Phillips Curve Representation on Inflation in Nigeria: Evidence from Vector Error Correction Model.

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Abstract

The Phillips curve represents the relationship between the rate of inflation and the unemployment rate. This paper investigated the interrelationship between inflation rate and unemployment rate in Nigeria from 1970 to 2014. Annual data for these variables were collected from secondary sources. The ADF test revealed that inflation and unemployment rates are stationary at first difference while the Johansen cointegration test indicated one (1) cointegrating equation at 5% level of significance. The VECM model at lag 2 was used to investigate the short and long run interrelationship between inflation and unemployment rates in Nigeria. The result revealed a positive long run relationship between inflation and unemployment rate in Nigeria which negates the Phillip curve while the equilibrium error correction coefficient (ECM) estimate of -0.795 is highly significant with the correct sign. This implies a high speed of adjustment to equilibrium after shock. The Granger causality test revealed that inflation is not influenced by unemployment in the short run. This paper therefore recommends that the government should formulate economic policy to reduce inflation rate and unemployment in the long run.

Keywords: Phillips Curve; Stationary; Cointegration; Inflation; Unemployment; Vector Error Correction Model (VECM)

Introduction

Nigeria's inflation report indicated 15.4 per cent in the month of June, 2016 which slightly drop from 15.6 per cent recorded in the month of May, 2016 (Anaeto, 2016). The present

inflation figure still revealed that inflation in Nigeria remains two digits. While on the other hands, the unemployment rate in Nigeria has increased to 9.9 per cent in the third quarter of 2015 as reported by National Bureau of Statistics (NBS) (Opeyemi, 2015). These figures of inflation and unemployment rates presents the fact that the Nigerian economy is managing a shocking rate of inflation together with a severe recession as the unemployment rate has risen astronomically (Umoru & Anyiwe, 2013).

Inflation can be defined as a positive rate of growth of the general price level (Lipsey & Chrystal, 1999). High inflation rate is harmful to the economy especially when unexpected. The reason is because inflation distorts the working of the price system, creates arbitrary redistribution from debtors to creditors, create incentives for speculative as opposed to productive investment activity. Infact inflation is usually costly to eliminate from any economy. Unemployment on the other hand, is defined by the International Labour Organization (ILO) as the unemployed member of the economically active population, who are without work but are available for and seeking for work, which also include people who have lost their jobs and those who have voluntarily left work (World Bank, 1998). This definition of unemployment rate revealed the present situation of the Nigerian economy.

Phillips curve refer to as the relationship between inflation and unemployment rates (Pettinger, 2013). The Phillips curve originated out of the analysis of comparing money wage growth and unemployment rate. The findings of Phillips in the relationship between unemployment and the rate of change of money wages in the United Kingdom 1861-1957 suggested there was an inverse correlation between the rate of change in money wages and unemployment rate (Pettinger, 2013). Mohammed et al (2015) noted that there are two possible explanations of the relationship between inflation rate and unemployment rate. One is the short run relationship while the other is long run relationship. In the short run, there is an inverse relationship between unemployment and inflation rates. Other researchers have reported that in the long run the concepts of unemployment and inflation rates are not related.

Therefore, this study examines the Phillips curve representation of inflation and unemployment rates in Nigeria from 1970 to 2014 both in the short and long runs using the Vector Error Correction Model (VECM).

Some researchers have studied Phillips curve and modified Phillips curve in Nigeria and in other economy. For example Umoru & Anyiwe (2013) examined the dynamics of inflation and unemployment rates in Nigeria using the Vector Error Correction Model over a period of twenty seven (27) years. Their findings revealed evidence of stagflation in the Nigerian economy over the period they studied; Mohammed et al (2015) studied the relationship between unemployment, inflation and economic growth in Nigeria. Their findings confirmed that in the long run, interest rate and total public expenditure have significant impact on economic growth in Nigeria, while inflation and unemployment has negative effects on growth in Nigeria; Orji et al (2015) examined the inflation and unemployment nexus in Nigeria by testing if the original Phillips curve proposition holds for Nigeria. They adopted a distributed lag model on data covering a period from 1970 to 2011. Their findings revealed that unemployment is a significant determinant of inflation and there is a positive relationship between inflation and unemployment rate in Nigeria; Ojapinwa & Esan (2013) also examined the existence and the stability of Phillips curve for Nigeria using time series data from 1970 to 2010. They reported that the estimates from the relationship between the change in inflation rate and the unemployment rate were theoretically negative in the short run. They also added that the relationship became non-existence in the long run with positive relationship between inflation and unemployment signifying stagflation; Aminu & Anono (2012) investigated the relationship between unemployment and inflation in the Nigerian economy between 1977 and 2009. They reported that inflation impacted negatively on unemployment, the causality test reveals that there was no causality between unemployment and inflation in Nigeria and there exist a long run relationship between unemployment and inflation rates in Nigeria; Bula (2014) reported that inflation is negatively correlated with unemployment rates in Nigeria as stipulated by the Phillips curve; Torruam & Abur (2014) investigated the relationship between unemployment, inflation and crime in Nigeria using Vector Error Correction Model (VECM). Their result revealed that there is unidirectional causality running from unemployment and inflation to crime in Nigeria. The study concluded that unemployment in Nigeria Granger causes crime.

Examples of phillips curve in other economy includes: Furuoka (2008) investigated the interrelationship between unemployment and inflation rates in the Philippines using VECM; Golosov & Lucas (2007) developed a model of a monetary economy in which individual firms

are subject to idiosyncratic productivity shocks as well as general inflation. They examined the behavior of Phillips curves, in the sense of correlations between inflation rates and levels of production and employment. They found out that a Phillips curve estimated from data generated by the model implied that a one-percentage point reduction in inflation rate will depress production by 0.05 percent; Mohaddes & Raissi (2014) examined the long-run relationship between consumer price index industrial workers (CPI-IW) inflation and GDP growth in India using cross-sectionally augmented distributed lag (CS-DL) as well as the standard Panel ARDL method. Their findings suggested that on average, there is a negative long-run relationship between inflation and economic growth in India; Al-Zeaud & Al-Hosban (2015) examined the relationship between inflation rate and unemployment rate in order to predict and estimate the existence of Phillips curve trade-off relation within Jordanian economy over the period of 1976 to 2013. Their findings revealed that there was a negative and non-linear relationship between unemployment and inflation rates. Their study further prove a strong empirical existence of Phillips curve on Jordanian economy.

Model Specification

Vector Error Correction Model (VECM)

The use of Vector Error Correction Models (VECM) in the study of multivariate non stationary time series has become of increased interest in recent years. The main reason is that VECM allows one to describe the long run relationships and short run relationships of non-stationary variables (Raissi, 2010). The main feature of the VECM is its capability to correct for any disequilibrium that may shock the system from time to time. The error correction term picks up such disequilibrium and guides the variables of the system back to equilibrium (Hossain, 2009).

There are two major conditions that must hold before using the VECM. They are:

1. The variables should be stationary at first difference.
2. The cointegration between the variables must exist.

The following VECM specifications usually exist (Pfaff, 2008) such as:

$$\Delta y_t = \alpha\beta^T y_{t-p} + \Gamma_1 \Delta y_{t-1} + ... + \Gamma_{p-1} y_{t-p+1} + u_t \quad (1)$$

with

$$\Gamma_i = -(I - A_1 - ... - A_i) \quad (2)$$

and

$$\Pi = \alpha\beta^T = -(I - A_1 - ... - A_p) \quad (3)$$

The Γ_i matrices contain the cumulative long run impacts, hence this VECM specification is signified by long run form. The other specification is given as follows and is commonly used:

$$\Delta y_t = \alpha\beta^T y_{t-1} + \Gamma_1 \Delta y_{t-1} + ... + \Gamma_{p-1} y_{t-p+1} + u_t \quad (4)$$

with

$$\Gamma_i = -(A_{i+1} + ... + A_p) \quad (5)$$

and

$$\Pi = \alpha\beta^T = -(I - A_1 - ... - A_p) \quad (3)$$

Hence, the Π matrix is the same as in the first specification. However, the Γ_i matrices now differ, in the sense that they measure transitory effects. Therefore this specification is signified as transitory form. In case of cointegration the matrix $\Pi = \alpha\beta^T$ is of reduced rank. The dimension of α and β is $K \times r$ is the cointegration rank, that is, how many long run relationships between the variables y_t do exist. The matrix α is the loading matrix and the coefficients of the long-run relationships are contained in β (Pffaf, 2008).

Johansen and Juselius Cointegration Test

The most popular test for cointegration testing is the Johansen and Juselius cointegration test (i.e Maximum Eigenvalue test and the trace test) (Johansen & Juselius, 1990). The maximum eigenvalue test and the trace test are used as procedures to determine the number of co-integration vectors.

The maximum eigenvalue statistic test the null hypothesis of r cointegrating relations against the alternative of r+1 cointegrating relations for r= 0, 1, 2, . . .,n-1. This test statistic is computed as

$$\lambda_{\max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1})$$

where $\hat{\lambda}$ is the computed maximum eigenvalues and T stands for the sample size.

The main difference between the maximum eigenvalue test and the trace test is that the trace test is a joint test, whereas the maximum eigen value test conducts separate test on the individual eigenvalues.

Trace statistic examines the null hypothesis of r cointegrating relations against the alternative of n cointegrating relations, where n is the number of variable in the system for r= 0,1,2, . . ., n-1.

It is computed according to the following formula

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{n}\ln(1-\hat{\lambda}_i)$$

The results of trace test should be chosen where trace and maximum eigenvalue statistic may yield different results in some case (Habte, 2014).

Materials and Methods

The data used in this paper was sourced from Bula, (2014); Eme, (2014) and CBN 2014 Statistical Bulletin. The data on annual inflation and unemployment rates in Nigeria spanned from 1970 to 2014 and were recorded in percentage. The data was transform using natural logarithm, in order to achieve stability in the data set.

Results and Discussion

This section begins with examination of the statistical properties of the inflation and unemployment time series variables. The ADF test on the variables revealed that inflation and unemployment time series variables in Nigeria are stationary at first difference employing the AIC criterion. The ADF result is presented in table 1 below.

Table 1: ADF test for unit root

Variable	Intercept only	Intercept and Trend
D(LNINF)	-5.249990*	-5.311038*
D(LNUNEMP)	-7.645218*	-7.724033*
*Significant at 1%, 5% and 10% level of significance		

Table 2: Johansen Cointegration Test

Date: 06/22/16 Time: 14:12
Sample (adjusted): 1973 2014
Included observations: 42 after adjustments
Trend assumption: Linear deterministic trend
Series: LNINF LNUNEMP
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.449614	25.18471	15.49471	0.0013
At most 1	0.002498	0.105050	3.841466	0.7458

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.449614	25.07966	14.26460	0.0007
At most 1	0.002498	0.105050	3.841466	0.7458

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LNINF	LNUNEMP
-2.304526	-0.886301
0.118767	-1.464994

Unrestricted Adjustment Coefficients (alpha):

D(LNINF)	0.344965	-0.020556
D(LNUNEMP)	0.119310	0.013586

1 Cointegrating Equation(s): Log likelihood -41.70348

Normalized cointegrating coefficients (standard error in parentheses)

LNINF	LNUNEMP
1.000000	0.384591
	(0.12072)

Adjustment coefficients (standard error in parentheses)

D(LNINF)	-0.794981
	(0.21551)
D(LNUNEMP)	-0.274954
	(0.11606)

In table 2 above present the cointegration testing, the result from Trace and Maximum Eigenvalue tests indicated one (1) cointegration equation. That is, there exist a long run association between inflation and unemployment in Nigeria. With this result, VECM is appropriate in studying the short and long runs interrelationship between inflation and unemployment rates in Nigeria.

Table 3: VAR Lag Order Selection Criteria

Endogenous variables: LNUNEMP LNINF
Exogenous variables: C
Date: 06/22/16 Time: 14:16
Sample: 1970 2014
Included observations: 35

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-77.43454	NA	0.320906	4.539117	4.627994	4.569797
1	-45.31282	58.73687*	0.064393	2.932161	3.198792*	3.024202
2	-40.20279	8.760046	0.060623*	2.868731*	3.313116	3.022132*
3	-38.65135	2.482308	0.070216	3.008648	3.630788	3.223411
4	-36.58171	3.074890	0.079406	3.118955	3.918848	3.395078
5	-34.59035	2.731006	0.090901	3.233734	4.211382	3.571218
6	-32.35137	2.814716	0.103645	3.334364	4.489766	3.733209
7	-28.07742	4.884511	0.106592	3.318710	4.651865	3.778915
8	-22.41604	5.823135	0.102993	3.223774	4.734683	3.745340
9	-21.55359	0.788526	0.133811	3.403062	5.091726	3.985989
10	-15.09299	5.168482	0.129937	3.262457	5.128874	3.906744

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

In table 3 above present the lag selection criteria for the VEC Model. Employing the AIC criterion lag 2 is selected as the optimal lag. This means that the VEC model in this study will employ lag 2. The VEC Model estimates are presented in table 4 below.

Table 4: Vector Error Correction Estimates
Date: 06/22/16 Time: 13:32
Sample (adjusted): 1973 2014
Included observations: 42 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
LNINF(-1)	1.000000	
LNUNEMP(-1)	0.384591 (0.12072) [3.18584]	
C	-3.393987	
Error Correction:	**D(LNINF)**	**D(LNUNEMP)**
CointEq1	-0.794981 (0.21551) [-3.68887]	-0.274954 (0.11606) [-2.36904]
D(LNINF(-1))	0.381454 (0.17358) [2.19753]	0.117375 (0.09348) [1.25559]

D(LNINF(-2))	-0.029001	0.048374
	(0.16118)	(0.08680)
	[-0.17993]	[0.55729]
D(LNUNEMP(-1))	0.254075	-0.226126
	(0.25252)	(0.13600)
	[1.00614]	[-1.66273]
D(LNUNEMP(-2))	-0.053529	-0.208035
	(0.25536)	(0.13753)
	[-0.20962]	[-1.51270]
C	0.019705	0.083662
	(0.09493)	(0.05112)
	[0.20758]	[1.63648]
R-squared	0.447944	0.253314
Adj. R-squared	0.371269	0.149608
Sum sq. resids	13.22257	3.834986
S.E. equation	0.606048	0.326385
F-statistic	5.842149	2.442607
Log likelihood	-35.32479	-9.331837
Akaike AIC	1.967847	0.730087
Schwarz SC	2.216085	0.978326
Mean dependent	0.021816	0.064477
S.D. dependent	0.764318	0.353933
Determinant resid covariance (dof adj.)		0.033994
Determinant resid covariance		0.024975
Log likelihood		-41.70348
Akaike information criterion		2.652546
Schwarz criterion		3.231770

The table 4 above presented the estimates of the short and long runs coefficients from the VEC Model at lag 2. With particular interest in the inflation model, the long run coefficient in inflation model is 0.384591. This result negates the Phillips curve representation in Nigeria as stipulated by the result presented in Bula, (2014).

The result revealed the equilibrium error correction coefficient (ECM) estimate of -0.795 is highly significant with the correct sign. This implies a high speed of adjustment to equilibrium after shock. This means there is a long run relationship between inflation and unemployment rates in Nigeria. The short runs coefficient of the unemployment rate at lag 1 is positive while it is negative at lag 2 but they are not significant at 5% level of significance. The system analysis present the coefficients in the VEC model with their respective p-values are presented in table 5 below.

Table 5: System Analysis of the VEC Models

Estimation Method: Least Squares
Date: 06/22/16 Time: 13:40
Sample: 1973 2014
Included observations: 42

Total system (balanced) observations 84

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.794981	0.215508	-3.688867	0.0004
C(2)	0.381454	0.173583	2.197531	0.0312
C(3)	0.254075	0.252524	1.006140	0.3177
C(4)	-0.029001	0.161178	-0.179931	0.8577
C(5)	-0.053529	0.255364	-0.209617	0.8346
C(6)	0.019705	0.094928	0.207577	0.8361
C(7)	-0.274954	0.116061	-2.369041	0.0205
C(8)	0.117375	0.093483	1.255585	0.2133
C(9)	-0.226126	0.135996	-1.662734	0.1007
C(10)	0.048374	0.086802	0.557292	0.5791
C(11)	-0.208035	0.137526	-1.512698	0.1347
C(12)	0.083662	0.051123	1.636481	0.1061
Determinant residual covariance		0.024975		

Equation: D(LNINF) = C(1)*(LNINF(-1) + 0.384591458145*LNUNEMP(-1) - 3.39398712867) + C(2)*D(LNINF(-1)) + C(3)*D(LNUNEMP(-1)) + C(4)*D(LNINF(-2)) + C(5)*D(LNUNEMP(-2)) + C(6)

Observations: 42

R-squared	0.447944	Mean dependent var	0.021816
Adjusted R-squared	0.371269	S.D. dependent var	0.764318
S.E. of regression	0.606048	Sum squared resid	13.22257
Durbin-Watson stat	2.038788		

Equation: D(LNUNEMP) = C(7)*(LNINF(-1) + 0.384591458145 *LNUNEMP(-1) - 3.39398712867) + C(8)*D(LNINF(-1)) + C(9) *D(LNUNEMP(-1)) + C(10)*D(LNINF(-2)) + C(11)*D(LNUNEMP(-2)) + C(12)

Observations: 42

R-squared	0.253314	Mean dependent var	0.064477
Adjusted R-squared	0.149608	S.D. dependent var	0.353933
S.E. of regression	0.326385	Sum squared resid	3.834986
Durbin-Watson stat	2.047312		

The system analysis in table 5 revealed that the long run coefficients and the inflation at lag 1 in the inflation are significant at 5% level of significance. The significance of the inflation at lag 1 suggest that future inflation depends on today's inflation rate (Eitrheim, HusebΦ & Nymoen, 2004).

Table 6: VEC Granger Causality/Block Exogeneity Wald Tests

Date: 06/22/16 Time: 14:21
Sample: 1970 2014
Included observations: 42

Dependent variable: D(LNINF)

Excluded	Chi-sq	df	Prob.
D(LNUNEMP)	1.177664	2	0.5550
All	1.177664	2	0.5550

Dependent variable: D(LNUNEMP)

Excluded	Chi-sq	df	Prob.
D(LNINF)	1.584113	2	0.4529
All	1.584113	2	0.4529

In the table 6 above present the result on the short run causality between inflation and unemployment rate in Nigeria. The result revealed that there is no short run causality running from unemployment rate to inflation rate in Nigeria. The result is supported by the VEC model presented in table 4 above.

Table 7: VEC Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 06/22/16 Time: 13:35
Sample: 1970 2014
Included observations: 42

Lags	LM-Stat	Prob
1	2.207661	0.6976
2	5.728673	0.2203

Probs from chi-square with 4 df.

The VEC residual serial correlation LM Tests revealed that there is no serial correlation. This suggests the suitability of the VEC Model obtained in this study.

The impulse response and variance decomposition for the models are presented at the appendix in table 8 and table 9 respectively. Result from variance decomposition for inflation model in table 9 revealed that inflation explain the variation in the inflation model at about 90.1% while unemployment explain the variation in the inflation model for about 8.9%. The shocks from inflation and unemployment rates on inflation and unemployment model are presented in figures 1 and 2 respectively.

Summary, Conclusion and Recommendations

The Phillips curve represents the relationship between the rate of inflation and the unemployment rate. This paper investigated the interrelationship between inflation rate and unemployment rate in Nigeria from 1970 to 2014. Annual data for these variables were collected from secondary sources. The ADF test revealed that inflation and unemployment rates are stationary at first difference while the Johansen cointegration test indicated one (1) cointegrating equation at 5% level of significance. The VECM model at lag 2 was used to investigate the short

and long run interrelationship between inflation and unemployment rates in Nigeria. The result revealed the inflation and unemployment rates are positively related in the long run. While the equilibrium error correction coefficient (ECM) estimate of -0.795 is highly significant with the correct sign. This implies a high speed of adjustment to equilibrium after shock. The Granger causality test revealed that inflation is not influenced by unemployment in the short run.

This paper therefore concludes that there is no short run causality between inflation and unemployment rate in Nigeria but there is a positive long run interrelationship between inflation and unemployment rates in Nigeria as this negates the Phillips curve.

The following are recommended:

1. The government should formulate economic policy to reduce inflation rate and unemployment in the long run.
2. Investment should be encouraged in the non-oil sector such as agriculture and mining sectors in order to create employment.

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Appendix

Table 8: Impose Response Functions

Response of LNINF: Period	LNINF	LNUNEMP
1	0.606048	0.000000
2	0.361538	-0.015719
3	0.008656	-0.113301
4	-0.067161	-0.113664
5	0.036926	-0.063363
6	0.118541	-0.052041
7	0.111418	-0.067004
8	0.073883	-0.075956
9	0.060837	-0.074479
10	0.070627	-0.070459
Response of LNUNEMP: Period	**LNINF**	**LNUNEMP**
1	-0.118215	0.304224
2	-0.174483	0.203261
3	-0.217505	0.143785
4	-0.228698	0.181972
5	-0.200537	0.192957
6	-0.184974	0.185433
7	-0.192770	0.183312
8	-0.201383	0.183187
9	-0.201583	0.183395
10	-0.198504	0.184199
Cholesky Ordering: LNINF LNUNEMP		

Table 9: Variance Decomposition

Variance Decomposition of LNINF: Period	S.E.	LNINF	LNUNEMP
1	0.606048	100.0000	0.000000
2	0.705869	99.95041	0.049589
3	0.714956	97.44030	2.559700
4	0.727044	95.08055	4.919447
5	0.730733	94.37822	5.621779
6	0.742113	94.05756	5.942445
7	0.753415	93.44360	6.556399
8	0.760830	92.57412	7.425881
9	0.766884	91.74768	8.252324
10	0.773346	91.05492	8.945083
Variance Decomposition of LNUNEMP: Period	**S.E.**	**LNINF**	**LNUNEMP**

1	0.326385	13.11858	86.88142
2	0.422240	24.91451	75.08549
3	0.496256	37.24686	62.75314
4	0.575922	43.42375	56.57625
5	0.639636	45.03311	54.96689
6	0.691183	45.72853	54.27147
7	0.740606	46.60387	53.39613
8	0.789057	47.57011	52.42989
9	0.834793	48.33145	51.66855
10	0.877618	48.84570	51.15430

Cholesky Ordering: LNINF LNUNEMP

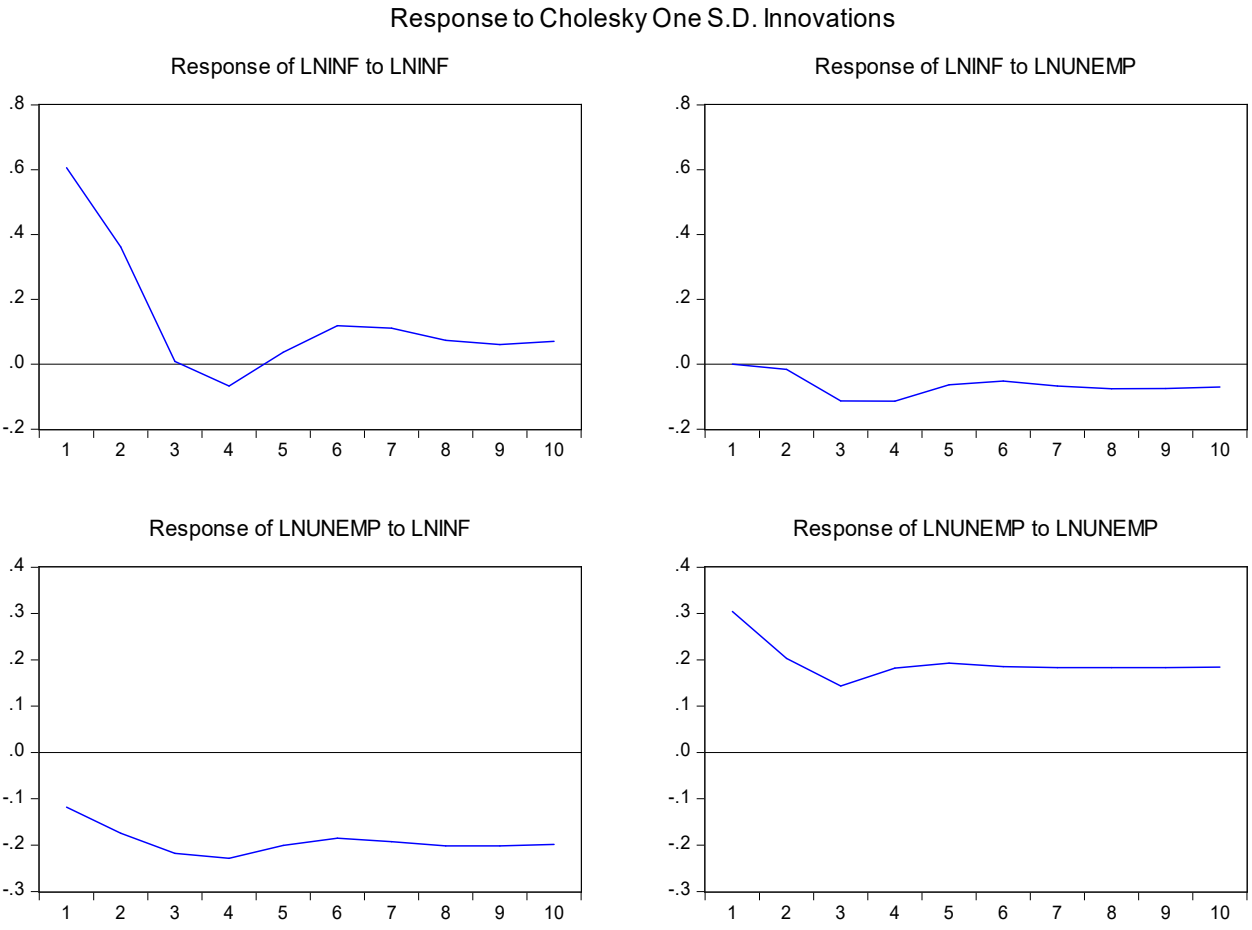


Fig. 1: Impulse Response Response Graph

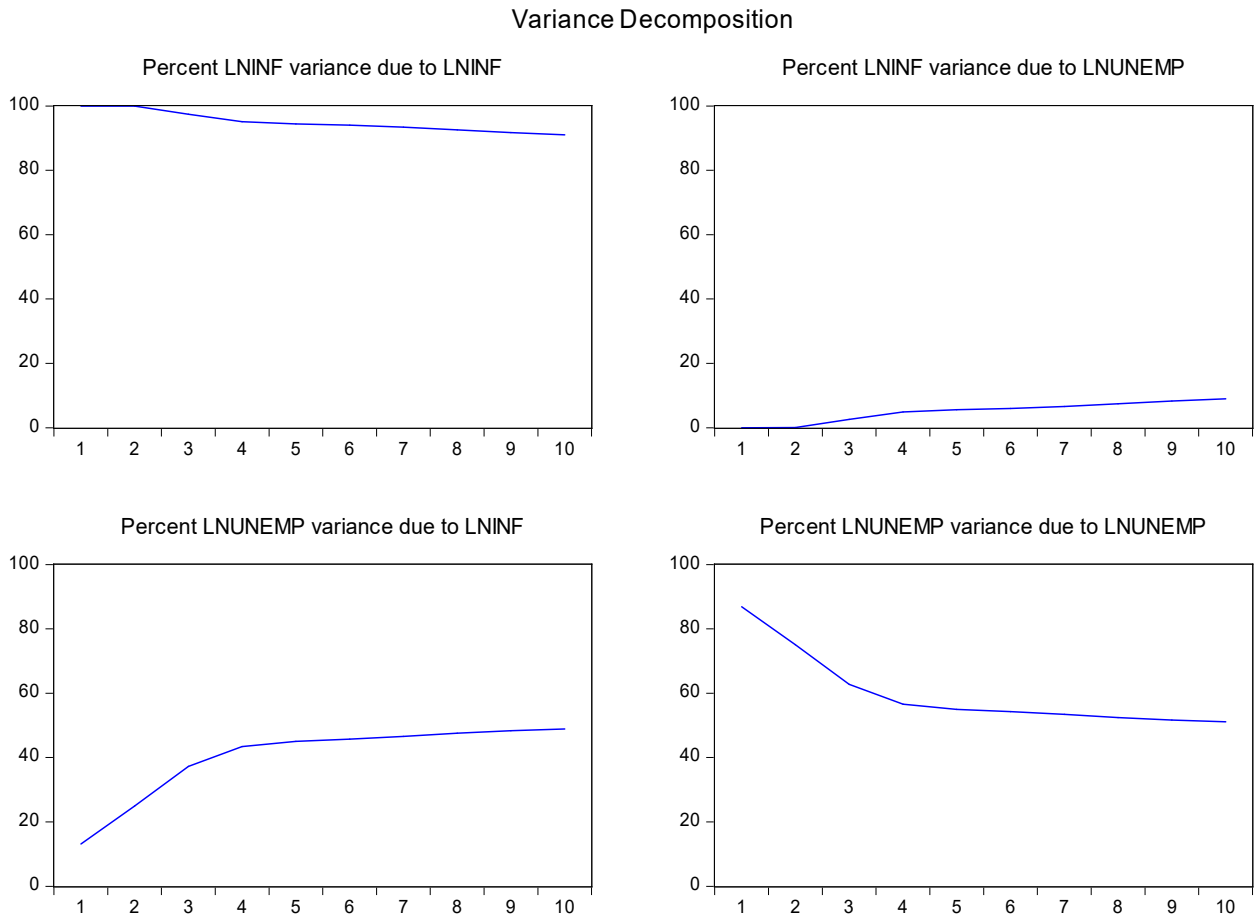


Fig. 2: Variance Decomposition Graph