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An analysis of the effect of monetary policy changes on macroeconomic factors

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Abstract. *One important role of the Reserve Bank of India (RBI) or any central bank is to ensure economic stability in the country. For the purpose, the central bank adopts various measures to ensure that the inflation rates, GDP, interest rates, exchange rates, money supply and other target macroeconomic parameters remain under control. It uses reserve ratios like Cash Reserve Ratio and interest rates like Repo rates to control liquidity and inflation in the country. The effectiveness of such policies and monetary rates in ensuring economic stability needs to be verified and tested. The decision maker needs to understand the effect of these changes on the affected (targeted) variable. This research is an attempt to test and verify the effectiveness of the changes in monetary and policy rates on the desired critical variables. What is the effect and how much is the effect? Can these effects help in better policy making? These are some of the questions aimed to be addressed in the research.*
The research uses basic statistical tools such as correlation, regression and advance statistical tools such co-integration and Vector Auto Regression to study the variables and draws conclusion based on the results. The data used is from Indian economy and the time period used is 2011-2014. Monthly and quarterly data has been used as required. The research is aimed to provide information to decision makers in formulating policies and to contribute to the existing literature on the subject.

Keywords: macroeconomy, monetary policy, policy rates, central bank.

JEL Classification: G21, E1, E5.

1. Introduction

'The biggest challenge facing the conduct of fiscal and monetary policy in India is to continue the accelerated growth process while maintaining price and financial stability', Rakesh Mohan (2008).

Hutchison et al. (2012) focused on accumulation of international reserves and sterilization by the RBI using quarterly data from 1996 to 2009. Their analysis confirm that an increase in financial integration has changed the policy trade-offs facing emerging market economies like India. Mohan (2008) in his paper focuses on the role of fiscal and monetary policies in the evolution of the Indian economy over the years, with particular attention being given to the reforms undertaken in these policies since the early 1990s. He argues that monetary policy aims to maintain a judicious balance between price stability and economic growth. Palakkeel (2007) argues that apart from interest rate spread and financial deregulation, income, previous period's financial savings and inflation rate can affect compositional variation of financial assets. Gottschalk and Moore (2001) studied the efficacy of inflation targeting regime for Poland and argued that inflation targeting regime could be successful in Poland with understanding of the linkages between monetary policy and inflation outcomes with a focus on prerequisites. Khatkhate (2006) asserted that inflation targeting might be good policy framework for India as RBI always has to be on alert to maintain its credibility and authority in controlling inflation although source may often be non-monetary. The interest rate pass through process is one in which bank interest rates respond to changes in monetary policy rates. This process is simply the rate or process at which the official interest rate is transmitted to other interest rates (Kovanen, 2011). A weak and incomplete interest rate pass-through is an indication of an unhealthy financial system (Aydim, 2007) and the failure of monetary policy to stabilize macroeconomic shocks (Marotta, 2009). In order to tighten liquidity in the market, central bank interest rates are increased which further cuts back on investments by increasing cost of borrowing for banks as well as consumers. It is imperative to study the degree and speed of this change amongst interest rates. In the study conducted by Sander and Kleimerier (2006), it was found that there exists a greater response to anticipated monetary policy changes measures rather than to unanticipated changes. Aziakpono, Wilson and Manuel (2007) found market interest rates to respond quickly to monetary policy rates, the study conducted by Aziakpono and Wilson (2010) found that commercial bank's lending rates are more rigid in response to positive shocks in monetary policy official rate in South Africa. In one of the latest study by Kelulime (2014), a similar data set, as this study, was used where monthly data was used for time period 2007-2012 for regression analysis on macroeconomic factors. Suthar (2008) observed that the monetary policy intentions depicted by the bank rate of the RBI, the short-term and long-term domestic interest differentials and interest yield differentials, and the rate of change of foreign exchange reserves have a significant impact on the monthly average of the exchange rate between the rupee and the dollar indicating that the exchange rates are affected by monetary policy rates. Mishra (2013) attempted to

evaluate the independence of monetary policy in India from all the possible spheres and concludes that the inflation targeting framework may be amended and targeting inflation band rather than inflation point would be a better option for RBI.

2. Methodology and discussion

The general objective of the research is to understand the interrelationship amongst selected macroeconomic variables, specifically, in the banking sector, for effective monetary policy making. The specific objective is to understand the dynamics between monetary policy rates and ratios with inflation, liquidity and foreign exchange as the three key functions of the Reserve Bank of India (RBI) are controlling inflation, liquidity management and stabilizing foreign exchange rate. RBI has been using the policy rates such as Repurchase rate (Repo), Reverse Repurchase rate (Reverse Repo), Bank Rate and statutory ratios such as Cash Reserve Ratio (CRR) and Statutory Liquidity Ratio (SLR) to tame inflation and control liquidity in the economy but the effectiveness of this policy needs to be studied. This paper tries to understand the dynamics between monetary policy, inflation and liquidity by working on mathematical models and drawing conclusions based on the analysis.

Interest rate pass through process has been highlighted in previous researches indicating the effect of one rate over another in an economic system (Kovanen, 2011; Kelilume, 2014). References were found for and against, both, in using the level data (Ahmad and Rao, 2006) or first difference of data for analysis (Kelilume, 2014) and this given study uses first difference of data for all time series. Quarterly data for GDP has been used in the study as this data set is available from RBI (Prabheesh et al., 2006). This study also used quarterly data for GDP and related variables.

The data used in the research is for the time period January, 2011 to December, 2013. The raw data was retrieved from the RBI database. The variables used in the study are given below along with a brief description of the same. The terms in bracket indicate the acronym used in equations and SPSS analysis. Also 'Gretl' software was used as an additional tool for analysis.

Table 1. *List of variables used along with their descriptions*

1. Cash Reserve Ratio (CRR): The percent of deposits which banks have to keep with RBI as cash.
2. Repo rates (Repo): The rate of interest at which banks borrow from RBI.
3. Exchange Rate of one US Dollar in Indian rupees (USD/INR).
4. Consumer Price Index (CPI): The measure of inflation applicable on consumer prices.
5. Banking credit (Credit): The level of credit extended by banks.
6. Statutory Liquidity Ratio (SLR): The percent of deposits, which the banks are required to invest in liquid assets, excluding CRR.
7. Reverse Repo Rate (ReRepo): The rate at which the banks park their money with RBI.
8. Bank Rate (BnkRate): The long term reference rate as decided by RBI.
9. Velocity of Money (VoM): Calculated as a percentage of GDP over Broad money supply.
10. GDP: The economic dependent of the country taken as current price at base 2011-2112.

The variables used have been categorized as:

- *Independent variables*: Cash Reserve Ratio (CRR), Statutory Liquidity Ratio (SLR), Repo rates, Reverse Repo rates and Bank Rates.

- *Dependent variables*: Foreign Exchange Rate, Consumer Price Index (CPI), Banking credit, GDP, Velocity of Money.

The units of various parameters were different for different variables, varying from percentages to absolute values to index numbers. For the convenience of effective analysis, data of all the variables was worked upon for uniformity. All the variables were converted into index numbers with their initial value of the time period made as the base value at 100 and the subsequent values were converted into index number at this base. Thus, the size effect anomaly in data was eliminated by use of index numbers. These index numbers were then used to calculate monthly averages, which were subsequently used for analysis. Different variables changed in different dates thus making it difficult to compare. This anomaly of difference in dates was eliminated by calculating monthly averages. *Thus the data series for all the variables was converted into a monthly time series*. Since GDP data is available on quarterly basis, for some variables the monthly series has been further converted into quarterly series for analysis.

After the initial analysis it was observed that size anomaly is not significant and that absolute and index numbers are giving the same result. Thus subsequent analysis was done using absolute values only.

The research uses basic statistical tools such as correlation, regression and advance statistical tools such co-integration to study the effect and draws conclusion based on the results. The data used is from Indian economy and the time period used is 2011-2014. Monthly and quarterly data has been used as required. Basic statistics of monthly averages for each of the parameter is calculated. Correlation analysis is done amongst selected variables. Linear Regression analysis is done amongst few of the variables based on the research objectives considering multicollinearity. Bivariate and Multivariate regression analysis was done using level data as well as data at first difference to account for stationary and autocorrelation in regression. Here, Durbin-Watson (D-W) statistic is used to understand autocorrelations. The D-W statistic is a number that tests for autocorrelation in the residuals from a statistical regression analysis. The Durbin-Watson statistic is always between 0 and 4. A value of 2 means that there is no autocorrelation in the sample. Co-integration is found by looking at the time series graphs of the residuals of respective regressions. Cointegration analysis was done to study the relation amongst time series of variables and finally Vector Auto Regression (VAR) was done on selected variables to understand the dynamics of macroeconomic variables further including the Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD) analysis using log values of Credit, Inflation, CRR and Repo. To understand the lag effect of five macroeconomic variables for India (Inflation, GDP, Exchange rate, Interest rates and FDI), VAR methodology is followed based on Sims (1980). Thus, VAR systems were analyzed at different lags and the best VAR system was selected based on Akaike Information Criterion (AIC) based on Akaike (1981).

Correlations

Analyzing variables from Table 2, the correlation was found to be high and negative for CRR with Inflation and CRR with Credit off take of commercial banks which clearly indicates towards the 'double edged sword' which a central bank faces. If CRR is reduced, it will increase the credit off take and liquidity in the market but on the other hand it will also increase the inflation level. The correlation between Repo rates and bank borrowings from central bank was negative but medium, indicating that although reducing repo would encourage banks to borrow and increasing liquidity but the effect is not high. Bank rate and call money rates were found to be low on correlation. Bank rate and Deposits with banks were correlated on the higher side indicating that if bank rate is increased, it will increase the deposit rates which will encourage deposits with banks.

Table 2. *Correlations of selected variables using absolute data, monthly series*

	CPI	Credit	USD.INR
CRR	-0.913	-0.950	-0.681
SLR	-0.877	-0.856	-0.583
Repo	-0.643	-0.645	-0.762
ReRepo	-0.658	-0.660	-0.762
BankRate	0.731	0.776	0.502

Source: author's calculation.

Table 3 indicates some interesting correlations about the policy rates. The GDP was found to be negatively correlated with CRR, SLR (High) and repo rates indicating that any increase in these rates by the central bank would negatively affect the economic growth of the country. Also, GDP was found to be highly positive correlated with credit levels and money demand, which is a technically and logically correct phenomenon.

Table 3. *Correlations of selected variables using absolute data, quarterly series*

	GDP	CRR	SLR	Repo	BankRate	Credit	VoM
GDP	1.000	-0.891	-0.858	-0.306	0.758	0.951	0.408
CRR	-0.891	1.000	0.908	0.477	-0.902	-0.959	-0.072
SLR	-0.858	0.908	1.000	0.551	-0.710	-0.894	-0.123
Repo	-0.306	0.477	0.551	1.000	-0.248	-0.476	0.411
BankRate	0.758	-0.902	-0.710	-0.248	1.000	0.829	0.076
Credit	0.951	-0.959	-0.894	-0.476	0.829	1.000	0.114
VoM	0.408	-0.072	-0.123	0.411	0.076	0.114	1.000

Source: author's calculation.

Regressions

The regression analysis was done in bi-variable and multivariate mode using monthly and quarterly time series data at level and at first difference. The regression equations are also given in brackets.

Regression 1: Inflation (CPI) over Cash Reserve Ratio (CRR) at first differences

The R-squared and DW statistic was found to be 0.035 and 0.68 at first difference data. (CPI_d = 1.11+0.84 × CRR_d). The two series were found to be not co-integrated.

Regression 2: Bank Credit over Cash Reserve Ratio

The R-squared and DW statistic was found to be 0.17 and 2.47 at first difference data. (Credit_d= 490 -1466.6 × CRR_d). The two series were found to be co-integrated at first difference.

Regression 3: Foreign exchange rate over CRR

The R-squared and DW statistic was found to be 0.0238 and 1.6 at first difference data. (ExRate_d = 0.545 + 1.61 × CRR_d).

The two series are co-integrated at first difference.

Regression 4: Inflation with CRR, SLR, Repo, Re-Repo and Bank Rate

Multicollinearity was expected to effect the regression because of high correlation between CRR and SLR (0.862). CRR and Bank rate (-0.869) and between Repo and Re-repo rates (0.999).

Thus, SLR, Re-repo and Bank rate were reduced from the equation to counter multicollinearity.

At Level: CPI = 187.14 -8.92 × CRR -2.72 × Repo

At first difference: CPI_d= 1.1 + 0.71 CRR_d + 0.44 Repo_d

The Rsquared was found to be 0.843 with DW statistic of 0.23 at level. The Rsquared was found to be 0.046 with improved DW statistic at 0.68 at first difference. The series were not co-integrated at level or at first difference.

Regression of quarterly time series

Regression 5: GDP over Credit

At level: GDP = 2702 + 0.44 × Credit

The Rsquared was found to be 0.9 and DW statistic was found to be 2.13 at level.

At first difference, the Rsquared was found to be 0.0003 and DW statistic was 2.15 with almost no autocorrelation. The series were co-integrated at first difference but low Rsquared is a concern.

Regression 6: GDP over CRR

At level: GDP = 38670 - 2889 × CRR

The Rsquared was found to be 0.793 at level and 0.014 at first difference. The DW statistic was 1.56 at level and 2.1 at first difference indicating almost no autocorrelation in the regression. The series are also found to be co-integrated at first difference but with a very low Rsquared value.

Regression 7: GDP over Repo

At level: GDP = 40990 - 2082 × Repo

The Rsquared was found to be 0.093 at level and 0.29 at first difference. The DW statistic was found to be 0.53 at level and 1.8 at first difference with almost no autocorrelation. The two series were found to be co-integrated at first difference. The series can be said to be a good fit at first difference with 29% explained variance and low autocorrelation.

Regression 8: GDP over CRR and Repo

At level: GDP = 31561 -3128 × CRR + 1052 × Repo

The Rsquared was found to be 0.811 at level and 0.3 at first difference. The DW statistic was found to be 1.34 at level and 1.78 at first difference with almost no autocorrelation. The two series were found to be co-integrated at first difference. The series can be said to be a good fit at first difference with 30% explained variance and low autocorrelation.

Regression 9: Velocity of Money over CRR

At level: VoM = 131 -0.001 × CRR

The Rsquared was found to be very low at 0.005 at level and 0.06 at first difference. Although, the DW statistic was encouraging with 2.1 at level and 2.25 at first difference but with almost no autocorrelation the series were found to be co-integrated at first difference.

Regression 10: Velocity of Money over Repo

At level: VoM = 0.22 + 0.012 Repo

The Rsquared was found to be at 0.16 at level and 0.31 at first difference. The DW was 2.04 at level and 2.02 at first difference with no autocorrelation at level or at first difference. The two series were found to be co-integrated at first difference.

Regression 11: Velocity of Money over CRR and Repo

At level: VoM = 0.20 -0.004 × CRR + 0.016 × Repo

The Rsquared was found to be 0.26 at level and 0.32 at first difference. The DW statistic was found to be 2.19 at level and 2.02 at first difference with no autocorrelation. The two series were found to be co-integrated at first difference.

Vector Auto Regression (VAR) Models

Many VAR systems could be analyzed based on the dependent and independent variables but considering the research objective, two VAR based models are analyzed as given below.

VAR system 1: Inflation, CRR and Repo

VAR system 2: Credit, CRR and Repo

VAR system 1

The Akaike Information Criteria (AIC) was used to select the optimum lag for the system, which had a minimum value of -18.59 at lag 2. Thus, the VAR system was analyzed at lag 2. Three models were formulated as a part of this VAR system with the three variables as dependent variables, each at a time. The variables were used at first difference.

Table 4. *(Equation 1) Inflation (CPI) as the dependent variable*

	Coefficient	p-value
Const	0.202	0.44
l_CPI_1	1.492	0.00
l_CPI_2	−0.518	0.01
l_CRR_1	−0.014	0.68
l_CRR_2	0.006	0.88
l_Repo_1	−0.049	0.48
l_Repo_2	0.022	0.72

R-squared	0.997	Durbin-Watson	1.75

Table 5. *(Equation 2) CRR as dependent variable*

	Coefficient	p-value
Const	2.873	0.057
l_CPI_1	−0.538	0.64
l_CPI_2	0.069	0.95
l_CRR_1	1.381	0.00
l_CRR_2	−0.580	0.01
l_Repo_1	0.216	0.58
l_Repo_2	−0.368	0.28

R-squared	0.985	Durbin-Watson	1.75

Table 6. *(Equation 3) Repo rate as dependent variable*

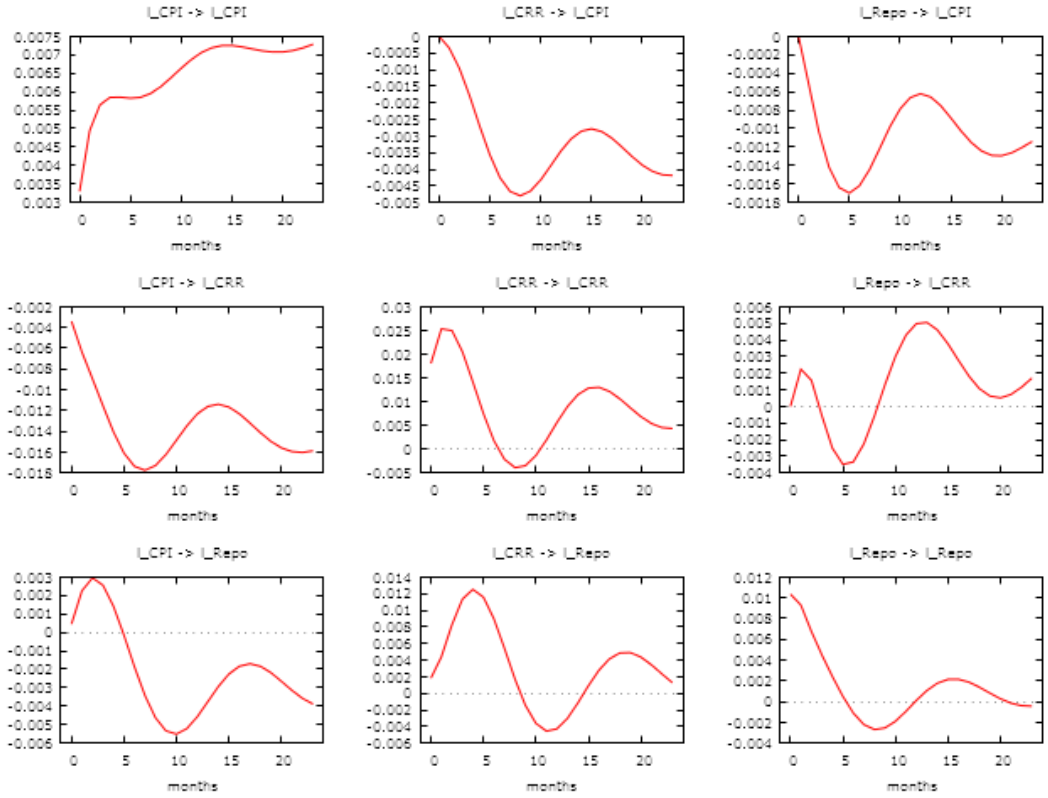
	Coefficient	p-value
Const	−1.208	0.15
l_CPI_1	0.716	0.28
l_CPI_2	−0.422	0.49
l_CRR_1	0.152	0.17
l_CRR_2	0.053	0.66
l_Repo_1	0.898	0.00
l_Repo_2	−0.153	0.43

R-squared	0.958	Durbin-Watson	1.81

Testing for auto correlation separately, no auto correlation was found in all the three equations, which is evident from the DW statistic also.

Testing for ARCH effect, the null hypothesis of NO ARCH effect was accepted for all the three equations.

Chart 1. *The Impulse Response Functions (IRF) for all the equations in VAR 1*



Each graph in Chart 1 is indicated for two variables where the first variable indicates the response of one shock (positive standard deviation) from second variable over 20 months. From response of Inflation to CRR, it can be observed that initially the inflation comes down till seventh month but again it goes up and stabilizes. Similarly, for response to Repo, the inflation initially goes up for three months and then it comes down and stabilizes.

Analyzing Table 7, it can be interpreted that Inflation forecast for one quarter is totally dependent on itself (100% explained variance) but as we forecast for long term, it is also dependent on Repo rate and CRR. In Table 8, the variation in Repo rates can be observed as largely dependent on Inflation and CRR in long term and according to Table 9, CRR largely depends on Inflation in long term.

Table 7. *Forecast error variance decomposition for CPI (Equation 1, VAR 1)*

period	I_CPI	I_Repo	I_CRR
1	100	0.0	0.0
2	98.92	0.9	0.18
3	96.58	2.49	0.94
4	93.04	4.26	2.69
5	88.54	5.87	5.59
6	83.64	7.02	9.33
7	79.09	7.64	13.26
8	75.46	7.78	16.75
9	73.03	7.59	19.38
10	71.76	7.22	21.02
11	71.48	6.77	21.75
12	71.89	6.34	21.78
13	72.71	5.94	21.35
14	73.70	5.62	20.68
15	74.68	5.36	19.95
16	75.53	5.19	19.28
17	76.18	5.08	18.7
18	76.62	5.04	18.34
19	76.82	5.05	18.12
20	76.85	5.08	18.07
21	76.74	5.12	18.14
22	76.57	5.14	18.29
23	76.38	5.14	18.47
24	76.25	5.12	18.63

Table 8. *Forecast error variance decomposition for Repo (Equation 2, VAR 1)*

period	I_CPI	I_Repo	I_CRR
1	0.18	99.81	0.0
2	2.37	94.31	3.31
3	4.07	79.78	16.15
4	4.11	63.09	32.80
5	3.38	50.56	46.05
6	2.82	42.82	54.36
7	2.94	38.71	58.34
8	4.06	36.96	58.98
9	6.17	36.32	57.52
10	8.80	35.73	55.47
11	11.32	34.71	53.97
12	13.29	33.43	53.27
13	14.68	32.31	53.02
14	15.58	31.65	52.77
15	16.14	31.49	52.36
16	16.43	31.65	51.92
17	16.49	31.80	51.70
18	16.41	31.72	51.86
19	16.31	31.38	52.31
20	16.31	30.87	52.82
21	16.53	30.33	53.14
22	17.01	29.85	53.14
23	17.73	29.44	52.83
24	18.63	29.08	52.29

Table 9. *Forecast error variance decomposition for CRR (Equation 3, VAR 1)*

period	l_CPI	l_Repo	l_CRR
1	3.43	2.92	93.66
2	5.09	5.21	89.68
3	7.65	5.08	87.26
4	11.64	4.24	84.11
5	17.26	3.61	79.14
6	23.98	3.37	72.65
7	30.78	3.31	65.91
8	36.66	3.20	60.13
9	41.29	2.98	55.71
10	44.81	2.80	52.39
11	47.42	2.82	49.76
12	49.23	3.14	47.63
13	50.24	3.72	46.05
14	50.51	4.37	45.11
15	50.28	4.93	44.79
16	49.89	5.27	44.84
17	49.69	5.39	44.92
18	49.89	5.36	44.75
19	50.55	5.23	44.22
20	51.59	5.07	43.33
21	52.88	4.91	42.21
22	54.26	4.76	40.97
23	55.61	4.64	39.75
24	56.84	4.55	38.60

VAR system 2

The Akaike Information Criteria (AIC) was used to select the optimum lag for the system which had a minimum value of -16.69 at lag 2. Thus, the VAR system was analyzed at lag 2. Three models were formulated as a part of this VAR system with the three variables as dependent variables, one by one. The three variables were used at first difference.

Table 10. *(Equation 1) Credit as the dependent variable*

	Coefficient	p-value
Const	−0.647	0.51
l_Credit_1	0.710	0.003
l_Credit_2	0.347	0.13
l_CRR_1	−0.182	0.06
l_CRR_2	0.233	0.02
l_Repo_1	−0.045	0.78
l_Repo_2	0.024	0.84

R-squared	0.993		Durbin-Watson	1.85

Table 11. *(Equation 2) CRR as the dependent variable*

	Coefficient	p-value
Const	4.643	0.037
l_Credit_1	0.010	0.98
l_Credit_2	−0.375	0.45
l_CRR_1	1.354	0.00
l_CRR_2	−0.583	0.01
l_Repo_1	−0.049	0.89
l_Repo_2	−0.120	0.67

R-squared	0.98		Durbin-Watson	1.64

Table 12. *(Equation 3) Repo rate as the dependent variable*

	Coefficient	p-value
Const	−0.446	0.73
l_Credit_1	−0.235	0.43
l_Credit_2	0.311	0.31
l_CRR_1	0.078	0.54
l_CRR_2	0.053	0.69
l_Repo_1	1.101	0.00
l_Repo_2	−0.378	0.04

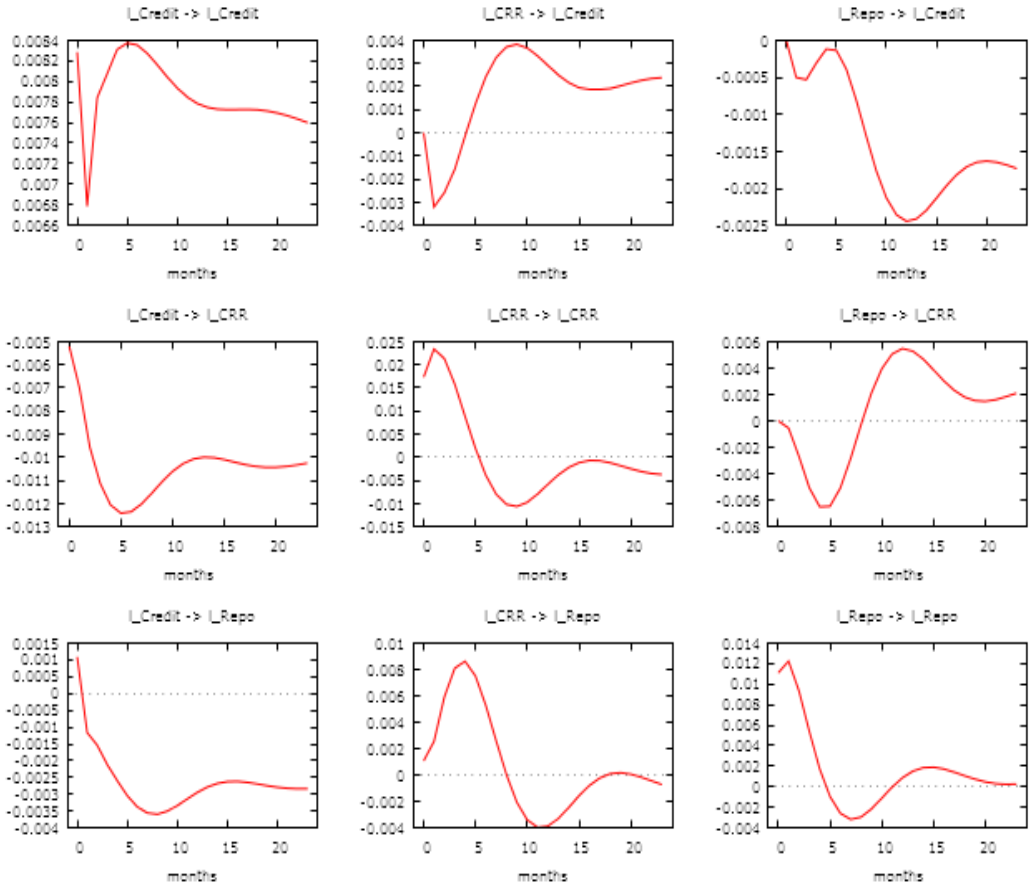
R-squared	0.95		Durbin-Watson	1.97

Testing for autocorrelation with a null hypothesis of NO autocorrelation, the hypothesis was rejected for equation 1 but accepted for equation 2 and equation 3 at 5% confidence indicating that autocorrelation was found in equation 1 only.

Testing for ARCH effect, the null hypothesis of NO ARCH effect was accepted for all the three equations indicating that no ARCH effect was found in all the three equations.

Each graph in Chart 2 is indicated for two variables where the first variable indicates the response of one shock (positive standard deviation) from second variable over 20 months. The response of credit to CRR can be interpreted as if CRR is increased, the Credit comes down for five months and then it rises a little bit and stabilizes. Similarly the response of Repo rates on Credit is very interesting and logical. As Repo rate is increased, Credit comes down drastically till seventh month and stays below zero level till 20 months.

Chart 2. *The Impulse Response Functions (IRF) for all the equations in VAR 2*



According to Table 13, the fluctuation in variance for forecasted Credit is observed to be more effected by CRR rather than Repo rates, which goes up to 10.32% for 13th quarter and vice versa for variance in CRR (Table 14). The variance in Repo can be explained by both Credit and CRR in long term (Table 15).

Table 13. *Forecast error variance decomposition for 1_Credit (Equation 1, VAR 2)*

period	I_Credit	I_CRR	I_Repo
1	100	0.0	0.0
2	91.59	8.2	0.20
3	90.96	8.76	0.27
4	92.31	7.44	0.24
5	93.91	5.89	0.19
6	94.61	5.22	0.16
7	94.21	5.62	0.17
8	93.02	6.71	0.26
9	91.49	8.0	0.49
10	90.00	9.12	0.87
11	88.78	9.87	1.35
12	87.89	10.24	1.86
13	87.34	10.32	2.34
14	87.05	10.21	2.74
15	86.97	9.99	3.05
16	87.01	9.73	3.26
17	87.13	9.47	3.39
18	87.27	9.25	3.48
19	87.41	9.07	3.52
20	87.51	8.94	3.55
21	87.58	8.85	3.57
22	87.61	8.80	3.59
23	87.60	8.78	3.62
24	87.58	8.77	3.65

Table 14. *Forecast error variance decomposition for 1_CRR (Equation 2, VAR 2)*

period	I_Credit	I_CRR	I_Repo
1	8.27	91.73	0.0
2	8.25	91.72	0.03
3	11.37	88.12	0.51
4	15.57	82.66	1.77
5	20.44	76.04	3.52
6	25.28	69.71	4.99
7	29.38	64.98	5.63
8	32.32	62.19	5.48
9	34.22	60.73	5.05
10	35.46	59.73	4.81
11	36.43	58.62	4.95
12	37.38	57.22	5.39
13	38.43	55.63	5.94
14	39.57	53.99	6.43
15	40.80	52.43	6.77
16	42.08	50.99	6.93
17	43.39	49.65	6.96
18	44.69	48.40	6.89
19	45.97	47.23	6.79
20	47.18	46.14	6.68
21	48.30	45.13	6.56
22	49.33	44.22	6.45
23	50.25	43.38	6.36
24	51.09	42.61	6.29

Table 15. *Forecast error variance decomposition for 1_Repo (Equation 3, VAR 2)*

period	l_Credit	l_CRR	l_Repo
1	0.94	0.93	98.13
2	0.89	2.70	96.39
3	1.21	10.47	88.31
4	1.86	21.35	76.79
5	2.74	30.87	66.39
6	3.88	36.32	59.80
7	5.24	37.92	56.84
8	6.76	37.31	55.92
9	8.28	36.25	55.46
10	9.64	35.80	54.55
11	10.75	36.18	53.07
12	11.61	36.96	51.43
13	12.30	37.66	50.04
14	12.89	37.99	49.11
15	13.46	37.96	48.57
16	14.03	37.69	48.27
17	14.63	37.32	48.05
18	15.24	36.96	47.79
19	15.88	36.62	47.48
20	16.55	36.31	47.13
21	17.24	35.99	46.76
22	17.93	35.69	46.37
23	18.62	35.41	45.98
24	19.28	35.14	45.57

Conclusion

The effect of monetary policy changes was observable and was observed in the research but no 'confident' conclusive evidence was found, although, the results can be used to understand the direction and quantum of effect of monetary policy in limited constraints. Most of the time series were found to be co-integrated at first difference and with no autocorrelation indicating good fit for forecasting. However, the unexplained variance was a concern in many such cases which needed to be further explored. For most of the regressions, when autocorrelations were removed, the R-squared values came down. The problem of low R-squared was eliminated by using VAR models where R-squared values increased and the models also improved on autocorrelation and ARCH effect. The Impulse response functions (IRF) were very helpful in understanding the responses of Inflation and Credit to CRR and Repo. It was observed that the effect of policy rates (CRR and Repo) affects Inflation and Credit till five to ten months and then the affect subsides.

An analysis of basic statistics of the variables indicated that CRR and Bank rate emerged as two most widely used rates by the central bank, RBI, as Coefficient of Variation for the two were found to be highest amongst the five policy and monetary rates, also including Repo, Reverse Repo and SLR.

The best fit was found between Velocity of Money over Repo and CRR indicating the direct effect of rates and reserves upon Money supply and GDP. Interpretation of the correlation and regression results from the research enhances the understanding of the macroeconomic variables and policy rates and would surely assist in policy making and further research on the subject.

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