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AN EMPIRICAL ANALYSIS OF THE EXISTENCE OF PHILIPS CURVE: A CASE OF INDIA

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Abstract: The problems of Inflation and Unemployment are the issues that are central to all countries especially developing countries. The government needs to optimize the goals of these two variables since according to the theory of Phillips curve there exists an inverse relationship between Inflation and Unemployment rate. As propounded by Phillips curve if this relationship exists in any economy then it is possible to manage these two variables as required. However there are evidences that this relationship for many economies does not hold true. Unless we know if such a relationship exists for any particular economy it is difficult to control inflation and unemployment rate. Therefore using time series data this study makes a modest attempt to test the existence of long run trade-off between inflation and unemployment and further tries to examine the causal relationship between the variables viz Inflation, expected inflation, output gap and international oil price over the period 1965-2013. In this study Johansen Multivariate Cointegration Test (JMCT) has been used to estimate the Phillips curve in Indian Context. The result of JMCT shows that there is no tradeoff between inflation and unemployment i.e there is a positive relationship between inflation and unemployment for India as against the theory of Phillips curve. Hence from the analysis it can be inferred that the relationship between inflation and unemployment such as the one that is established by the theory of Phillips curve does not exist for India.

I. INTRODUCTION

In 1958, William Phillips proposed that there existed a trade-off relationship between unemployment and inflation in the United Kingdom. Since then, the inverse relationship between unemployment and inflation has been known as the "Phillips curve". Though the Phillips curve has played an important role in the decision-making process on macroeconomic policy, there have been critics who doubted the existence of the "Phillips curve". Despite a number of studies on the Phillips curve, there has been a lack of research that probed the hypothesis in the developing countries' context. In this section we can look Phillips curve which shows the tradeoff between inflation and unemployment is critical for targeting inflation and economic growth for the country and is more useful for describing the prediction and determinants of unemployment.

Despite the Phillips curve being a result out of British Economist Phillips (1958), it is the United States of America that had devoted a considerable amount of research and validation of the Phillips curve and tried out various adaptations of the traditional Phillips curve viz., the New Keynesian Phillips curve, Expectation Augmented Phillips Curve, Gordon Triangle Model, etc.

Solow and Samuelson (1960) were the first to take Phillips' work and apply it to the context of United States. In their paper published in the American Economic Review, they agreed with the hypothesis put forward by Phillips and presented a Phillips-type relationship between unemployment and prices in the United States. Fumitaka, (2007) choose Malaysia as a case study to empirically examine the relationship between inflation rate and unemployment rate. Unit root test, Johansen cointegration test, and Granger causality based on the

VECM were used to examine the hypothesis. This paper has provided empirical evidence to support the existence of the Phillips curve in the case of Malaysia and also found a causal relationship between the unemployment rate and the inflation rate.

Quite opposite to the above findings Chicheke (2009) evaluated the existence of Phillips curve for South Africa by using data from 1980-2010 using Johansen Cointegration test and Vector Error Correction Model and found that there is a positive long run Phillips curve in South Africa during the study period which is a similar finding by Friedman and Phelps (1967).

In case of Indian context, Singh (2016) in his paper to evaluate the tradeoff between Inflation and Unemployment rate using OLS and Bivariate regression model finds that the relationship between inflation and unemployment is negative and Phillips curve does exist for India.

However Ray (2011) evaluated the existence of Phillips curve in India by using data from 1970 to 2010. This study uses Generalized Method of Moments (GMM) to estimate Phillips curve and the results suggested that there is a positive relationship between Inflation and Unemployment rate. The study also found no long run relationship between the variables viz., Inflation, Expected Inflation and Output Gap. Kumar (2012) also in his study fails to find any evidence of a significantly negative relationship between Inflation and Unemployment rate in the economy during the period 1951 to 2008 by using OLS. Further the Granger Causality test reveals that there is a unidirectional causal relationship running from output gap to Inflation rate and bidirectional causality between output growth rate gap and GNP deflator based Inflation rate.

Overall we can come across considerable number of studies that have been conducted on applicability and existence of the Phillips curve in the context of developed countries. Generally, empirical finds have shown the mixed results. However the work in the area seems to be very less explored in terms of developing countries especially in Indian context. Though there are studies that shows the applicability of Phillips curve in India the methodology that these papers have used are much elementary such as ordinary regression which may not capture long term relationship between the variables under study.

Therefore the this study tries to make a modest attempt to examine whether there exists a Philips curve type of relationship between inflation and unemployment rate in India during the period 1965-2013 using the concept of Expectation Augmented Phillips Curve (EAPC) and further to examine the causal relationship among inflation and its determinants such as expected inflation, supply shock and output gap using more appropriate methods such as Johansen's cointegration test and Granger causality test which better suit such studies.

II. EXPECTATION AUGMENTED PHILLIPS CURVE (EAPC)

The Phillips curve, originally due to Phillips (1958), measured a negative relationship between the rate of wage inflation and that of unemployment. In the late 1970s, Friedman (1968) and Phelps (1968) argued that the labor market equilibrium is determined by real wages as opposed to nominal wages. As expected real wage change equals the difference between nominal wage inflation and expected price inflation, they included expected inflation into the model and called it as Expectation Augmented Phillips Curve (EAPC). The theoretical model of Expectation Augmented Phillips Curve (EAPC) is shown in equation (1).

$$INFt = EINFt - \beta(U - Un) + ut \quad (1)$$

where INFt is the inflation at time t

EINFt is the expected inflation at time t

U is the unemployment rate

Un is the natural rate of unemployment 1

(U – Un) is the cyclical unemployment 2

ut is the error term

The term â is the coefficient of the difference between the current rate of unemployment and the natural rate of unemployment and it measures the response of inflation to cyclical unemployment. The negative sign of β coefficient shows that other things being equal, higher unemployment will be associated with a lower inflation rate.

III. TRENDS IN INFLATION AND UNEMPLOYMENT IN INDIA

The data represented in figure 1 shows the rate of inflation in India from 1965-2013 accounting for 49 years. As it can be seen from the table, Inflation had accelerated during the 1960s partly due to the two wars viz., Sino-Indian war (1962) and Indo-Pakistani war (1965) and the crop failure of 1965-66 when agricultural production fell by more than 16 percent. It became a matter of serious concern when it breached 20 percent in the early 1970s led by a setback in agricultural production and a hike in international oil prices.

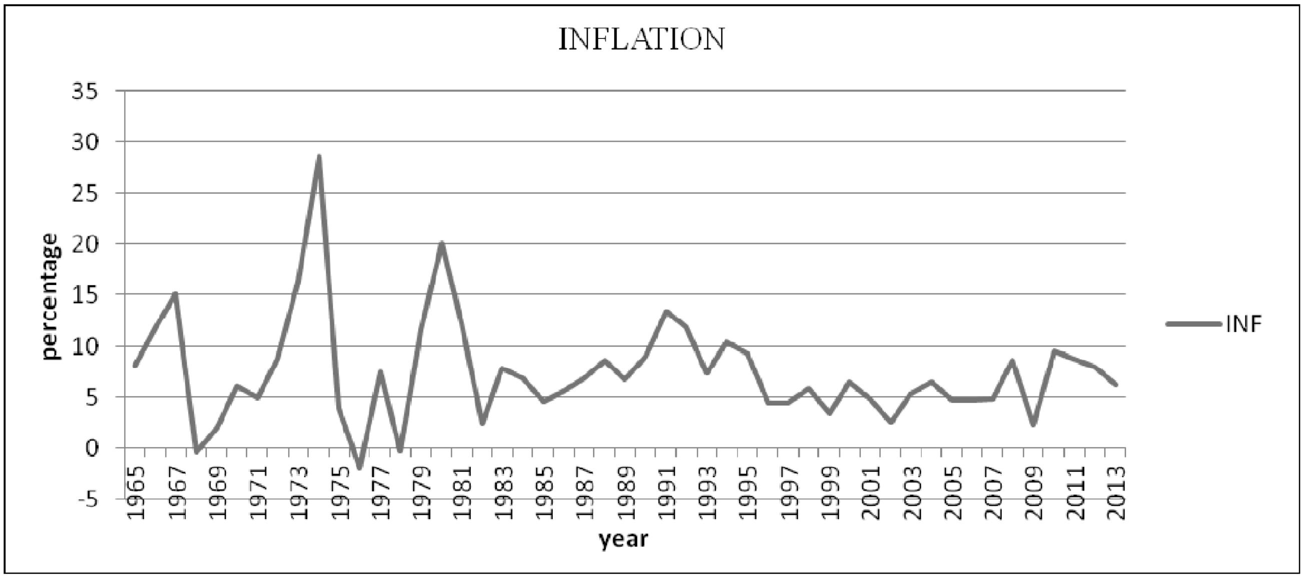

Figure 1: Trends in inflation in India

Source: World Bank

Constantly the inflation rate has decreased after 1980s but a sharp increase in inflation of about 13.49 percent was witnessed during the period 1991 as the Indian rupee depreciated by nearly 37 percent with respect to the US dollar. Notwithstanding this, depreciation added to inflationary pressures during the first half of the 1990s. Hike in procurement prices as well as supply demand imbalances in essential commodities like pulses, oil seeds and edible oils further added to inflation. The year 2010-11 was marked by a strong inflation rate of 9.56 percent because of elevated inflation expectations, hike in vegetable prices with unseasonal rains and rising global commodity prices that resulted in significant cost push and demand pull pressures since 2010.

As far as Unemployment is concerned India like most developing economies is known to be a labor surplus economy. According to National Sample Survey Office (NSSO), 68th round of the employment unemployment survey, the unemployment rate3 in Urban areas reduced from 4.5% in 2004-05 to 3.4% in 2011-12. In the five year period falling between 2004-05 and 2009-10, 2.7 million new jobs were created where as in the previous five years 60 million new jobs were created. As per the NSSO survey number of women who lost their jobs was more than that of men. Number of employed men between 2009 and 2012 remain almost same but number of employed women dropped from 18% to 16%. Though in terms of percentage it looks small but the actual figures are really daunting. In rural sector about 90 lakh women lost their jobs in the period of two years. On the other hand 35 lakh women were added to the workforce in urban areas. Overall unemployment rate in females was more as compared to males. For females it was 7.2% whereas for male the unemployment rate was 4%.

NSSO surveys on unemployment rate are conducted on quinquennial basis. In order to measure employment-unemployment on an annual basis, Employment-Unemployment Survey is being conducted by Labour Bureau only since 2009. But this study needs data on unemployment rate from 1965 which is not available; hence output gap is used as a proxy based on Okun's law. The Okun's law states that Output depends on the amount of labor used in the production process, so there is a positive relationship between output and employment. Hence, output gap can be used as a proxy for unemployment rate.

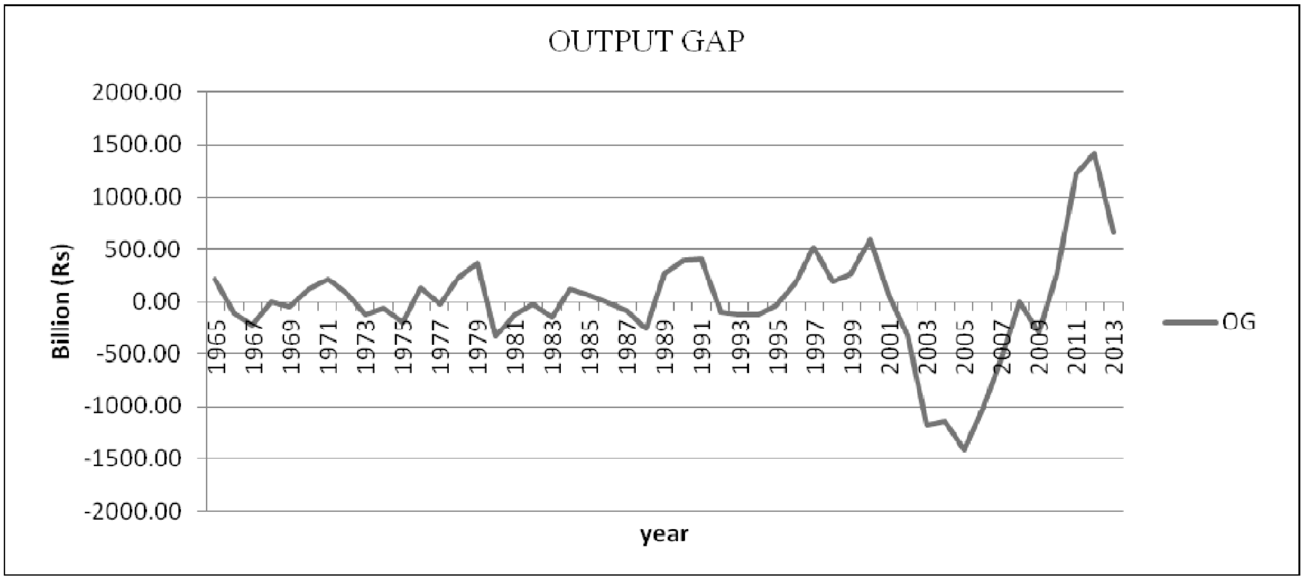

Figure 2: Trends in unemployment as measured by output gap

Source: Computed from data given in Handbook of statistics on Indian Economy, RBI

Figure 2 shows the trends in unemployment rate measured by output gap. It shows that the output gap is negative during 2002 to 2009 in which case the economy has failed to operate at its full capacity. Hence there existed a spare capacity in the economy due to weak demand. After 2009 the output gap is positive till 2013 meaning that the demand is very high and the economy has worked far above its efficient capacity to meet that demand. The data plots from 1965 to 2000 suggest constant fluctuations in output gap. Further it does not hint any negative relationship between the Inflation and output gap which needs to be empirically tested.

IV. METHODOLOGY & DATA SOURCES

To examine the existence of long term relationship between inflation and unemployment rate, Johansen Multivariate Cointegration Test (JMCT) is used. If two variables have a long term relationship then they are said to be cointegrated, if there is cointegration then in short run there may me disequilibrium. To understand the rate of adjustment or disequilibrium and also to ascertain the direction of relationship a Vector Error Correction Model (VECM) is used. To understand the direction of influence among the variables viz., Inflation, expected inflation, unemployment rate and international oil price Granger Causality Test is used.

All the empirical analysis of this study uses Annual data set on Unemployment rate (measured by output gap) and Inflation rate in India for 49 years over a period of 1965-2013. Inflation rate has been computed using the Wholesale Price Index (WPI) which is obtained from World Bank and the expected Inflation rate has been computed using the Inflation rate by applying Auto Regressive Integrated Moving Average (ARIMA). The output gap is used as a proxy for unemployment rate. To compute output gap GDPFC at constant prices has been obtained from the Handbook of Statistics on Indian economy, Reserve Bank of India (RBI) and data on

International Crude Oil price has been obtained from World Bank.

V. VARIABLES USED IN THE STUDY AND ITS MEASUREMENTS

(i) Inflation (INF)

Data on Wholesale Price Index (WPI) has been obtained from the World Bank and is converted into Inflation rate using the formula,

$$INF = (WPI_t - WPI_{t-1}) \;/\; WPI_{t-1}) * 100 \qquad (2)$$

where *WPIt* = the Wholesale Price Index at time period *t*

WPIt-1 = the Wholesale Price Index at time period *t*-1

(ii) Output Gap (OG)

The Output gap is the indicator of the difference between actual and potential output of the economy expressed as a percentage of the GDP. The potential output is calculated using the Hodrick-Prescott filter (HP) which is a commonly used method for estimating potential output in developing countries (Mohanty and Klau, 2011).

The Hodrick-Prescott filter decomposes a time series into growth and cyclical components as

$$Y_t = Y_t^g + Y_t^c \qquad (3)$$

where Y_t is the observed time series i.e GDP in this case

Y_t^g is the growth or trend component at time period *t*

Y_t^c is the cyclical component at time period *t*

The filter is given as

$$\text{Min } Y_t^g = \Sigma\,(Y_t - Y_t^g)^2 + \lambda\,\Sigma\,[(Y_{t+1}^g - Y_t^g) - (Y_t^g - Y_{t-1}^g)^2 \; t = 1, 2, \ldots\ldots T \qquad (4)$$

Hodrick and Prescott (1997) minimize the variance of Y_t^c subject to a penalty for variations in the second difference of the growth term, where the parameter λ controls the smoothness of Y_t^g. A low value of λ will produce a trend output that follows actual output more closely and a high value of λ reduces the sensitivity of the trend output to short term fluctuations in actual output. Though a lot of subjectivity is involved in determining the appropriate value for ë, it is set to 14400 for Monthly data, 1600 for Quarterly data and 100 for Annual data (A.W.Phillips, 1958).

Having established the method to derive the trend and cyclical component, Output gap is derived simply as follows,

$$OG_t = Y_t - Y_t^p \qquad (5)$$

where OG_t = the output gap at time *t*

Y_t = the output in real terms at time *t*

Y_t^p = the potential output of the economy at time *t*

Here, the potential output is the decomposed trend component derived from the Hodrick-Prescott Filter.

(iii) Expected Inflation (EINF)

For Expected Inflation, this study uses adaptive expectations hypothesis which concentrates upon the past information and gives more weight to near observations than the distant past observations. The specification used for calculating the Expected Inflation is as follows,

$$EINF_t = \alpha INF_t + (1-\alpha)\, INF_{t-1} \qquad (6)$$

where $EINF_t$ = the Expected Inflation rate at time period *t*

INF_t = the inflation rate at time period *t*

α = the coefficient of adjustment which lies between 0 and 1

For taking appropriate lags the Auto Regressive Integrated Moving Average (ARIMA) model is used. In this estimation, inflation series is found to be ARIMA (2,0,2) process. Therefore, expected inflation at a period depends upon a constant, the inflation of its previous 2 periods and the error term of the previous 2 periods. So the expected inflation is calculated as

$$\mathbf{EINF_t = \delta + \alpha_1\, INF_{t-1} + \alpha_2\, INF_{t-2} + u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2} + v_t} \qquad \mathbf{(7)}$$

From the results of table 1 using equation (7), the expected inflation series is calculated as

$$EINF_t = 1.181 + 0.3857\, INF_{t-1} + 0.4407\, INF_{t-2} - 0.3751 + 0.00039\, u_{t-1} - 0.9458\, u_{t-2} + v_t \qquad (8)$$

Table 1
Results of ARIMA (2,0,2) model for computation of expected inflation

Variable	*Coefficient*	*Standard Error*	*t value*	*P value*
Constant	1.181	1.006	1.1741	0.2465
AR(1)	0.3857	0.1515	2.5447	0.0144
AR(2)	0.4407	0.1456	3.0254	0.0041
MA	-0.3751	0.3289	-1.1406	0.2601
MA(1)	0.00039	0.0656	0.0060	0.9952
MA(2)	-0.9458	0.0645	-14.653	0.0000
R^2	0.2686	Adjusted R^2	0.1874	

Thus, from the discussions of this section, expected inflation series is calculated using Adaptive Expectations hypothesis with ARIMA model.

(iv) International Oil Price (OP)

Oil price shocks have received considerable importance in the empirical literature. Macroeconomists have viewed changes in the oil prices as an important source of economic fluctuations as the oil shocks of mid and late 1970s was followed by low growth, high unemployment and high inflation in most of the developed countries. The data on international oil price has been taken from the World Bank database for the period 1965-2013 and is converted into Rupees per barrel using the exchange rate data from 1965-2013 obtained from the same source.Descriptive statistics of all the variables used in this study are given in Table 2.

Table 2
Descriptive statistics of Variables used in the Study

Variable	*Description*	*Minimum*	*Maximum*	*Mean*	*SD*
INF	Inflation (%)	-1.96	28.57	7.53	5.21
EINF	Expected Inflation (%)	1.88	17.13	7.29	3.47
OG	Output Gap (billion Rs.)	-1418.72	1419.05	-1.40	504.529
OP	Oil price (Thousand Rs.)	64.33	6477.99	1386.68	1621.30

Stationarity of variables used – Unit Root test

A unit root test is used to test whether a time series variable is non-stationary and possess a unit root. The time series under consideration has to be made stationary because if the variable is non-stationary the t ratios will not follow normal distribution and the variance of the series will vary making it impossible to analyze the series. Hence Augmented Dickey Fuller test is used to check for the stationarity of the variables.

Table 3
Results of the Unit Root test for testing the stationarity of the variables

variables	*ADF (with drift)*	*ADF (without drift)*	*ADF (with drift and trend)*
INF	-4.72*	-1.55	-4.53
EINF	-4.37*	-4.53*	-1.55
OG	-2.39	-2.35	-2.42*
OP	3.70*	0.201	4.486*

Note: *denotes significance at 5% level.

H_0 : There is a unit root and the time series is non-stationary

H_a : There is no unit root and the time series is stationary.

The result in table 3 shows that all the variables are tested for stationarity at levels. On the basis of this the null hypothesis of non-stationarity is rejected at 5% level of significance and hence the variables are stationary at levels i.e they are integrated of order 0, I(0).

Before estimating the model it is essential to know which theory of the Phillips curve equation is used in this study and is discussed in section II.

VI Empirical Results of Johansen Multivariate Cointegration Test (JMCT) & Vector Error Correction Mechanism (VECM)

Cointegration of two (or more) time series suggests that there is a long run or equilibrium relationship between them. To test if there is a cointegration among more than two variables a Johansen Multivariate Cointegration Test is used. The specification of Johansen Multivariate Cointegration test for the present study is as follows,

$$INF_t = \beta_0 + \beta_1 EINF_t + \beta_2 OG_t + u_t \qquad (9)$$

where INF_t is the inflation rate at time t

$EINF_t$ is the expected inflation rate at time t

OG_t is the output gap

Equation (9) is the cointegrating equation and β_1 & β_2 are the cointegrating parameters for $EINF_t$ and OG_t in this study. As a precondition to apply cointegration test, a maximum lag length of 4 is chosen based on the Akaike Information Criteria (AIC) and Hannan Quinn Information criteria (HQ).

Table 4
Results of Johansen Multivariate Cointegration Test

Number of cointegrating vectors (r) / Null & Alternative hypothesis	*Eigen value*	*Max Eigen statistic (λ_{max})*	*Critical value*	*P value*
H_0: r = 0* (no cointegrating vectors) H_1: r = 1 (one cointegrating vector)	0.4293	24.684	21.131	0.0151
H_0: r = 1 (one cointegrating vector) H_1: r = 2 (two cointegrating vector)	0.2500	12.662	14.264	0.0882
H_0: r = 1* (one cointegrating vector) H_1: r = 2 (two cointegrating vector)	0.1845	8.975	3.8414	0.0027

Note: *denotes rejection of the hypothesis at 5% level of significance

From the above results of cointegration test it can be seen that in table 4 the calculated value of λ_{max} is greater than the critical value in both first and third row at 5% level of significance. Hence, reject H_0 in both the cases and infer that there are two cointegrating vectors.

To identify whether the two cointegrating vectors obtained in table 4 has a positive or negative relationship it can be generated by using VECM and the results are as follows,

$$INF_t = \beta_0 + \beta_1 EINF_t + \beta_2 OG_t + u_t$$

$$INF_t = -0.067 + \underset{\substack{(-1.1722)\\ [-3.78]}}{1.211 EINF_t} + \underset{\substack{(-4.730)\\ [-3.78]}}{0.025 OG_t} \quad (10)$$

Note: computed t statistics in ( ) & critical t-statistics in [ ]

The result in equation (9) shows that the coefficient of expected inflation ($\beta 1$) is not significant at 5% as the computed t value (-1.172) is lesser than the critical value (-3.78) whereas the coefficient of output gap ($\beta 2$) is statistically significant as the computed t value (-4.730) is higher than the critical value (-3.78) at 5% level of significance. The sign of $\beta 2$ coefficient shows that there exists a positive long run relationship between inflation and unemployment rate which is against the Phillips curve theory of inverse relationship between Inflation and Unemployment in long run.

The specification of Vector Error Correction Model for the present study is as follows

$$\Delta INF_t = \beta_0 + \beta_1 \Delta EINF_t + \beta_2 \Delta OG_t + \varepsilon_t \quad (11)$$

From the results of equation (10), if Inflation (INFt) and Output gap (OGt) are cointegrated then the error term can be expressed as

$$INF_t - \beta_0 - \beta_1 EINF_t - \beta_2 OG_t = u_t \quad (12)$$

For mathematical simplicity let u_t lagged by one time period then (12) becomes,

$$\Delta INF_t = \beta_0 + \beta_1 \Delta EINF_t + \beta_2 \Delta OG_t + \delta u_{t-1} + \varepsilon_t$$

$$\Delta INF_t = \beta_0 + \beta_1 \Delta EINF_t + \beta_2 \Delta OG_t + \delta(INF_{t-1} - \beta_0 - \beta_1 EINF_{t-1} - \beta_2 OG_{t-1}) + \varepsilon_t \quad (13)$$

The term $\delta\ (INF_{t-1} - \beta_0 - \beta_1 EINF_{t-1} - \beta_2 OG_{t-1})$ is the error correction term and equation (13) is the error correction model for the present study.

Table 5
Results of the Vector Error Correction Model

ECT	*Coefficient*	*P value*
Coefficient	0.073	0.5630
R square	0.4963	
Diagnostic checking		
Name of the test		*Prob. Chi square*
White 's test for Heteroscedasticity		
$H_0 : E(u_i^2) = \sigma^2$ i = 1,2,3,……n		0.6322
$H_a : E(u_i^2) \neq \sigma^2$ i = 1,2,3,……n		
LM test for Serial Correlation		0.2041
$H_0 : E(u_i u_j) = 0$ $i \neq j$		
$H_a : E(u_i u_j) \neq 0$ $i \neq j$		

Note: *denotes rejection of null hypothesis at 1%, 5% and 10% level of significance.

The Error Correction Term (ECT) in table 5 is positive and is not significant at 5% level of significance. To check for the validity and applicability of the model Heteroscedasticity White's test and Lagrange Multiplier (LM) test for serial correlation are applied.

H_0: there is no serial correlation/ no heteroscedasticity

H_1: there is serial correlation/heteroscedasticity

White's test for heteroscedasticity does not reject the null hypothesis at 5% level of significance implying that the error terms are homoscedastic. Breusch Godfrey lagrange multiplier (LM) test does not reject the null hypothesis at 5% level of significance implying that there is no serial correlation between the error terms. So from the results we ascertain that our model is valid.

VII. EMPIRICAL RESULTS OF GRANGER CAUSALITY TEST

The specification and results of the pairwise granger causality test observed for the variables viz., inflation, expected inflation, output gap and oil price are as follows:

Pairwise granger causality test between INF_t and $EINF_t$

$$\mathbf{INF_t = \sum_{i=1}^{4} \alpha_i INF_{t-i} + \sum_{j=1}^{4} \beta_j EINF_{t-j} + u_{1t}} \quad (14)$$

$$\mathbf{EINF_t = \sum_{i=1}^{4} \lambda_i EINF_{t-i} + \sum_{j=1}^{4} \delta_j INF_{t-j} + u_{2t}} \quad (15)$$

Pairwise granger causality test between INF_t and OG_t

$$\mathbf{INF_t = \sum_{i=1}^{4} \alpha_i INF_{t-i} + \sum_{j=1}^{4} \beta_j OG_{t-j} + u_{1t}} \quad (16)$$

$$\mathbf{OG_t = \sum_{i=1}^{4} \lambda_i OG_{t-i} + \sum_{j=1}^{4} \delta_j INF_{t-j} + u_{2t}} \quad (17)$$

Pairwise granger causality test between INF_t and OP_t

$$\mathbf{INF_t = \sum_{i=1}^{4} \alpha_i INF_{t-i} + \sum_{j=1}^{4} \beta_j OP_{t-j} + u_{1t}} \quad (18)$$

$$\mathbf{OP_t = \sum_{i=1}^{4} \lambda_i OP_{t-i} + \sum_{j=1}^{4} \delta_j INF_{t-j} + u_{2t}} \quad (19)$$

Pairwise granger causality test between $EINF_t$ and OG_t

$$\mathbf{EINF_t = \sum_{i=1}^{4} \alpha_i EINF_{t-i} + \sum_{j=1}^{4} \beta_j OG_{t-j} + u_{1t}} \quad (20)$$

$$\mathbf{OG_t = \sum_{i=1}^{4} \lambda_i OG_{t-i} + \sum_{j=1}^{4} \delta_j EINF_{t-j} + u_{2t}} \quad (21)$$

Pairwise granger causality test between $EINF_t$ and OP_t

$$\mathbf{EINF_t = \sum_{i=1}^{4} \alpha_i EINF_{t-i} + \sum_{j=1}^{4} \beta_j OP_{t-j} + u_{1t}} \quad (22)$$

$$\mathbf{OP_t = \sum_{i=1}^{4} \lambda_i OP_{t-i} + \sum_{j=1}^{4} \delta_j EINF_{t-j} + u_{2t}} \quad (23)$$

Pairwise granger causality test between OG_t and OP_t

$$\mathbf{OG_t = \sum_{i=1}^{4} \alpha_i OG_{t-i} + \sum_{j=1}^{4} \beta_j OP_{t-j} + u_{1t}} \quad (24)$$

$$\mathbf{OP_t = \sum_{i=1}^{4} \lambda_i OP_{t-i} + \sum_{j=1}^{4} \delta_j OG_{t-j} + u_{2t}} \quad (25)$$

From the results of table 6 it can be seen that there is no causality in pair 2, pair 3, pair 4 and pair 5 i.e., there is no relationship among the variables mentioned in those pairs. Pair 1 rejects the null hypothesis of inflation does not granger cause expected inflation at 5% level of significance. There is a unidirectional causality running from inflation to expected inflation as peoples' expected inflation depends on the current inflation. Pair 6 rejects the null hypothesis of oil price does not granger cause output gap at 5% level of significance. There is a unidirectional causality running from oil price to output gap i.e an increase in oil price contributes to the increase in output gap for India.

Table 6
Results of granger causality test

Pair	*Null hypothesis*	*obs*	*Wald stat*	*P value*
Pair 1	EINF does not granger cause INF	45	0.9815	0.4299
	INF does not granger cause EINF	45	84.7084*	0.0008
Pair 2	OG does not granger cause INF	45	0.2831	0.8870
	INF does not granger cause OG	45	1.448	0.2382
Pair 3	OP does not granger cause INF	45	1.542	0.210
	INF does not granger cause OP	45	0.227	0.921
Pair 4	OG does not granger cause EINF	45	0.4778	0.7517
	EINF does not granger cause OG	45	0.9536	0.446
Pair 5	OP does not granger cause EINF	45	1.587	0.198
	EINF does not granger cause OP	45	0.553	0.697
Pair 6	OP does not granger cause OG	45	3.597*	0.014
	OG does not granger cause OP	45	0.553	0.240

Note: *denotes rejection of the null hypothesis at 5% level of significance

VIII. SUMMARY FINDINGS & CONCLUSION

The empirical results of Johansen Multivariate Cointegration Test in section VI indicates a long run positive relationship between Inflation and Unemployment rate of the Phillips curve in India and therefore it can be stated that Phillips curve does not exist for India. The empirical results of Granger Causality Test in section VII suggests that there is a unidirectional causality running from running from inflation (INF_t) to expected inflation ($EINF_t$) and from oil price (OP_t) to output gap (OG_t) but there is no short run causality between inflation (INF_t) and output gap (OG_t) in any direction. Hence we can conclude that the data does not warranty the existence of Philips curve type of relationship between Inflation and unemployment rate in India and therefore the policy makers in India need to be cautious in using the theory of Philips curve for any development and growth policies.

NOTES

1. The natural rate of unemployment is a combination of frictional (the unemployment which exists in any economy due to people being in the process of moving from one job to another) and structural unemployment (unemployment resulting from industrial reorganization, typically due to technological change, rather than fluctuations in supply or demand) that persists in an efficient, expanding economy when labor and resource markets are in equilibrium.
2. Cyclical unemployment is a factor of overall unemployment that relates to the cyclical trends in growth and production that occur within the business cycle. When business cycles are at their peak, cyclical unemployment will be low because total economic output is being maximized.
3. Persons who, owing to lack of work, had not worked but either sought work through employment exchanges, intermediaries, friends or relatives or by making applications to prospective employers or expressed their willingness or availability for work under the prevailing conditions of work and remuneration, were considered as those 'seeking or available for work' (or unemployed).

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