Impact of REPO Rate on Inflation In India

Susmita Das[*1]; Debjani Mitra[*2]
Dept. of Economics
Bijoy Krishna Girls' College, Howrah
5/3 M.G Road, Howrah-711101, West Bengal, India
[*1]susmita.327das@gmail.com; [*2]mitrdebjani@gmail.com

Abstract: Repo or repurchase transaction is a collaterized lending i.e. banks borrow money from Reserve Bank of India to meet short term needs by selling secuirities to RBI with an agreement to re-purchase the same at predetermined rate and date. Here we are taking repo rate as a specific part of this monetary policy. On the olther hand, inflation occurs when general price level is rising. In this field we want to develop the relationship between repo rate and inflaion. Basically, the main thing is to observe that how repo rate is depend on inflation. Here, we have used secondary data over the years. Using some statistical tools we have got that repo rate is positively dependent with inflation. In this study we also test our observed value in 99% confidence level. The result is that repo rate is positively related to inflation at 1% level of significance.
Keywords: Repo rate; Inflation; JEL Classification: E52, E31

I. INTRODUCTION

The Reserve Bank of India (RBI) is the central bank of India. The RBI, like any other central bank, performs almost all traditional central banking functions. One of these functions is to control money supply. The RBI pursue monetary policy refers to that part of public policy to control inflation. The major objective of monetary policy is controlled expansion. Monetary policy has to make a judicious balance between price stability and economic growth. RBI uses the bank rate, the repo rate, the reverse repo, Cash Reserve Ratio (CRR) and Statutory Liquidity Ratio (SLR) as monetary policy.

The Reserve Bank of India

The Reserve Bank of India was established as a shareholders' bank on April 1, 1935. After 14 years RBI was nationalized on January 1,1949 as central bank of India by the Indian government to initiate the process of development. Four major functions of RBI is as follows –

1. Currency authority: The RBI has the sole right to issue currency other than one rupee notes and coins and other small coins (which are issued by the GOI).
2. Bankers to government: RBI is in charge of all banking business of the central as well as state governments. It transacts money on account of these governments carries out their banking operation like remittances and exchange. The RBI gives advices to the government about loans and financial markets.
3. Banker's bank: Under the Reserve Bank of India Act, 1934 the RBI has been vested with extensive power to control commercial banks, lends funds to them in need and keeps notice on their activities.
4. Foreign exchange control: Another important function is to stabilize exchange value of rupee. In 1947, by the Foreign Exchange Regulation Act (FERA) it became a crucial function of the RBI to control and manage the foreign exchange. Now, it is replaced by Foreign Exchange Management Act (FEMA).

Other functions of RBI are :

5. Credit control: This is another important function of RBI. As RBI has the sole right to issue currency note it plays many role in the financial market. It issues many monetary policies to control credit expansion, price stability and development. RBI has also the control over bank's credit.
6. Agricultural finance: This function has particular significant role in agriculture country like India. To meet the requirement of the agricultural finance role RBI took the initiative to setting up of a special agricultural credit department. Latter the setting up of the NABARD on July 12, 1982, the major functions of the agriculture credit department of the RBI were taken over by the former.
7. Collection and publication of data: The RBI does the collection and compilation of statistical information of banking, financial market of the economy. For example, RBI Bulletin is a monthly publication. They publish many data in Annual, Half-yearly, Quarterly, Bi-monthly, Monthly, Weekly and Occasional.

Instruments of Monetary policy

Monetary policy refers to that part of public policy perused by a central bank that influences monetary and other financial conditions with the broader objectives of price stability, sustainable growth and high employment. This policy changes overtime in tune with development in economic theory. Central bank (RBI) has some instruments to frame its monetary policy. These policies pertain to day-to-day implementation by RBI. Monetary policy can broadly be classified into direct and indirect instruments. Direct instruments are Cash Reserve Ratio (CRR), Statutory Liquidity Ratio (SLR), administered interest rates and directed credit. CRR is a certain percentage of total bank deposit which has to keep with RBI and which bank cannot lend to anyone. Similarly, SLR claims banks to maintain a part of their deposit in form of liquid assets (e.g. government secuirities). Administered interest rates and directed credit acts as a normative economics, it takes the form of prescribed targets for allocation of credit among sectors. Direct instruments are effective; these are considered inefficient as these are not guided by the financial market. On the other hand, indirect instruments are Repurchase Transaction (Repo), Reverse repo, Open Market Operation (OMO), Standing facilities (Refinance), Market based discount window (Bank rate). Repo and reverse repo are under LAF adjustment. These two instruments and OMO are in form of outright purchases/sales of government secuirities. The use of indirect instrument depends the development of supporting financial market and institution and these instruments are usually directed at attaining a prescribed value of operating target.

Repurchase transaction

LAF (Liquidity Adjustment facility) consists of repo and reverse repo operation. Therefore, repo rate is one of the component of LAF. Repo or repurchase transaction is a collaterized lending i.e. banks borrow money from Reserve Bank of India to meet short term needs by selling secuirities to RBI with an agreement to re-purchase the same at predetermined rate and date. The rate charged by RBI for this transaction is called repo rate. Therefore, repo operation inject liquidity into the system. The collateral used for repo is government of India secuirities. It is a form of short term borrowing mainly in government secuirities. The dealer sells underlying security to investors and buys them back shortly afterwards usually the following day-to-day, at a slightly higher price.

Inflation

Inflation occurs when the general level of prices is rising i.e. value of money goes down. This imply that purchasing power fall. There are three types of inflation: (I) Low inflation (ii) Galloping inflation, (iii) Hyper inflation.

Inflation affects the distribution of income and wealth because of differences in the assets and liabilities that people hold. Not only the distribution of income and wealth it affects the real economy. It can harm economic efficiency and it can affect the total output as well. Rising price is not good for the economy. As the value of money decreases inflation occurs at high rate. Excessive money supply brings this situation to the economy which is harmful. Higher inflation is a sign of bad situation. People spend more money to get little amount of goods and services. That implies it increases consumer spending across the economy. People lost trust on money. Holding money balance become more costly with the rise in inflation. So people holds less money thus shoe leather cost of inflation goes up. In this situation borrowers are happier than lenders for rising prices because repayment is lighter than it was previous. It affects both real interest rate and nominal interest rate. Government wants to control this expansion using monetary policies.

Objectives of this study

- Examine the relationship between repo rate and inflation in India
- Effects of inflation on repo rate.

II. LITERATURE REVIEW

There are some brief discussion related to monetary policy and inflation collected from some books.

Sir B. Rama Rau (1960) emphasizes the fact of monetary policy in the context of inflation in India during and after Second World War. In this book he shows the inability of the Central bank (RBI) in controlling expansion. During the war and post war period India faces inflationary pressure. According to him the causes were (I) the failure of the rate of production, mainly of food grains, to keep pace with the growth of the population and (ii) deficit financing and other government policies which caused the increase in money supply with population. He also discussed the steps taken by the Reserve Bank of India through monetary policy, calls for caution in the matter of deficit financing for combating inflation.

Vail, C.N. (1966) describes the devaluation of rupee in1966 which resulted in price rise in the country. According to him, the factors responsible for the continuously rising prices in India were plan expenditure on projects including long time periods, increasing deficit financing. He explains in a simple language the background and implications of the devaluation of rupee to the people and suggests many measures to avoid inflationary price rise and devaluation of rupee.

Reddy, Y.V. (2000) states that the period 1950-51 to 1997-98 has been satisfactory. According to him, the inflation rate in India has also been far less volatile than in most developing countries. He also mentions that higher inflation were felt on almost all occasions due to exogenous shocks such as oil price hike, the gulf crisis and wars and domestic supply shocks such as monsoon conditions.

Simha, S.L.N. (1974) makes an attempt to study the link between black money and inflation. He examines to what extent black money contributes to inflation or whether in fact it is a result of inflation. According to him, the phenomenon of black money is, by and large, the result of inflation and not its cause. He thus disproves the thesis that black money is the cause of inflation and presents the proposition that black money, if anything, is a result of inflation which is caused largely by wrong fiscal, monetary and economic policies, and aggravated by administrative inefficiency, poor planning, lack of a sense of discipline and austerity and a general lowering of standards of vigilance at all levels.

Simha, S.L.N. (1974) explains the impact of govt. borrowing from R.B.I., commercial banks and non banking sector on money supply and inflation. His conclusions from his study are: i) govt.'s borrowing from the RBI (i.e. RBI investment in govt. securities) is doubly inflationary. In other words it increases money supply not by the amount of investment by RBI in govt. securities but by something more. ii) govt.'s borrowing from the commercial banks (i.e. commercial banks investing in govt. securities) is also inflationary as it increases the money supply by the amount of investment. iii) borrowing by the govt. from the non banking sector (i.e. non banking sector's (household & corporate sector) investment in govt. securities) is however, non-inflationary, as its impact on money supply is neutral.

Singh, Bal want (1989) challenges the proposition that changes in the price level are primarily the result of changes in the rate of growth of money. He, using the data on broad money (M3) and movements in the wholesale price index, reaches a conclusion that "in the Indian setup, there is a bi-directional causality between money supply and prices. However, the impact of money supply (M3) on prices (WPI) is less significant in terms of granger causality tests. This suggest that the causality between prices and money supply is of certainty in nature, i.e. rise in prices invariably leads to rise in money supply. As against this, the rise in prices may not be always due to the rise in money supply". In his opinion, in the Indian conditions much of the variation in prices is due to structural influences, e.g. crop failures, commodity shortages, administrated pricing policies etc. rather than a result of monetary operations only.

Rangarajan, c. And Arif R.R. (1990) offer an econometric model for the Indian economy, which explains the interrelationship between money, output and prices. The model links the monetary and the fiscal sector and allows for the stock of money to vary endogenously with fiscal deficits. The empirical results arrived at indicate that the price effects of an increase in money supply are stronger than the output effects

Sinha, Surojit(1998) explores the possibility of a correlation between the government budget deficits and inflation in India, by using the data for the period of nine years from 1987 to 1996. He finds no positive correlation between the two and therefore concludes that budget deficits are not inflationary in India. According to him, in fact a negative correlation exists between budget deficits and inflation in India. He also studies the impact of debt/bond financing of budget deficit on inflation.

Government of India (2002)discusses the trend in inflation in India since 1050 and states that the WPI inflation remained below 7% during 1950's & 1960's, but accelerated to touch double digit figures in the first half of 1970's. Though the inflation moved southward during the second half of 1970's, it remained elevated until 1995-96. It states that inflation has however remained at a low level from 1995-96 onwards in terms both the 52 week average and point-to-point basis.

Reserve bank of India(2005) makes an assessment of inflation record of India during the past half century. It that the inflation increased from the 1970's onwards and started moderating in the mid-1990's. Large and unsustainable fiscal deficit and its monetization were the primary factors responsible for the higher inflation, maintains the report. It attributes the lower inflation since the mid-1990's to better monetary management made possible by the structural reforms since19991, improvement in monetary-fiscal interface and reforms in govt. securities market. It also underscores the importance of fiscal consolidation for keeping inflation and inflationary expectations under control.

III. METHODOLOGY

In this paper we want to see the relation between Repo rate and Inflation. For this we will use some data and statistical tools. Our preliminary work is to see repo rate and inflation data over the time. After this we will discuss about methods.

To conduct inflation data we use the consumer general price index. As we know that, **Inflation** = $\frac{(\text{CPI current year} - \text{CPI previous year})}{\text{CPI previous year}} \times 100$ Now using this formula we compute inflation data as follows –

(percent)		
Year	**CPI(new combined)**	**Inflation**
1	**2**	**3**
2011-12	93.3	...
2012-13	102.7	10.07
2013-14	112.3	9.35
2014-15	118.9	5.88
2015-16	124.7	4.88
2016-17	130.3	4.49
2017-18	135	3.61

Source: rbi.org.in

Here, this is new CPI, which was introduced from January 2011. Data for this series are available for Base: 2012= 100.

Now, we need the data for Repo rates. Here we have taken fix range of LAF from the year 2013 to compare with inflation. These repo rates are imposed frequently by RBI. For this reason, we may have many changes in repo rate in one particular year. So, we will use Arithmetic Mean (A.M) of the repo in each year to get a specific value for the single year. The tables are as follows:

Table of fix range LAF rates:

(percent)		
Effective Dates	**Fix Range LAF Rates**	
	Repo	**Reverse**
1	**2**	**3**
29-01-2013	7.75	6.75
19-03-2013	7.50	6.50
03-05-2013	7.25	6.25
20-09-2013	7.50	6.50
29-10-2013	7.75	6.75
28-01-2014	8.00	7.00
15-01-2015	7.75	6.75
04-03-2015	7.50	6.50
02-06-2015	7.25	6.25

29-09-2015	6.75	5.75
05-04-2016	6.50	6.00
04-10-2016	6.25	5.75
06-04-2017	6.25	6.00
02-08-2017	6.00	5.75
06-06-2018	6.25	6.00
01-08-2018	6.50	6.25

Source: rbi.org.in

Appling A.M for each year:

(Per cent)		
Years	**Average of Repo**	**Average of Reverse**
1	**2**	**3**
2013	7.55	6.55
2014	8.00	7.00
2015	7.31	6.31
2016	6.38	5.88
2017	6.13	5.88
2018	6.38	6.13

Now, we want to see the relation between inflation and repo rate. To check that we will use correlation coefficient. here we have taken inflation as variable *x* and repo rate as variable y so, the formula is as follows –

Correlation coefficient (r_{xy}) = $\frac{\mathrm{cov}(x,y)}{\sigma_x \sigma_y}$

This value is a measure of degree of *association* between two variable. For comparing two series of observations, it is sometimes necessary to determine whether they are associated or not, and to establish relations of cause and effect.

After that we want to see how the variable *x* i.e. inflation is regressed on the variable y i.e. repo rate. To see that result we have to find the regression equation. Regression of a variable y on another variable *x* we mean the dependence of y on *x*, on the average. So, the methods of regression equation of y on *x*is,

y - $\bar{y} = b_{yx}$ (x - $\bar{x}$)

or, y = $\alpha + \beta x$

where, $b_{yx} = \frac{cov(x,y)}{\sigma_x^2} = r_{xy}\frac{\sigma_y}{\sigma_x}$. This equation is used to estimate y, when the value of *x* is known.

Regression is used to denote estimation or prediction of the average value of one variable for a specified value of the other variable. That coefficient appearing in the regression equation of y on *x* is known as the *Regression coefficient* of y on *x*. The geometrical representation of linear regression equation is known as *Regression line*. This line is "best fitting" straight line obtained by the Method of Least Squares.

Now, we will use Method of Least Squares to choose $\hat{\alpha}$ and $\hat{\beta}$ as estimates of α and β respectively, so that Q = $\sum_{i=1}^{n}(y_i - \hat{\alpha} - \hat{\beta}x_i)^2$ is minimum. Here Q is the sum of squares of the prediction errors when we predict y_i given x_i and the estimated regression equation. Normally, we will want to reduce errors. So to minimize Q with respect to $\hat{\alpha}$and $\hat{\beta}$, we equate its first derivatives with respect to $\hat{\alpha}$ and $\hat{\beta}$ to zero.

$\frac{\partial Q}{\partial \hat{\alpha}} = 0$ or, $\sum_{i=1}^{n} 2(y_i - \hat{\alpha} - \hat{\beta}x_i)(-1) = 0$

Or, $\sum_{i=1}^{n} y_i = n\hat{\alpha} + \hat{\beta}\sum_{i=1}^{n} x_i$

Or, $\bar{y} = \hat{\alpha} + \hat{\beta}\bar{x}$.....(1)

And, $\frac{\partial Q}{\partial \hat{\beta}} = 0$ or, $\sum_{i=1}^{n} 2(y_i - \hat{\alpha} - \hat{\beta}x_i)(-x_i) = 0$

Or, $\sum_{i=1}^{n} x_i y_i = \hat{\alpha}\sum_{i=1}^{n} x_i + \hat{\beta}\sum_{i=1}^{n} x_i^2$.....(2)

These equation (1) and (2) called the normal equations. Now, substituting the value of $\hat{\alpha}$ from equation (1) into equation (2), we get

$\sum_{i=1}^{n} x_i y_i = \sum_{i=1}^{n} x_i (\bar{y} - \hat{\beta}\bar{x}) + \hat{\beta}\sum_{i=1}^{n} x_i^2$

Or, $n\bar{x}(\bar{y} - \hat{\beta}\bar{x}) + \hat{\beta}\sum_{i=1}^{n} x_i^2$

Let us define, $S_{yy} = \sum_{i=1}^{n}(y_i - \bar{y})^2 = \sum_{i=1}^{n} y_i^2 - n\bar{y}^2$

$S_{xy} = \sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y}) = \sum_{i=1}^{n} x_i y_i - n\bar{x}\bar{y}$

And $S_{xx} = \sum_{i=1}^{n}(x_i - \bar{x})^2 = \sum_{i=1}^{n} x_i^2 - n\bar{x}^2$

Then equation (2) can be written as

$\hat{\beta}S_{xx} = S_{xy}$ or, $\hat{\beta} = \frac{S_{xy}}{S_{xx}}$

Hence the Least Square estimator of α and β are

$\hat{\beta} = \frac{S_{xy}}{S_{xx}}$ and $\hat{\alpha} = \bar{y} - \hat{\beta}\bar{x}$

So, the estimated errors or residuals are

$\hat{u}_i = y_i - \hat{\alpha} - \hat{\beta}x_i$

So, our main objective is to get minimum value of the sum of residual i.e. the sum of residuals tends to be zero then this estimated values are best fitted.

The residual sum of squares (RSS) is given by,

$$RSS = \sum_{i=1}^{n}(y_i - \hat{\alpha} - \hat{\beta}x_i)^2$$

$$= \sum_{i=1}^{n}[y_i - \bar{y} - \hat{\beta}(x_i - \bar{x})]^2$$

$$= \sum_{i=1}^{n}(y_i - \bar{y})^2 + \hat{\beta}^2\sum_{i=1}^{n}(x_i - \bar{x})^2 - 2\hat{\beta}\sum_{i=1}^{n}(y_i - \bar{y})(x_i - \bar{x})$$

$$= S_{yy} + \hat{\beta}^2 S_{xx} - 2\hat{\beta}S_{xy}$$

$$\hat{\beta} = S_{xy} / S_{xx}$$

But , we have

$$RSS = S_{yy} - \frac{S_{xy}^2}{S_{xx}} = S_{yy} - \hat{\beta}S_{xy}$$

Now, denoting new terms

S_{yy} = Total Sum of Squares (TSS)

$\hat{\beta}S_{xy}$= Explained Sum of Squares (ESS)

Then, **TSS = ESS + RSS**

Now, coming to the problem of hypothesis testing, we want to test the hypothesis for the true value of $\hat{\beta}$.

We know that $t_0 = \frac{\hat{\beta} - \beta}{SE(\hat{\beta})}$ has a t- distribution with (n-2) degrees of freedom.

To calculate SE($\hat{\beta}$) $= \sqrt{var(\hat{\beta})}$

$$= \frac{S_u}{\sqrt{\sum_{i=1}^{n} x_i^2}}$$ here, S_u is an unbiased estimator of σ

Here, $S_u^2 = \frac{RSS}{n-2}$

For this hypothesis testing the null hypothesis of no relationship between *x* and y is $H_0 : \beta = 0$ and we have to test it against the alternative hypothesis $H_1 : \beta > 0$.

This hypothesis testing shows that our alternative hypothesis is accepted or rejected at $\alpha\%$ level of significance i.e. the tabulated value of $t_{\alpha,n-2}$ has to be compare with the observed value t_0. If null hypothesis is accepted then these variables has no relation. To check this with certain confidence level we use this hypothesis testing.

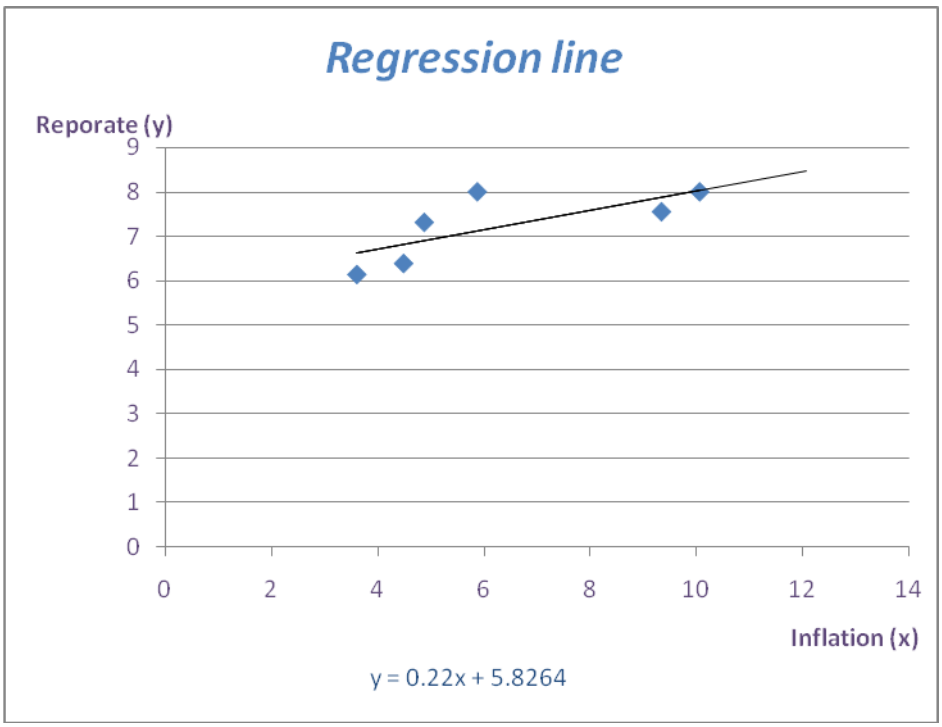
IV. ANALYSIS

Our aim is to develop the relation between inflation and repo rate. For this we have already discussed about the statistical tools what we used before. The **correlation coefficient** shows that the relation between these two economic variables. We have taken inflation in x-axis and repo rate in y-axis i.e. here inflation is an independent variable and repo rate is dependent variable. Calculating this our result is as follows –

r_{xy}= 0.74 (Appendix-1)

This implies they are positively correlated i.e. if inflation increases repo rate tends to increase. As we know correlation coefficient lies between -1 to 1. So, as we can see repo rate is much positively dependent on inflation.

Now, the **regression equation** is, y = 0.22x + 5.8264 which shows how the variable y is dependent on *x* . The regression line is given below – (Appendix-2)



This regression line shows the linear dependency between inflation and repo rate. Slope of this line implies the correlation coefficient i.e. the association between these two variables.

Now, using **method of least square** first we derive estimated residuals which show the different between given v_i and estimated $\hat{y}$. These residuals are denoted by i_n to calculate this $\hat{y}$ using normal equations we derive $\hat{\alpha}$ and $\hat{\beta}$ which is the estimated value of α and β respectively. So, our optimum position is to have a minimum value of the total residuals.

Here, $\sum_{i=1}^{n} u_i = -0.01$ (Appendix-3)

So, sum of the residuals is tends to zero. Here the sum of residuals are minimum. This method shows that this regression line is "best fitting" line.

For **hypothesis testing** we want to test the hypothesis for the true value of $\hat{\beta}$ using t-statistics.

The null hypothesis is $H_0: \beta = 0$ i.e. *x* (inflation) and y (repo rate) has no relation against the alternative hypothesis is $H_1: \beta > 0$ i.e. *x* (inflation) and y (repo rate) is positively related.

$t_0 = 5.5$ (Appendix-4)

t_0 is the observed value from the testing of hypothesis. At 1% level of significance from t table we obtain the value of $t_{0.01,4} = 3.75$. This implies $t_0 > t_{0.01,4}$ i.e. observed value exceeds the critical value. Hence, we reject null hypothesis (H_0) at 1% level of significance and accept alternative hypothesis (H_1) for 99% confidence limits.

Throughout this process we get a clear vision about the relationship between inflation and repo rate. Repo rate is much dependent on inflation and here we have seen that how repo rate is regressed on inflation as well. In this framework we have got minimum the sum of residuals which is good. The hypothesis testing result shows that inflation and repo rate are positively related and it is proved for 99% confidence limits.

V. CONCLUSION

Our entire target was to develop the relationship between inflation and repo rate. In this frame work we know that repo rate is positively dependent on inflation. That means, as inflation increases RBI increases the repo rate. It helps to control expansion. Inflation is devalued of rupee. So, commercial banks needs more money to meet short term needs. For this they sell government securities to RBI with an agreement to repurchase that at predetermined repo rate and date. So repo rate inject money to the economy. Imposing this repo rate on the commercial bank RBI accrue money from the economy slowly. So higher inflation implies higher repo rate. Increase in the repo rate increase the cost of borrowing so commercial banks are then less interested to lend money to public. On the other hand when commercial bank purchases government security from the RBI then reverse repo rate is paid by the RBI to the commercial bank. Hence, from our study we can say that repo rate is a good instrument of RBI to control inflation.

VI. REFERENCES

1. Basu, K., & Maertens, A. (2010). *The concise Oxford companion to economics in India*. Oxford University Press.
2. Das, N. G. (1991). Statistical methods in commerce. *Accountancy and economics, M. Das & Co., Kolkata. Part–pp*, 269-300.
3. Govt. of India (2002): "Economic Survey", 2001-02. Govt. of India, New Delhi.
4. Maddala, G. S., & Lahiri, K. (1992). *Introduction to econometrics* (Vol. 2). New York: Macmillan.pp.68-80
5. Rangarajan, C., & Arif, R. R. (1990). Money, output and prices: A macro econometric model. *Economic and Political Weekly*, 837-852.
6. Reserve Bank of India. (2008). *Handbook of statistics on Indian economy*. The Bank.
7. Reddy, Y. V. (2000). *Monetary and Financial Sector Reforms in India: A Central Banker's Perspective*. UBS Publishers' Distributors.
8. Reserve Bank of India. (2004). *Report on Currency and Finance 2003-04*. Reserve Bank of India.
9. Samuelson, P.A. and Nordhaus, W.D. : "Economics" Indian adaptation by Sudip Chaudhuri and Anindya Sen, McGraw Hill Education (India) Private Limited, New Delhi, Nineteenth Edition, chapter-30, pp. 793-800.
10Singh, B. (1989). Money supply-prices: Causality revisited. *Economic and Political Weekly*, 2613-2615.
11. Sinha, Surojit (July, 1998): "Are Budget Deficits Inflationary?" Yojana, Vol. 42, No. 7, pp. 8-10.
12. Sir B. Rama Rau (1960): "Evolution of Central Banking in India", Vora and Co. Publishers Pvt. Ltd., Bombay, pp. 35-61.
13. Vakil, C.N. (1966): "The Devaluation of the Rupee: A Challenge and An Opportunity", Lalvani Publishing House, Bombay.

APPENDIX

Table for calculation:

(percent)

Year	Inflation x	Repo rate y	xy	X^2	Y^2
2012-13	10.07	8	80.56	101.4049	64
2013-14	9.35	7.55	70.5925	87.4225	57.0025
2014-15	5.88	8	47.04	34.5744	64
2015-16	4.88	7.31	35.6728	23.8144	53.4361

2016-17	4.49	6.38	28.6462	20.1601	40.7044
2017-18	3.61	6.13	22.1293	13.0321	37.5769
Total	38.28	43.37	284.6408	280.4084	316.7199

For correlation coefficient: **(Appendix-1)**

$r_{xy} = \frac{cov(x,y)}{\sigma x \sigma y} = \frac{\frac{1}{n}\sum_{i=1}^{n} x_i y_i - \bar{x}\bar{y}}{\sigma_x \sigma_y}$

Now, $\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} = \frac{38.28}{6} = 6.38$

$\bar{y} = \frac{\sum_{i=1}^{n} y_i}{n} = \frac{43.37}{6} = 7.23$

$\sigma_x = \sqrt{\frac{\sum_{i=1}^{n} x^2}{n} - (\bar{x})^2} = \sqrt{\frac{280.4084}{6} - (6.38)^2} = 2.46$

$\sigma_y = \sqrt{\frac{\sum_{i=1}^{n} y^2}{n} - (\bar{y})^2} = \sqrt{\frac{316.7199}{6} - (7.23)^2} = 0.72$

$\therefore r_{xy} = \frac{(\frac{1}{6} \times 284.6408) - (6.38 \times 7.23)}{(2.46 \times 0.72)} = 0.74$

For regression equation: **(Appendix-2)**

$y - \bar{y} = b_{yx}(x - \bar{x})$

or, $y - 7.23 = r_{xy}\frac{\sigma_y}{\sigma_x}(x - 6.38)$

or, $y - 7.23 = 0.74 \times \frac{0.72}{2.46}(x - 6.38)$

or, $y - 7.23 = 0.22\,(x - 6.38)$

or, $y = 0.22x - 1.4036 + 7.23$

or, $y = 0.22x + 5.8264$

∴the regression equation is, $y = 0.22x + 5.8264$

For method of Least Square : **(Appendix-3)**

From the above table we get

$S_{yy} = \sum_{i=1}^{n} y_i^2 - n\bar{y}^2 = 316.7199 - \{6 \times (7.23)^2\} = 3.0825 \cong 3.10$

$S_{xy} = \sum_{i=1}^{n} x_i y_i - n\bar{x}\bar{y} = 284.6408 - (6 \times 6.38 \times 7.23) = 7.8764 \cong 7.88$

$S_{xx} = \sum_{i=1}^{n} x_i^2 - n\bar{x}^2 = 280.4084 - \{6 \times (6.38)^2\} = 36.182 \cong 36.20$

$\therefore \hat{\beta} = \frac{S_{xy}}{S_{xx}} = \frac{7.88}{36.20} = 0.217679 \cong 0.22$

$\therefore \hat{\alpha} = \bar{y} - \hat{\beta}\bar{x} = 7.23 - (0.22 \times 6.38) = 5.8264$

Calculation for estimated residuals :

(percent)

Year	Inflation x	Repo rate Y	xy	x^2	y^2	u_i
2012-13	10.07	8	80.56	101.4049	64	-0.0418
2013-14	9.35	7.55	70.5925	87.4225	57.0025	-0.3334
2014-15	5.88	8	47.04	34.5744	64	0.88
2015-16	4.88	7.31	35.6728	23.8144	53.4361	0.41
2016-17	4.49	6.38	28.6462	20.1601	40.7044	-0.4342
2017-18	3.61	6.13	22.1293	13.0321	37.5769	-0.4906
Total	38.28	43.37	284.6408	280.4084	316.7199	-0.01

$\therefore \sum_{i=1}^{n} u_i = -0.01$

For hypothesis testing : **(Appendix-4)**

To do this test we need certain things as follows –

RSS = $S_{yy} - \hat{\beta} S_{xy}$ = 3.10 – (0.22 × 7.88) = 1.37

$S_u^2 = \frac{RSS}{n-2} = \frac{1.37}{6-2} = 0.34$

$\therefore S_u = \sqrt{0.34} = 0.5830 \cong 0.58$

SE($\hat{\beta}$) = $\frac{S_u}{\sqrt{\sum_{i=1}^{n} x_i^2}} = \frac{0.58}{\sqrt{280.4084}} = 0.0346 \cong 0.04$

We take, null hypothesis $H_0: \beta = 0$ against

Alternative hypothesis $H_1: \beta > 0$

$t_0 = \frac{\hat{\beta} - \beta}{SE(\hat{\beta})} = \frac{0.22}{0.04} = 5.5$

So, the observed value is $t_0 = 5.5$

At 1% level of significance $\alpha = 0.01$

$\therefore t_{\alpha, n-2} = t_{0.01,4} = 3.75$

So, t_0(observed) > $t_{0.01,4}$

Hence, we reject null hypothesis

And accept alternative hypothesis at 1% level of significance.