CHAPTER –III

RESEARCH METHODOLOGY

3.1 Research Design

The study is empirical and causal in nature which provides insights into and an understanding of the various concepts related to inflation and money supply growth in India and attempts to reveals the interaction amongst them.

3.2 Data Description and Model Formulation

The study is based on secondary data. There is no comprehensive source of entire data used in the study. The data used in this study was therefore obtain from multiple sources. The fouth chapter is used only the growth variation, average, correlation and standard deviation for using the panel data from1970 to 2016. In the fifth chapter will analyse the study of vector error correction model with separate sheet and e-views 9.5 software is used to analyse the data. Four models are formulated on the basis of a wide range of literature of review. The time series data are used for the period of 46 years from 1970-71 to 2015-16 respectively for the analysing the contribution of money supply and inflation growth in India.

INFL = f (M1, M3, R, V1, V3, YG)

The above function provides information that, inflation is determined by growth rate of Narrow and Broad Money, rate of Interest, Velocity of money based on Narrow and Broad Money Supply and GDPat Market Price.

Table 3.1 Description of Variables

Variables	Definitions
INFL	Inflation Rate based on WPI
M1	Growth rate of M1- Narrow Money Supply
M3	Growth rate of M3- Broad Money Supply

R	Rate of Interest on Medium Term Deposit
V1	Velocity of Money base on Narrow Money
V3	Velocity of Money base on Broad Money
Y	GDP at Market Price

Considering the function following equations have been framed to test the relations between the rate of inflation and the host of the explanatory variables. Various model specifications are experimented as below.

INFL= β_1 M1 + β_2 R + β_3 YG +ε ……….. (1)

INFL= β_1 M3 + β_2 R + β_3 YG +ε ……….. (2)

INFL= β_1 V1 + β_2 R + β_3 YG +ε ………… (3)

INFL= β_1 V3 + β_2 R + β_3 YG +ε ………… (4)

Table 3.2 Money Demand Specifications

Sr. No.	Dependent Variable	Independent Variables
1.	INFL	M1, R, YG
2.	INFL	M3, R, YG
3.	INFL	V1, R, YG
4.	INFL	V3, R, YG
5.	β, β2, β3	The Parameter of the study
6.	E	The Error Term

3.3 Unit Root test

The prime assumption of time series technique is to examine the stationary of the data for the variables taken in the study. The stationary of data has been characterized by a time variant mean and variance. If mean and variance of a data are constant then the data is called stationary. To avoid the problems of spurious regression, it is necessary to confirm whether a stationary co-integration relationship among the variables.. All these models are used for the examination of unit root.

The stationary point is the unit root stochastic process that we discussed in the following way

$\Delta Yt = (Yt - Yt\text{-}1) = \mu t$……………………….(1)

$(-1 \leq p \geq 1)$

T= time or trend variable, μt is the error term. Null hypothesis is that $\delta = 0$, there is a unit root we can say the time series is stationary whereas alternative hypothesis is that $\delta \leq 0$ that is the time series is stationary.

3.4 ADF (Augmented Dickey Fuller) Test

This study has applied Augmented Dickey Fuller (ADF) test to check the stationary of the variables. The stationary test has been carried out at the level as well as at their first and second difference. There are three models of ADF test which are intercept, trend and intercept and no trend and no intercept.

The ADF for the non- stationary of a series is done for the following three forms of data series

$\Delta Yt = \alpha Yt\text{-}1 + Ut$……………………………….. (2)

$\Delta Yt = \beta 1 + \delta Yt\text{-}1 + Ut$…………………….. (3)

$\Delta Yt = \beta 1 + \beta 2t + \alpha Yt\text{-}1 + Ut$………………………………………………………… (4)

$\alpha Yt = \alpha Yt\text{-}1 + \alpha i \sum \alpha Yt\text{-}i + \varepsilon t$………………………... (5)

$\alpha Yt = \beta 1 + \delta Yt\text{-}1 + \delta i \sum \alpha \Delta Yt\text{-}1 + \varepsilon t$…………………... (6)

$\alpha Yt = \beta 1 + \beta 2t + \delta Yt\text{-}1 + \alpha i \sum \alpha \Delta Yt\text{-}I + \varepsilon t$…………………………………………... (7)

Where

ΔYt is the first difference of the series Yt, αi, $\beta 1$, $\beta 2$ are the parameters to be estimated.t is the time or trend variable, εt is the noise term.

The ADF test the null hypothesis (H0) against the alternative (H1) hypothesis;

H0: Each variable has a unit root, $\delta = 0$

H1: Each variable does not have a unit root, $\delta \neq 0$

3.5 Johansen co-integration test

It deals with long run relationship between the variables of the study. To examine the long run relationship between money supply and inflation Johansen co-integration test has been utilized in this study. This test is based on Trace statistics and max statistics. When there are more than two variables in a model, the number of co-integrating vectors can be more than one. In fact for number of variables there can be up to n-1 co-integrating vectors. This problem cannot be resolved by the Engel- granger single equation. Since we have five variables in this model, Johansen approach for multiple equations in adopted here. Considering in the variables all are to be endogenous, a vector auto regression model with higher order. Which is written in order below.

$Xt = A1Xt\text{-}1 + A2Xt\text{-}2 + \ldots + ApXt\text{-}p + et$………………………………… (8)

$Xt = (n \times 1)$ vector (X1t, X2t,……….Xnt)

εt = independently and identically distribute dimensional vector with zero mean and variance matrix $\sum \varepsilon$. This equation can be reformulated in a vector error correction model (VECM).

$$\Delta Xt = \prod Xt\text{-}1 + \sum_{i=1}^{p-1} \prod i \Delta Xt\text{-}1 + \varepsilon t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

Where $\prod = -(1- \sum_{i=1}^{p-1} Ai)$ and $\prod i = -\sum_{j=i+1}^{p-1} Aj$

This shows the rank of the matrix ∏, the rank of ∏ is equal to the number of independent co- integrating vectors. Clearly it rank of (∏) = 0, the matrix is null hypothesis is the usual VAR model in first difference. If ∏ is of rank n, the vector process is stationary. Intermediate class, if rank (∏) =1, there is single co-integration vector and the expression ∏ Xt-1 is the vector correction model. For the other cases in which 1< rank (∏<n, there are multiple co integrating vectors, Johansen (1988) and Johansen and Juselius (1990) suggest two tests for determining the number co-integrating vectors. In practice only estimates of ∏ and its characteristics roots can be obtained.

$$\lambda trace\ (r) = -T\sum_{i=r+1}^{n} Ln(1-\lambda) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(10)$$

And

$$\lambda max\ (r, r+1) = -T\ Ln\ (1-\lambda\ r + 1) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

Where λi = the estimated values of the characteristic roots (Eigen values) obtained from the estimated ∏ matrix, T =number of observations.

The first statistics tests the null hypothesis that the number of distinct co-integrating vectors is less than or equal to r against the alternative hypothesis that co-integrating vectors is greater than r. the second statistics tests the null hypothesis that the number of co-integrating vectors is r against the alternative of r+1 co integrating vectors.

3.6 Granger Causality Test

It deals with the causal relationship between the variables of the study. It does not only examine the causality but also it checks the direction of the causality. In this study causality has been examined between money supply and inflation. Two time series variable of x and

y. X is said to Granger cause Y. If Y can be better predicted using the histories of both X and Y then it can by using the history of Y alone.

$Y_t = a_0 + a_1 Y_{t-1} + \ldots + a_p Y_{t-p} + b_1 X_{t-1} + \ldots + b_p X_{t-p} + U_t$ ………………..(12)

$X_t = C_0 + C_1 X_{t-1} + \ldots + C_p X_{t-p} + d_1 Y_{t-1} + \ldots + d_p Y_{t-p} + U_t$ …………….... (13)

$H_0: b_1 = b_2 = \ldots = b_p = 0$

Ha: Not H0 is a test that x does not granger cause of Y.

$H_o: d_1 = d_2 = \ldots = d_p = 0$

Ha: Not H0 is a test does not granger cause X.

Rejection of the null hypothesis in each cause implies there is granger causality. Granger causality test helps to finding the forecasting ability of variables. Evaluating past values of a variables help in predicting the future values of another variables under the null hypothesis is not having Granger causality. In Granger Causality test for a VAR model in R computes the long run causality between the variables as also intentions causality between them. In VAR model there is a lags of money supply and inflation.M3 to WPI and GDP at MP. A bivariate Grange causality test is also done to check the Granger causality between each of the pairs of these three variables.

3.7 Lagrange Multiplier (LM) test for auto correlation

Once the causality test is completed it is necessary to examine the robustness of the model taken in this study. For this purpose it is necessary to check the presence of auto correlation and normality test of disturbance terms Lagrange multiplier (LM) test and Jarque – Bera test are applied respectively.

The Lagrange Multiplier test for auto correlation was developed by Brewch (1978) and Godfrey (1978). It investigates the auto –correlation among the variables. It became a slandered tool in applied econometrics. In this test the null hypothesis is there is no auto correlation and it can be rejected if the probability values is less than 5% level of significant.

3.8 Jarque –Bera test for normally distributed disturbances

It was developed to test normality, Heteroscedasticity and serial correlation or auto correlation of regression residuals (Jarque and Bera 1980). The statistics is this test is computed from Skewness and Kurtosis. It follows the Chi –Squared distribution with two degree of freedom. Here the null hypothesis is residuals are normally distributed which can be rejected if the probability value is less than 5%.

$JB = \frac{n-k+k}{6}(S2 + 1/4(C - 3)2$ ……………………………………………………………..(14)

n = Number of Observations (degree of freedom in general)

JB= Jarque Bera Test, S = Sample of Skewness,C =Kurtosis, k = Is the number of regressor.

3.9 Error Correction Model

The error correction mechanism used by the Sargan and popularized by the Engel and Granger corrects for disequilibrium. An important theory which is represented by the Granger representation that if two variables x and y are co-integrated then the relationship between the two can be expressed as ECM method. It is used for the specified variables, the short run dynamics is examined using the ECM. This model also used the long run equilibrium after the short run. The ECMt-1 past error term will explore the feedback relationship among variables. It will shows the long run relationship between money supply and other variables like WPI, GDP at MP, Broad money ,Narrow money and Other demand deposits. Some error correction model are directly implied y the Granger theorem. ADL91,1) model:

$Yt = \alpha0 + \alpha1Yt\text{-}1 + \beta0Xt\text{-}1 + \varepsilon t$………………………………………….(15)

$Yt = \alpha0+\alpha1Yt\text{-}1+\beta0Xt\text{-}1+\varepsilon t+Yt\text{-}1+Xt\text{-}1+\beta0Xt\text{-}1–\beta0Xt\text{-}1\text{-}\beta Xt\text{-}1+\alpha Xt\text{-}1–\alpha1Xt1$…….(16).

Rearrange this ECM model as

$$\Delta Yt = (\alpha1\text{-}1)\ (Yt\text{-}1) - \frac{\alpha0\ -\ \beta0 + \beta1\ Xt\ (Xt\text{-}1) + \beta0\Delta Xt + \varepsilon t}{(1\text{-}\alpha1)(1\text{-}\alpha1)}$$

…………………………………………………………………….(17)

Estimation the cointegration relationship with using different variables and lagged residuals from the co integrating relationship. When $(\alpha1\text{-}1) < 0.> 0$ is the disequilibrium expands.= 0 no error correction.

(-1;0) error correction close to 0:slow, close to 1.

-1 is the full error correction in 1 period.

< -1 is the overshooting, oscillory, adjustment of the variables.

This above models are coming from different literature study and the books. The total model is fit for the study of money supply and inflation in India: An Empirical Evidence.