC) established to describe the short-run dynamic disequilibrium among these economic variable. This VEC established by keep in mind the lag-length up to 2 lags as identified by AIC and SC criterions.

3.7 Short-run equation of economic growth

In the short run the coefficient of the ECM model is negative and first and second lag of economic growth both are positive, this indicates that disequilibrium previous periods the economy will be in the equilibrium automatically. Inflation rate lags (first and second) both are positive, this implies that high inflation rate leads to high economic growth. First lag of unemployment is negative and second is positive but it indicates that the high unemployment rate will cut the speed of economic growth. The detail of estimated equation is as shown in eq (9).

$$G = -2.2257ECM + 0.7782G(t - 1) + 0.3348G(t - 2) + 0.0705 I(t - 1) + 0.2178 I(t - 2) - 0.9789U(t - 1) + 0.8117U(t - 2) - 0.1214 \dots\dots \text{eq (9)}$$

3.8 Short-run equation of inflation rate

The short run relationship between inflation and economic growth seems negative for current year as well as for previous year, which indicates that the economic growth will decrease will cause the inflation rate to decrease. The

coefficient of the ECM is positive which implies that in the short run it is difficult for inflation rate to achieve equilibrium. Unemployment rate coefficients for both lag periods are negative and will cause the high inflation rate and decrease in the unemployment rate. The detail of estimated equation is as shown in eq (10).

$$I = 0.7879 ECM - 0.3079G(t - 1) - 0.2139G(t - 2) - 0.8779I(t - 1) - 0.7410I(t - 2) - 0.3867U(t - 1) - 0.2610U(t - 2) + 0.36 \dots \dots \text{eq (10)}$$

3.9 Short-run equation of unemployment

In short run the coefficient of unemployment rate is negative for current period and previous period but the magnitude is high in the previous year. The ECM coefficient is negative which clearly indicated that the economy will be in automatically in equilibrium if any disequilibrium occurs. Economic growth coefficients are positive for the current and previous year also. Inflation rate coefficient is positive in the current year but negative in the previous year which indicates that previously high inflation leads low unemployment and in current year high inflation raise unemployment rate. The detail of estimated equation is as shown in eq (11).

$$U = 0.4216ECM + 0.3294G(t - 1) + 0.1134G(t - 2) + 0.0754I(t - 1) - 0.0153I(t - 2) - 0.1837U(t - 1) - 0.3373U(t - 2) + 0.0003 \dots \dots \text{eq (11)}$$

3.10 Granger Causality

To assess the causal relationship between economic growth, inflation and unemployment Granger causality test was performed. Koremendi and Meguire (1985); Robert (1990), Grimes (1991) and many others assumed causality to run from inflation to growth, whereas Vogel (1974) assumed the opposite case in their studies of Chile and Latin America. The test of granger causality is performed so that the direction of influence of these variables can be confirmed. The results of the hypothesis that economic growth does not granger cause the unemployment, and unemployment does not granger cause economic growth is rejected on the basis of high p-values. On the basis of high p-value reject the hypothesis that inflation does not granger cause unemployment and unemployment does not granger cause inflation along with inflation does not granger cause economic growth and economic growth does not granger cause inflation rate. This depicted that these economic variables granger cause each other as shown in table-4.

Table-4 (Pair wise Granger Causality Tests)

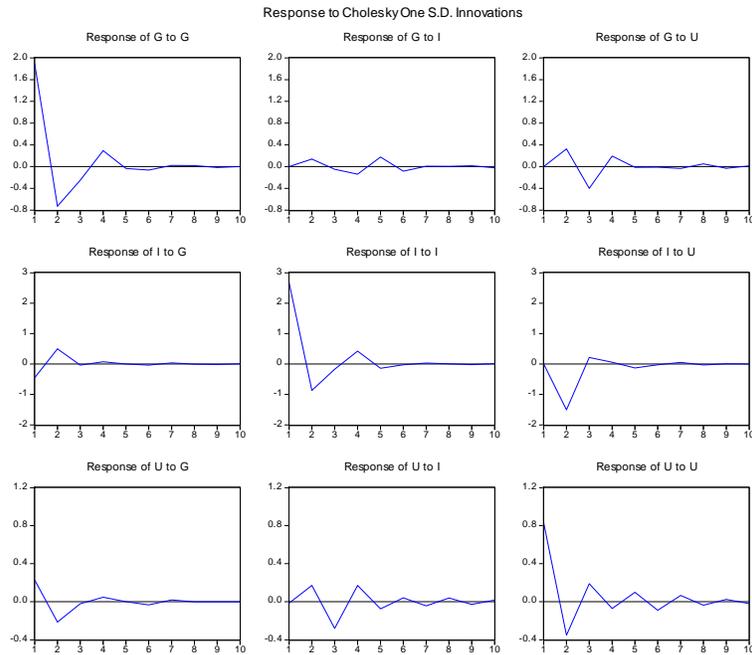
Null Hypothesis:	F-Statistic	F-Statistic
I does not Granger Cause G	0.21880	0.8051
G does not Granger Cause I	0.09979	0.9054
U does not Granger Cause G	0.72354	0.4957
G does not Granger Cause U	0.53810	0.5910
U does not Granger Cause I	2.89583	0.0756
I does not Granger Cause U	0.78798	0.4667

3.11 Impulse response function and variance decomposition

Impulse response function was calculated for three economic variables to address the reaction of any dynamic system in response to external change. The reaction of economy to external changes (shocks). Impulse response function was used to capture the dynamic effect of the one-time shock to current and future values of the endogenous variables. And variance decomposition was also used in analysis to the importance of structures and the contribution of each endogenous variable in the change. The effect of the economic growth shock was observed in both unemployment and inflation but more on the unemployment as it has positive impact in the first two periods then negative impact then stable. The shocks of the unemployment more observed on inflation as compare to economic growth in first two periods it has negative impact on unemployment then a slight positive after fourth periods it becomes stable. In the third part the effects of inflation were more on economic growth as compare to

unemployment, it has positive impact in second period, then negative in third again positive in the fourth period and negative in fifth period then stable as shown in figure-4. Given the importance of co-integration and unit roots of variables, in the next section, we will conduct unit root tests and co-integration tests.

Figure-3 (Impulse response function)



It can be observed that the results of variance decomposition indicated that major contribution of economic growth to itself which is 91.63% at the end of tenth period. Inflation and economic growth contributes but unemployment contribute more and in reached 6.59% at the tenth period but inflation does have 1.76% in tenth period as shown in table-5.

Table-5(Variance decomposition of economic growth)

Period	S.E.	G	U	I
1	2.180315	100.0000	0.000000	0.000000
2	2.371792	97.05072	2.452636	0.496639
3	2.434083	93.55853	5.899394	0.542073
4	2.472795	92.51066	6.558030	0.931312
5	2.481555	91.88335	6.518029	1.598624
6	2.484637	91.74370	6.503282	1.753021
7	2.485080	91.72040	6.525647	1.753952
8	2.485832	91.67279	6.574209	1.753002
9	2.486224	91.64916	6.593857	1.756984
10	2.486377	91.63786	6.596453	1.765687

Inflation rate has contributed to unemployment more as compare to economic growth, both increasing gradually but inflation reaches to 12.79% as compare to economic growth which have 9.02% contribution at tenth period but its own contribution is more which is 78.19% as shown in table-6.

Table-6(Variance decomposition of unemployment)

Period	S.E.	G	U	I
1	2.180315	7.024925	92.97508	0.000000
2	2.371792	10.39988	86.69246	2.907660
3	2.434083	9.306436	80.80018	9.893388

4	2.472795	9.198608	78.58859	12.21280
5	2.481555	9.071023	78.40348	12.52549
6	2.484637	9.074081	78.38748	12.53844
7	2.485080	9.054305	78.32139	12.62430
8	2.485832	9.031264	78.24171	12.72703
9	2.486224	9.020724	78.20316	12.77611
10	2.486377	9.015710	78.19330	12.79098

As we can see in table-7 that the variance contribution of inflation to itself is greater than other variable that is 74.62% at the end of tenth period. On the other hand economic growth contributed to inflation at the end of tenth period about 4.26% as compare to that the unemployment rate has more variance contribution but with very low increments. The unemployment rate reached a maximum of 21.12% at the end of tenth period.

Table-7(Variance decomposition of inflation rate)

Period	S.E.	G	U	I
1	2.180315	2.812675	0.027874	97.15945
2	2.371792	4.291244	21.08064	74.62811
3	2.434083	4.272841	21.37186	74.35530
4	2.472795	4.247575	21.02342	74.72900
5	2.481555	4.232773	21.10806	74.65916
6	2.484637	4.244866	21.10775	74.64738
7	2.485080	4.256599	21.12052	74.62288
8	2.485832	4.256380	21.12721	74.61641
9	2.486224	4.257386	21.12632	74.61629
10	2.486377	4.257730	21.12601	74.61626

4. Conclusion

From the results of the analysis it has been noticed that economic growth granger cause the unemployment, and unemployment granger cause economic growth. Inflation granger cause unemployment and unemployment granger cause inflation along with inflation granger cause economic growth and economic growth granger cause inflation rate. Unemployment rate coefficients for both lag periods are negative and will cause the high inflation rate and decrease in the unemployment rate on the other hand coefficients of economic growth coefficients are positive for the current and previous year also in short run. In the long run economic growth is negatively related with inflation and positively related with unemployment rate. The results of ADF test for residual of for long run relationship are stationary, which implies that there is cointegration exist between these three economic variables. The effect of the economic growth shock was observed in both unemployment and inflation but more on the unemployment as it has positive impact in the first two periods then negative impact then stable. The shocks of the unemployment more observed on inflation as compare to economic growth in first two periods it has negative impact on unemployment then a slight positive after fourth periods it becomes stable. In the third part the effects of inflation were more on economic growth as compare to unemployment, it has positive impact in second period, then negative in third again positive in the fourth period and negative in fifth period then stable. These three economic variables contribute their variance themselves as compare to other variable. Inflation rate has contributed to unemployment variance more as compare to economic growth, unemployment contribute more to economic growth as compared to inflation and unemployment rate has also more variance contribution to inflation as compare to economic growth.

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