Return Volatilities in Money and FOREX Markets in India: Causes and Consequences in the Liberalised Era

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Abstract

This paper analyses the properties of the return volatilities in Money and FOREX markets in India and their causes and consequences in the liberalised era. Using monthly data, monthly volatility measures are estimated based on Schwert's (1989) methodology. Empirical results detected the volatility contagion in these markets - return volatility in any of these markets is transferred to other market through a bi-directional causal relationship. The volatility in output growth of the economy is also detected to have causal influence on return volatilities in both the financial markets and inflation volatility has influence on money market volatility. Results also show that financial market volatilities have influence on levels of both output growth and inflation rate. Further, we found that the financial volatilities have some influence on future output volatility but not on future inflation volatility.

Key Words: Return Volatility, Volatility Contagion, Causes and Consequences of Return Volatilities in Financial Markets.

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1. Introduction

For over a decade, many reform measures were introduced towards deregulation of Indian financial markets. In the liberalised era, these markets are experiencing higher price/return volatilities and have been a matter of concern to investors as well as regulators. Though volatility might be an indication of greater informational efficiency (Froot and Perold, 1990), it matters to investors for their concern about the uncertainty of future wealth. A high volatility episode may lead to loss of investors' confidence in financial markets. The solvency of Financial System may also be threatened, as, for example, an increase in money market (interest rate) volatilities may lead to liquidity problem for financial intermediaries with maturity mismatches between assets and liabilities. Policy makers' concern about increased financial market volatility stems from the perceived adverse affect on real activities. In this context, two issues assume importance in academic and policy debates. First, what are the underlying causes of financial market volatilities? Second, what are the consequences of these volatilities?

This paper makes an attempt to analyse the causes and consequences of the return volatilities in Money market and FOREX market in India since 1993, the year since when both the markets started functioning in a deregulated environment. The rest of the paper is organised as follows. Section 2 presents the measure of volatility used in the study and brings out some stylised facts about the return volatilities in the two asset markets (i.e. Money and FOREX markets). Section 3 examines the possible causes of return volatilities in financial markets. In Section 4, attempts are made to identify the consequences of financial volatility. Finally, Section 5 concludes.

2. Return Volatilities in Money and FOREX Markets in India

While analysing volatility, we need to define and measure the very concept of 'volatility' itself. The concept of volatility here refer to a measure of uncertainty about the realisation of expected future returns. In this respect, the question also arises as to whether total realised return fluctuations or only it's unexpected component should be considered. Besides, we need to be clear on whether to look into the *ex post* or *ex ante* volatility. An *ex ante* measure is needed to analyse the expected return fluctuations (*ex ante)*, and focuses on conditional volatility[1]. By contrast, an *ex post* measure of volatility is the result of market participants' behaviour and institutional arrangements as reflected in historical data. In this study, for sake of simplicity, we concentrate on the *ex post* volatility only.

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[1] After the seminal work of Engle (1982), the conditional volatility is generally modelled in Auto Regressive Conditional Heteroscedasticity (ARCH) or Generalised-ARCH (GARCH) framework (Bollerslev, 1986). This type of model estimation requires lots of data points.

2.1 Measures of *Ex Post* Volatility

The conventional measure of return volatility has been the standard deviation of the return – the sample standard deviation of a return series of a particular frequency would be treated as a volatility measure of relatively lower frequency. For example, using daily return data, an estimate of the variance of monthly returns can be derived by the following simple formula[2]:

$$s_t^2 \cong \sum_{j=1}^{n_t} (r_{tj} - \bar{r})^2 \qquad \textbf{….. (1)}$$

where r_{tj} is the daily returns on j-th day of the month t and n_t is the number of quotation available in the month. The *ex post* (historical) volatility of price in month t will then be given by the estimated standard deviation, σ_t. As noted by Hull (1997), if the returns are normally distributed, the standard deviation of this estimate approximately equals to $\sigma_t/\sqrt{(2\pi)}$.

Sometimes, desired daily data on some variables may not be available in public domain, so is the case in this study as data on output and price are integral parts of the study. We, therefore, preferred using monthly data to derive an estimate of monthly volatility along the lines of Schwert (1989)[3], so that uniformity can be maintained in volatility estimates. For so doing, following general autoregressive model of monthly returns, R_t, may be considered:

$$R_t = a_0 + \sum_{j=1}^{11} a_j D_j + \sum_{j=1}^{12} b_j R_{t-j} + e_t \qquad \textbf{….. (2)}$$

where D_j's are dummy variables for different months. In our case, the seasonal dummy D_1 pertains to the month of May, D_2 pertains to the month of June, and so on. Since there is only one observation for each month, *t*, the standard deviation of monthly returns is then measured as the absolute value of the estimated error term[4], $|\varepsilon_t|$. As Schwert notes, this measure of volatility is a generalised version of the rolling standard deviation method used by Officer (1973); the autoregressive term (together with the dummy variables) is used to generate an estimate of the average return in time *t* using information about past monthly returns.

2.2 Estimated Returns and Volatilities - Some Stylised Facts

For estimating volatility measures, we need to estimate returns in different financial markets. In our study, the money market condition is represented by monthly weighted average Call Money Rate. The FOREX market condition is captured through spot exchange rate of US $ in terms of Indian Rupee (i,e, INR/US$ rate). These data are published in various regular publications of Reserve Bank of India (RBI). Using these data for the period from April 1993 to June 2002, price returns in Money market and FOREX market are derived as below;

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[2] We could have estimated the monthly volatility by using weekly data; but the procedure will not be theoretically sound because of the fact that the weekly returns in a month will not add up to the monthly return in our framework. So we have not considered this possibility.

[3] As observed by Anderson and Breedon (1996), the volatility measure estimated using equation 2, as suggested by Schwert (1989), is inferior to the variance method described in equation 1. Still the method suggested by Schwert (1989) is useful when one does not have high frequency data.

[4] In fact, since the mean value of the absolute error term under normality condition is given by $\sigma_t\sqrt{(2\pi)}$, where σ_t is the standard deviation, we should ideally multiply the absolute error terms by the constant $\sqrt{(2\pi)} \approx 2.2533$. However, we have not adjusted the absolute error terms with constant multiplication, as it does not have any tangible effect in our study.

$RM_t = CALL_t /12$ and $RF_t = \{\ln(S_{it}) - \ln(S_{t-1})\}*100$ **….. (3)**

Where RM_t and RF_t denote returns in money market and FOREX market respectively at time t, $CALL_t$ represents the above-mentioned call money rate and S_t is the spot rate of US$ in terms of INR at time t.

Note that in the case of money market, return series is readily available as $CALL_t$ actually represent the annual rate of return at time t. Hence the monthly rate of return is simply obtained by dividing $CALL_t$ by 12. In this case, K-month return is simply the addition of monthly returns of corresponding K consecutive months. For FOREX market, we need to derive return from spot rate series. The percentage change in spot rate could be a measure of return. However, we consider log-difference series instead of percentage spot rate changes to ensure that the monthly returns in K-consecutive months equals to the return in K-months. This type of return is generally known as log-return in financial literature.

2.2.1 Summary Statistics of Returns

The plot of each monthly return series obtained from equation 3 is presented in Figure 1. The summary statistics of these series are presented in Table 1. As can be observed from the Table 1, the average return in FOREX market is lower (than the return in money market) with higher volatility (or risk, represented by standard deviation), indicating that the risk-return trade off (risk per unit return) is more in FOREX market. The skewness statistics in case of money market (but not for FOREX market) is statistically significant at 1 per cent level. However, in each market, the measure is positive and thus indicates asymmetry in returns, characterised by a longer tail on the positive side. The kurtosis statistics indicates that return distribution in both the markets exhibits fat tails (as compared to normal distribution, for which the kurtosis is 3). However, the patterns of return autocorrelation in two markets differ substantially. The monthly returns are serially correlated in case of Money market and the null hypothesis of a white noise process is rejected by Ljung-Box Q-statistics against the alternative of 30-lag autoregressive process. In case of FOREX market, on the contrary, the evidence for rejecting the null hypothesis of zero serial correlation is not that strong. This phenomenon is indicative of relatively higher informational efficiency of FOREX market[5].

[5] It should be noted, however, that this evidence alone is insufficient to challenge market efficiency of Money market. The Ljung-Box test is a small sample test for null hypothesis of independently and identically distributed errors; the rejection of null hypothesis does not necessarily imply that the null hypothesis of uncorrelated returns should be rejected.

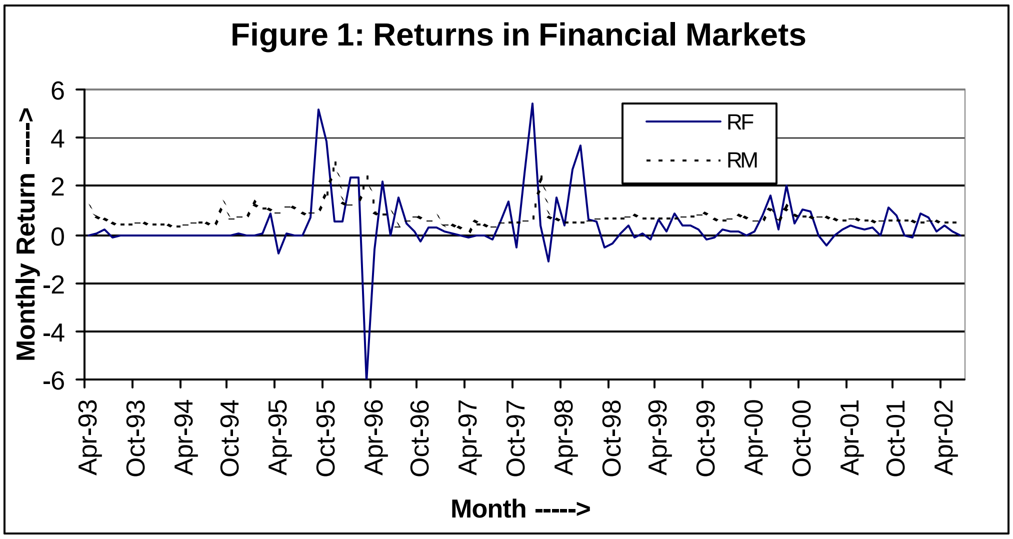

Table 1: Summary Statistics of Monthly Price Returns
(Sample Period: April 1993 to June 2002)

Statistics		Money Market	FOREX Market
No. of Observations on Return		111	110
Mean		0.7503*	0.4064*
Standard Deviation		0.3980	1.2111
Minimum		0.1017	-6.0812
Maximum		2.9025	5.4223
Skewness		2.9267*	0.3808
Excess Kurtosis (i.e. Kurtosis – 3)		8.4987*	8.6556*
Auto Correlations for			
	Lags 1, 2, 3	0.5330*, 0.3699*, 0.3445*	0.2170*, -0.1499, 0.0972
	Lags 6, 9, 12	0.1490, 0.0547, -0.0610	-0.0748, -0.0432, -0.0668
	Lags 16, 20, 24	-0.2497*, -0.2621*, -0.1706	0.0105, -0.1640, -0.0128
	Lag 30	-0.0997	0.1058
Ljung-Box Q(30)		175.1060*	34.0021

'*' Significant at 1 % level. '#' Significant at 5 % level (but not at 1 % level).

2.2.2 Summary Statistics of Estimated Volatilities

The estimates of monthly volatility of returns in two markets are plotted in Figure 2. In our study, VOLM and VOLF denote the estimated return volatility series based on Schwert's method for money market and FOREX market, respectively. Table 2 presents summary statistics of these estimates. Mean value of the volatility series broadly reflect the fact that the Money market is less volatile than the FOREX market, which is similar to the findings based on the standard deviation of returns (Table 1). Further, the standard deviation of estimated volatility for money market is less than that of FOREX market. Thus the volatility estimate for FOREX market is less reliable than that for Money market. In each market, the distribution of volatility is skewed to the right and possess fat-tails. Further, these estimates exhibit some degree of persistence with strong significance of auto-correlations of order 1 as well as Ljung-Box Q-statistics.

Figure 2: Return Volatilities in Financial Markets

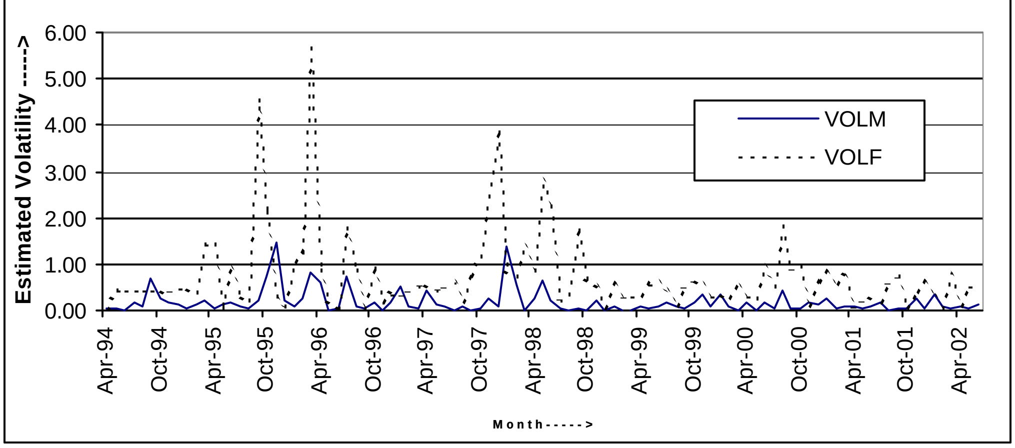

Table 2: Summary Statistics of Volatilities in Monthly Returns of Two Financial Markets
(Study Period: April 1993 to June 2002)

Statistics		Money Market	FOREX Market
No. of Observations		99	98
Mean		0.1839*	0.8895*
Standard Deviation		0.2548	8.2591
Minimum		0.0020	0.0222
Maximum		1.4892	5.6376
Skewness		3.0471*	3.2663*
Excess Kurtosis (i.e. Kurtosis – 3)		8.3087*	9.8895*
Auto Correlations for			
	Lags 1, 2, 3	0.2358*, -0.0743, 0.0398	0.2557*, -0.0222, -0.0240
	Lags 6, 9, 12	-0.0475, 0.0919, 0.0429	0.3836*, -0.0519, -0.0748
	Lags 16, 20, 24	-0.0979, -0.1410, -0.0042	0.0823, 0.0236, -0.0117
	Lag 30	0.0809	0.0987
Ljung-Box Q(27)		47.1617*	74.1828*

'*' Significant at 1 % level. '#' Significant at 5 % level (but not at 1 % level).

2.2.3 Time series Properties of Volatility Estimates

A necessary (but not sufficient) condition for a series to be mean reverting is that it is stationary. The rate at which it reverts to the mean is determined by the persistence of the series. The persistence of the shock in the above type of series can be estimated by fitting a suitable GARCH model. However, in this study, we are not modelling volatility series and narrowly concentrating only on the stationarity aspect of those series. Because of the choice of the sample period, we naturally do not expect any structural break in the series. Thus it is expected that the unit root test will suffice the test of non-stationarity in the series. The Augmented Dickey-Fuller (ADF) tests are employed for examining the issue. The ADF tests are extensively used in the literature for examining stationarity of a series and also for discriminating between two non-stationary classes, i.e., Difference Stationary (DS) and Trend Stationary (TS) (Dickey and Fuller, 1979, 1981). When a series is non-stationary, knowledge on whether it belongs to DS or TS class is helpful to suggest transformation for achieving stationarity. The ADF tests can be carried out based on following general regression equation for a time series X_t;

$$X_t = \alpha + \beta t + \rho X_{t-1} + \Sigma_k \delta_k \Delta X_{t-k} + e_t \qquad \textbf{.....(4)}$$

where α, β, ρ and δ_k's are unknown constants, Σ_k indicates summation over suitably chosen lags, Δ is the first-difference operator (i.e. $\Delta X_t = X_t - X_{t-1}$) and e_t is the usual error series.

The regression equations without intercept and/or without time trend (i.e. when value of β is set to zero) may also be considered (Dickey and Fuller, 1979, 1981). For simplicity in illustration and practical implementation, the general form is considered here. While conducting ADF tests, the possibilities of $\rho > 1$ and $\rho \leq -1$ are kept outside the domain of analysis as, for such cases, X_t represents an explosive series for which it is difficult to carry out any formal analysis. Depending on the value of (α,β,ρ) in equation (4), three alternative scenarios may arise. First, if $\beta=0$, $\rho < 1$, then X_t is a stationary series. Second, if $\beta=0$, $\rho =1$, then X_t is a DS series. In addition, if $\alpha \neq 0$, the DS series posses a non-zero drift term. The first order difference of a DS series produces a stationary series. Third, if $\beta \neq 0$ and $\rho < 1$ then X_t is a TS series. To achieve stationarity in this case, one needs to fit a time trend for X_t and subtract the fitted trend from X_t.

A number of procedures are available for testing the hypothesis relating to alternative scenarios and we employed three of the several test statistics suggested by Dickey and Fuller (1981), namely the statistics, (i) Φ_2 for testing the joint-hypothesis $(\alpha,\beta,\rho)= (0,0,1)$; (ii) Φ_3 for testing the joint-hypothesis $(\alpha,\beta,\rho)=(\alpha,0,1)$ and (iii) the t-ratio associated with the estimate of β (denoted by the symbol $\tau_{\beta t}$), under the hypothesis $(\alpha,\beta,\rho)=(0,0,1)$. For conducting these tests, one may use the finite sample percentiles/critical values for relevant test statistics estimated by Dickey and Fuller (1981) based on simulation exercise.

Empirical results of ADF Tests using Φ_2, Φ_3 and $\tau_{\beta t}$ are presented in Table 3. For VOLM series, it is seen that while both Φ_2 and Φ_3 are statistically significant at 1 per cent level (hence significant at 5 per cent level also), the $\tau_{\beta t}$ statistics is insignificant at 5 per cent level (thus insignificant at 1 per cent level also). Thus, the estimates of VOLM do accept none of the two hypotheses $(\alpha,\beta,\rho)=(\alpha,0,1)$ and $(\alpha,\beta,\rho)=(0,0,1)$, though the hypothesis $\beta = 0$ is accepted. These results indicate stationarity of VOLM series. Following a similar argument, the series VOLF is also considered to be stationary.

Table 3: Results of ADF Tests

Variable	Optimal Lags$	Observed Value of the Statistics		
		F_2	F_3	t_{bt}
VOLM	1	23.2250*	27.6327*	-2.2872&
VOLF	6	27.3126*	30.3428*	-1.9961&

Note: '$' Indicate the selected lags of DX_t in equation 4. '*' Significant at 1 per cent level (thus significant at 5 per cent level also); '&' Insignificant at 5 per cent level (thus insignificant at 1 per cent level also).

2.2.4 Volatility Contagion

As the financial markets in India are becoming increasingly open, global and integrated, the correlation between volatilities in Money market and FOREX market is expected to be increasingly strong. In this context, it is useful to check whether volatility in one market leads to volatility in other market. In order to examine this possibility, we conducted tests for Granger's (1969, 1988) causality. In so doing, we have estimated following regression model:

$$Y_t = \alpha + \sum_{j=1}^{l} \delta_j Y_{t-j} + \sum_{j=1}^{l} \eta_j X_{t-j} + \varepsilon_t \qquad \text{..... (5)}$$

To test the volatility contagion (X_t affects/causes Y_t) is then simply an F-test for null hypothesis that all η_j are zero against the alternative that not all η_j are zero[6]. Similarly, by interchanging the role of X_t and Y_t in equation (5), we may test whether Y_t causes X_t or not. In this type of test the selection of lag-structure assumes importance and depends partly on judgment. Keeping in view the data frequency, we have fixed maximum lag (i.e. maximum value of l in equation 5) to be 12. However, selection of the lag-structure in equation (5) is very important as results are sensitive to model specification. We adopted two alternative strategies. First, we select only the likely important lags from {1,2, ….., 12} using the 'Stepwise Regression' procedure (Doan, 1990). Second, we estimated equation (5) for l = 1,3,6,9, and 12. Final model is selected from the models estimated under two strategies using Akaike Information Criteria (AIC). In Table 4, we present relevant results for both the strategies.

From Table 4, it is clear that the model specifications obtained through 'Stepwise Regression' are superior in terms of AIC. In these cases not only the AIC are minimum but also the coefficients of determination (i.e. $\overline{R}^2$) and Ljung-Box Q-statistics are better. The observed values of F-statistics indicate some evidence of lagged-influence of FOREX market volatilities to money market volatilities and vice-versa. This indicates that volatility in one market is getting transferred to another market, re-confirming the integrity of two markets.

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[6] The test statistics will be given by, F= {(RSS_r – RSS_{ur})/m}/{(RSS_{ur})/(n-k)} which follows under null the F distribution with m and (n-k) degrees of freedom, where m is no. of linear restrictions, k is the no. of parameters in the unrestricted form of regression and n is the no. of observations. RSS_r and RSS_{ur} are the Residual Sum of Squares under restricted (null) and unrestricted (alternative) hypothesis respectively.

Table 4: F-Test Statistics for Volatility Contagion Effect

(A) Testing the Hypothesis "VOLF Does not Cause VOLM" (where Y=VOLM and X = VOLF)

Sr. No.	**Form of Regression Equation**	**Regression Statistics**				**F-Statistics for Testing**	
		AIC	$\overline{R}^2$	**D.W.**	**Q(27)**	**b_0 = 0**	**All b_j's, j ³ 1 are zero**
1$	$Y_t = m + \sum_{i \in \{1,4,6,11,12\}} a_i Y_{t-i} + \sum_{j \in \{1,2,8,10\}} b_j X_{t-j} + u_t$	-3.56	0.59	1.90	14.74	-	26.71* (4,76)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-2.96	0.26	2.24	31.45	4.42# (1,82)	16.44* (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-3.09	0.35	2.02	28.72	5.23# (1,78)	10.14* (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-3.22	0.44	2.12	29.79	0.73 (1,72)	8.69* (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-3.28	0.47	2.00	31.38	0.32 (1,66)	6.97* (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-3.44	0.54	2.00	13.25	0.04 (1,60)	7.32* (12,60)

(B) Testing the Hypothesis "VOLM Does Not Cause VOLF" (where Y=VOLF and X=VOLM)

Sr. No.	**Form of Regression Equation**	**Regression Statistics**				**F-Statistics for Testing**	
		AIC	$\overline{R}^2$	**D.W.**	**Q(27)**	**b_0 = 0**	**All b_j's, j ³ 1 are zero**
1$	$Y_t = m + \sum_{i \in \{1,6,8,12\}} a_i Y_{t-i} + \sum_{j \in \{4,5,10,12\}} b_j X_{t-j} + u_t$	-0.67	0.42	1.84	21.03	-	8.56* (4,77)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-0.21	0.08	1.93	45.21#	4.42# (1,82)	0.63 (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-0.19	0.06	2.03	39.51	5.23# (1,78)	0.08 (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-0.47	0.29	1.97	25.53	0.73 (1,72)	2.57# (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-0.43	0.26	2.02	19.31	0.32 (1,66)	1.90@ (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-0.55	0.34	1.90	12.96	0.04 (1,60)	2.01# (12,60)

'*' Significant at 1 % level. '#' Significant at 5 % level. '@' Significant at 10 % level.

'$' Corresponds to Stepwise Regression.

3. Causes of Return Volatility in Financial Markets

In an informationally efficient financial market, asset prices efficiently incorporate all information about economic fundamentals. In such a market volatility will be of very little interest as it simply reflect the volatile economic fundamentals. However, efficient market hypothesis seldom holds and there is a strong/growing concern about the possible causes of return volatilities in financial markets.

3.1 Possible Causes

The possible factors, identified in the literature, influencing return volatilities in financial markets are: (i) macroeconomic volatilities, (ii) macroeconomic imbalances, (iii) macroeconomic policy regimes and dynamics, (iv) financial innovation and (v) international integration of financial markets. In the next few paragraphs we discuss about the possible ways in which these factors influence the volatility in financial markets.

Macroeconomic Volatility

Both the real and nominal macroeconomic volatilities can be expected to influence the asset price returns, though may be with a lag. Real shocks in the economy are expected to affect all sectors of the economy including the financial sector. Thus the volatility generated in the economy by real shock is expected to spillover to financial sector. Further, economic theory implies that a decline in the volatility of a country's inflation rate may lead to decline in volatility in bond yields, which in turn may affect the money market. Similarly, a fall in the volatility of inflation differential between countries may lead to a fall in volatility of their bilateral exchange rate. With the sticky goods prices, this link between the volatilities of interest differential and exchange rate is expected to be strong, even under rational behaviour of the investors and their belief in the monetary authority's control over money supply (Dornbusch, 1976).

However, working with OECD countries with moderate inflation rates, Gruen (1996) found little evidence of the above propositions. In case of UK economy, Anderson & Breedon (1996) found that while volatility in Treasury bill price has a strong link with macroeconomic volatility, foreign exchange market does not exhibit such relationship.

Macroeconomic Imbalances

At the time of serious macroeconomic imbalances, like high budget deficit or current account deficits, it is likely that the asset price volatility will be higher as the investors assess the likelihood of major corrections in future to cure imbalances. The evidence in this respect is limited. However, in case of UK economy, Anderson & Breedon (1996) observed a very weak link between macroeconomic imbalances and asset price volatility.

Macroeconomic Policy Regimes and Dynamics

It is important to understand that policy regime itself does not heighten uncertainty. However, in a new policy regime, there will be a case of incomplete information about future. It is often quoted in the literature that the savings and investment decisions are ultimately based on available information about the future. Thus, in the absence of complete information about future, the basic allocation of resources may not be optimal, which may lead to variability in financial prices/returns. Rose (1995) found that in general, after the collapse or relaxation of a fixed exchange rate system, exchange rate volatility typically increases significantly. If above is true, then we may expect that the introduction of EURO might induce some amount of extra volatility in the financial markets. Another source of link between policy and volatility is the unclear policy signals (imperfect policy dynamics). The ERM crises in 1992 and 1993 clearly indicates that unclear policy signals may prompt an abrupt response by investors, increasing the volatility in liberalised financial markets also.

Financial Innovations

If derivatives markets facilitate price discovery, then we may well expect to see a higher volatility of price/return movements in those market in *short-run* as price start to react more *sharply* to new information. The underlying market may also observe simultaneous price movement. Further, the underlying market may also swing further due to the causes unrelated to price discovery in the derivatives markets, like, (i) low margin requirement which may lead to liquidity-related selling at times of large price swings, (ii) the ease of short selling in future market, which may accelerate price swing as short positions are covered and (iii) 'dynamic hedging', the practice whereby market participants, in order to maintain a prescribed price-sensitivity for portfolios containing options, adjust there cash positions in ways that may reinforce large price swings. However, if the process of price is a mean- reverting one (as we observe in the earlier section in case of India), the volatility in *long-run* will be relatively unaffected. To identify the impact of the introduction of future trading of Treasury Bills in USA in 1977 on price volatility in US market, Figlewski (1981) found, based on a predominantly regression analysis, that the market volatility increased significantly.

Alternatively, it is agreed by many analysts that because of lower transaction cost for derivative instruments than for the underlying instruments, new information often manifests itself more quickly in derivative markets than in cash markets. In such a situation, Cox(1976) argues that, because of close links between the two markets, the cash price may itself adjust more quickly to new information than it would have done had the derivative market been absent. It is also argued elsewhere that because of hedged position, participants are less likely to panic and sell into a down market and thus the derivative market will lend *stability* to cash market. Cohen (1996), based on variance ratio test[7] observed that derivatives did not add 'excessive' volatility to underlying markets in US, Germany and Japan.

International Integration of Financial Markets

A move to greater integration with international markets (i.e. opportunity for international diversification of asset holdings and increased cross border flows of capital) may increase or decrease the volatility in 'home' financial market depending on the relative asset preferences of investors and sources of financial market shocks. As generally argued, a shock in the market, for example, a decline in expected dividend, may lead to a commensurate adjustment in asset price in a comparatively closed economy. In a situation where the investors have easy access to foreign assets of similar kind, the price adjustment will be sharper in 'home' country. In this sense, the volatility will be higher in the case of relatively open economy.

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[7] Variance ratio test is a test for null hypothesis that the series is a random walk, based on the ratio of two variances calculated on the basis of one-period changes in price and non-overlapping k-period changes in price. Further details are available in Lo and McKinlay (1988).

However, as observed by Morton (1996), if the foreign country observes a similar simultaneous shock, the effect on price in 'home' country will diminish and the volatility will be expected to be lower than in the case of comparatively closed economy. If the foreign country observes an opposite kind of simultaneous shock, then this will tend to accentuate the volatility in asset price in the 'home' country. If we further consider the possibility of differing asset preferences and investor behaviour, like in a case where 'home' country investors consider the foreign assets as inherently risky, the potential outcome will expand further. In a situation like simultaneous similar shocks observed in both the countries, the volatility in price will be further moderated. However, in a situation where the 'home' country investors have inherent distrust on domestic assets, the repercussion may be higher volatility in assert price.

The above observations, though not exhaustive, indicate that international integration of financial market need not necessarily leads to higher volatility. In case of Spain, Ayuso, et al (1996) observed that the process of financial internationalisation has not been accompanied by upward trend in volatility. However, in this world, where the investors in the newly opened economies have more faith in the financial markets of the developed countries, the probability of high volatility in financial market of developing countries due to slight adverse shock is expected to be sufficiently large.

3.2 What about India?

From the policy point of view it is very important to understand the sources of return volatility in financial markets. In case its genesis is in macroeconomic factors, then the role of financial policy makers and regulators is limited. Otherwise, there is a need to have a re-look at the policy and regulation on financial markets. Therefore, it is important to test these propositions. However, as mentioned earlier, the twin financial markets are observing some sort of variability in the post liberalisation period. Thus the choice of sample period will not allow us to test the effect of many aspects, as mentioned above, on the return volatilities of those markets. The nonavailability of relevant data also poses several measurement problems. So, we concentrate only to test the much-debated aspects of the effect of macroeconomic volatility on Money and FOREX market return volatilities, leaving other aspects for future analysis.

To test the effects of macro volatilities, we looked at the importance of volatilities in output growth and inflation in causing return volatilities in two financial markets. We have used Wholesale Price Index (WPI) and lndex of Industrial Production (IIP) as representative of general price level and output. The primary source of WPI is the Ministry of Commerce and Industry, Government of India and the same for IIP is the Central Statistical Organisation (CSO). The RBI also disseminates these data through its regular publications. In our study, output growth and inflation rate represent the 100 times of the log-differences of IIP (base year 1993-94=100) and WPI (base year 1993-94 = 100), respectively (equation 3). These series are denoted by GIIP and INFL respectively. The volatilities in output growth and inflation rate, denoted by VOLO and VOLI, respectively, are derived by adopting Schwert's (1989) methodology (using equation 2) on GIIP and INFL series.

The procedure followed here is the test for Granger's (1969, 1988) causality based on F-test for exclusion of effects (as used in the test of volatility contagion). The results are presented in Table 5 and Table 6. Like the case of volatility contagion test, the model specifications here are best obtained through 'Stepwise Regression'. The empirical results also detect the causal influence of output volatility on return volatilities in both the financial markets. The causal influence of inflation volatility is also detected in case of money market. It is interesting to recall our earlier observation that the volatility in one financial market is spilling over to another financial market and now, in conjunction with the present observation, we may come to a conclusion that the volatility in output growth and inflation (i.e. macroeconomic volatilities) may also be spilling over to financial market via their impact on other markets. This assertion, however, requires further in-depth study.

Table 5: Effect of Output Volatility on Return Volatility in Financial Markets

(A) Testing the Hypothesis "VOLO Does Not Cause VOLM" (where Y=VOLM and X=VOLO)

Sr. No.	Form of Regression Equation	Regression Statistics				F-Statistics for Testing	
		AIC	$\overline{R}^2$	D.W.	Q(27)	$b_0 = 0$	All b_j's, j ³ 1 are zero
1$	$Y_t = m + \sum_{i e \{1,4,7\}} a_i Y_{t-i} + \sum_{j e \{1\}} b_j X_{t-j} + u_t$	-2.82	0.16	1.96	26.84	-	3.35# (3,80)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-2.76	0.10	1.98	40.34	0.47 (1,82)	6.20# (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-2.76	0.10	2.04	33.10	0.62 (1,78)	2.31@ (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-2.72	0.06	2.04	28.09	0.72 (1,72)	1.03 (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-2.69	0.04	2.00	24.24	0.45 (1,66)	0.96 (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-2.69	0.03	1.92	20.41	0.86 (1,60)	1.01 (12,60)

(B) Testing the Hypothesis "VOLO Does Not Cause VOLF" (where Y = VOLF and X = VOLO)

Sr. No.	Form of Regression Equation	Regression Statistics				F-Statistics for Testing	
		AIC	$\overline{R}^2$	D.W.	Q(27)	$b_0 = 0$	All b_j's, j ³ 1 are zero
1$	$Y_t = m + \sum_{i e \{1,2,6,12\}} a_i Y_{t-i} + \sum_{j e \{8\}} b_j X_{t-j} + u_t$	-0.45	0.28	1.97	25.89	-	3.10# (2,77)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-0.16	0.03	1.94	41.75#	0.52 (1,82)	0.10 (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-0.12	-0.00	1.96	39.14@	0.30 (1,78)	0.16 (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-0.25	0.12	1.89	43.17#	0.01 (1,72)	0.54 (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-0.26	0.12	2.01	27.89	0.01 (1,66)	0.77 (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-0.32	0.18	1.97	15.53	0.10 (1,60)	0.83 (12,60)

'*' Significant at 1 % level. '#' Significant at 5 % level. '@' Significant at 10 % level.
'$' Corresponds to 'stepwise regression'.

Table 6: Effect of Inflation Volatility on Return Volatility in Financial Markets

(A) Testing the Hypothesis "VOLI Does Not Cause VOLM" (where Y = VOLM and X = VOLI)

Sr. No.	Form of Regression Equation	Regression Statistics				F-Statistics for Testing	
		AIC	$\overline{R}^2$	D.W.	Q(27)	b 0 = 0	All b j's, j ³ 1 are zero
1$	$Y_t = m + \sum_{ie\{1,4,7\}} a_i Y_{t-i} + \sum_{je\{2,9\}} b_j X_{t-j} + u_t$	-2.82	0.15	1.95	22.43	-	2.86# (3,79)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-2.70	0.05	1.94	42.35#	0.00 (1,82)	2.09 (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-2.69	0.04	2.06	34.06	0.00 (1,78)	0.66 (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-2.67	0.02	2.04	25.94	0.04 (1,72)	0.56 (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-2.64	-0.01	1.99	21.12	0.19 (1,66)	0.53 (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-2.63	-0.02	1.98	18.38	0.07 (1,60)	0.77 (12,60)

(B) Testing the Hypothesis "VOLI Does Not Cause VOLF" (where Y = VOLF and X = VOLI)

Sr. No.	Form of Regression Equation	Regression Statistics				F-Statistics for Testing	
		AIC	$\overline{R}^2$	D.W.	Q(27)	b 0 = 0	All b j's, j ³ 1 are zero
1$	$Y_t = m + \sum_{ie\{5,6,8,11,12\}} a_i Y_{t-i} + \sum_{je\{2,11\}} b_j X_{t-j} + u_t$	-0.41	0.24	1.71	24.52	-	1.22 (2,78)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-0.17	0.04	1.93	41.92#	0.76 (1,82)	1.22 (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-0.13	0.01	1.96	39.71@	0.04 (1,78)	0.51 (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-0.26	0.12	1.86	41.41#	0.00 (1,72)	0.58 (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-0.22	0.09	2.01	32.06	0.02 (1,66)	0.47 (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-0.29	0.15	1.96	11.68	0.00 (1,60)	0.69 (12,60)

'*' Significant at 1 % level. '#' Significant at 5 % level. '@' Significant at 10 % level.
'$' Corresponds to 'stepwise regression'.

4. Consequences of Return Volatility in Financial Markets

If we assume that financial return volatility affects the broad contour of economic activity, then it should ideally be through the investment intention and consumer confidence. Though some data on investment intention is available[8], the frequency is very low. The data on consumer confidence is rare in India. So, it is difficult to test the above proposition directly. Based on a similar type of exercise, Anderson & Breedon (1996) found little evidence of any link between asset price volatilities and real activity in the context of UK economy.

However, if we believe that ultimately they will manifest themselves in the growth and inflation of the economy, presumably with a lag, then, with the available data, it will be a testable proposition. Here, the problem will be to identify the 'implementation lag'. In such a situation, if the 'implementation lag' is i-period, then we may employ F-test for exclusion of effects of financial volatilities on the i-th lead of output growth or inflation based on following specification:

$$Y_{t+i} = \alpha + \sum_{j=1}^{l} \delta_j Y_{t+i-j} + \sum_{j=0}^{l} \eta_j X_{t-j} + \varepsilon_{t+i} \qquad \text{..... (6)}$$

where Y's are either growth or inflation or volatility in any of them and X's are one of the financial volatilities. However, for sake of simplicity, we assume implementation lag to be zero (i.e. i=0 in equation 6). Thus the tests here are ultimately similar to those conducted to examine the volatility contagion (i.e. causality tests based on equation 5).

In our study, we investigate the effect of financial market volatilities on (i) inflation rate and output growth and (ii) volatilities in inflation and output growth. Empirical results for the case (i) are presented in Table 7 and 8 and for the Case (ii) are presented in Tables 9 and 10. As can be seen from these tables, the 'stepwise regression' produces minimum AIC for all cases except while testing whether VOLF causes GIIP. From Tables 7 and 8, it appears that each of VOLM and VOLF has causal influence – either instantaneously or with lag – on both of GIIP and INFL. In addition, as reflected in Tables 9 and 10, though financial volatilities do not have significant causal effect on inflation volatilities, they have lagged-impact on output volatility.

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[8] The investment intention surveys are conducted by Reserve Bank of India at regular interval (see RBI, 1997).

Table 7: Effect of return Volatility in Financial Markets on Output Growth

(A) Testing the Hypothesis "VOLM Does Not Cause GIIP" (where Y=GIIP and X= VOLM)

Sr. No.	Form of Regression Equation	Regression Statistics				F-Statistics for Testing	
		AIC	$\overline{R}^2$	D.W.	Q(27)	$\beta_0 = 0$	All β_j's, $j \geq 1$ are zero
1$	$Y_t = \mu + \sum_{i \in \{2,9\}} \alpha_i Y_{t-i} + \sum_{j \in \{5,8,12\}} \beta_j X_{t-j} + u_t$	1.29	0.83	3.01	113.19*	-	4.36# (1,82)
2	$Y_t = \mu + \alpha_1 Y_{t-1} + \beta_o X_t + \beta_1 X_{t-1} + u_t$	2.90	0.16	2.07	151.68*	0.01 (1,82)	0.78 (1,82)
3	$Y_t = \mu + \sum_{i=1}^{3} \alpha_i Y_{t-i} + \sum_{j=0}^{3} \beta_j X_{t-j} + u_t$	2.80	0.24	1.95	108.98*	0.43 (1,78)	4.17 (3,78)
4	$Y_t = \mu + \sum_{i=1}^{6} \alpha_i Y_{t-i} + \sum_{j=0}^{6} \beta_j X_{t-j} + u_t$	2.62	0.36	2.16	84.48*	0.22 (1,72)	3.43 (6,72)
5	$Y_t = \mu + \sum_{i=1}^{9} \alpha_i Y_{t-i} + \sum_{j=0}^{9} \beta_j X_{t-j} + u_t$	2.48	0.44	2.04	87.11*	0.14 (1,66)	1.90 (9,66)
6	$Y_t = \mu + \sum_{i=1}^{12} \alpha_i Y_{t-i} + \sum_{j=0}^{12} \beta_j X_{t-j} + u_t$	1.35	0.82	2.67	65.36*	1.19 (1,60)	0.86 (12,60)

(B) Testing the Hypothesis "VOLF Does Not Cause GIIP" (where Y = GIIP and X = VOLF)

Sr. No.	Form of Regression Equation	Regression Statistics				F-Statistics for Testing	
		AIC	$\overline{R}^2$	D.W.	Q(27)	$\beta_0 = 0$	All β_j's, $j \geq 1$ are zero
1$	$Y_t = \mu + \sum_{i \in \{1,2\}} \alpha_i Y_{t-i} + \sum_{j \in \{1,2,4,8,12\}} \beta_j X_{t-j} + u_t$	1.25	0.84	2.99	119.67*	-	3.54# (3,80)
2	$Y_t = \mu + \alpha_1 Y_{t-1} + \beta_o X_t + \beta_1 X_{t-1} + u_t$	2.82	0.22	1.97	139.72*	4.90# (1,82)	4.04# (1,82)
3	$Y_t = \mu + \sum_{i=1}^{3} \alpha_i Y_{t-i} + \sum_{j=0}^{3} \beta_j X_{t-j} + u_t$	2.85	0.19	2.00	135.92*	4.77# (1,78)	1.68 (3,78)
4	$Y_t = \mu + \sum_{i=1}^{6} \alpha_i Y_{t-i} + \sum_{j=0}^{6} \beta_j X_{t-j} + u_t$	2.76	0.27	2.18	113.88*	3.30@ (1,72)	1.32 (6,72)
5	$Y_t = \mu + \sum_{i=1}^{9} \alpha_i Y_{t-i} + \sum_{j=0}^{9} \beta_j X_{t-j} + u_t$	2.55	0.40	2.02	107.96*	3.86@ (1,66)	0.87 (9,66)
6	$Y_t = \mu + \sum_{i=1}^{12} \alpha_i Y_{t-i} + \sum_{j=0}^{12} \beta_j X_{t-j} + u_t$	1.22	0.84	2.77	123.26*	4.04# (1,60)	1.54 (12,60)

'*' Significant at 1 % level. '#' Significant at 5 % level. '@' Significant at 10% level.
'$' Corresponds to 'stepwise regression'.

Table 8: Effect of Return Volatility in Financial Markets on Inflation Rate

(A) Testing the Hypothesis "VOLM Does Not Cause INFL" (where Y=INFL and X= VOLM)

Sr. No.	Form of Regression Equation	Regression Statistics				F-Statistics for Testing	
		AIC	$\overline{R}^2$	D.W.	Q(27)	$b_0 = 0$	All b_j's, j ³ 1 are zero
1$	$Y_t = m + \sum_{ie\{1,2,8\}} a_i Y_{t-i} + \sum_{je\{8\}} b_j X_{t-j} + u_t$	-0.77	0.19	2.02	9.02	-	3.13# (4,78)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-0.56	-0.00	2.01	26.89	0.70 (1,82)	1.92 (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-0.53	-0.03	2.06	20.45	0.53 (1,78)	0.96 (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-0.58	0.02	2.03	14.28	0.33 (1,72)	1.70 (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-0.53	-0.03	2.07	14.66	0.25 (1,66)	1.20 (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-0.64	0.08	2.02	6.52	0.34 (1,60)	1.26 (12,60)

(B) Testing the Hypothesis "VOLF Does Not Cause INFL" (where Y = INFL and X = VOLF)

Sr. No.	Form of Regression Equation	Regression Statistics				F-Statistics for Testing	
		AIC	$\overline{R}^2$	D.W.	Q(27)	$b_0 = 0$	All b_j's, j ³ 1 are zero
1$	$Y_t = m + \sum_{ie\{8,7,8,9\}} a_i Y_{t-i} + \sum_{je\{11\}} b_j X_{t-j} + u_t$	-0.71	0.14	2.29	13.83	-	3.09# (2,81)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-0.58	0.02	2.01	31.10	0.06 (1,82)	4.02# (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-0.54	-0.01	2.02	27.71	0.05 (1,78)	1.31 (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-0.53	-0.02	2.01	21.23	0.28 (1,72)	1.14 (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-0.49	-0.07	2.02	17.83	0.37 (1,66)	0.91 (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-0.68	0.11	1.95	8.72	1.82 (1,60)	1.56 (12,60)

'*' Significant at 1 % level. '#' Significant at 5 % level. '@' significant at 10% level.
'$' Corresponds to 'stepwise regression'.

Table 9: Effect of Return Volatility in Financial Markets on Output Volatility

(A) Testing the Hypothesis "VOLM Does Not Cause VOLO" (where Y=VOLO and X= VOLM)

Sr. No.	**Form of Regression Equation**	**Regression Statistics**				**F-Statistics for Testing**	
		AIC	$\bar{R}^2$	**D.W.**	**Q(27)**	**$b_0 = 0$**	**All b_j's, j ³ 1 are zero**
1$	$Y_t = m + \sum_{ie\{2,9\}} a_i Y_{t-i} + \sum_{je\{5,8,12\}} b_j X_{t-j} + u_t$	-0.50	0.15	1.89	16.25	-	4.93* (4,78)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-0.30	-0.03	1.98	23.80	0.47 (1,82)	0.05 (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-0.29	-0.04	2.03	22.63	0.62 (1,78)	1.01 (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-0.25	-0.09	1.98	26.49	0.72 (1,72)	0.58 (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-0.22	-0.12	1.99	27.45	0.45 (1,66)	0.60 (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-0.33	-0.01	1.91	21.44	0.86 (1,60)	1.60 (12,60)

(B) Testing the Hypothesis "VOLF Does Not Cause VOLO" (where Y = VOLO and X = VOLF)

Sr. No.	**Form of Regression Equation**	**Regression Statistics**				**F-Statistics for Testing**	
		AIC	$\bar{R}^2$	**D.W.**	**Q(27)**	**$b_0 = 0$**	**All b_j's, j ³ 1 are zero**
1$	$Y_t = m + \sum_{ie\{1,2\}} a_i Y_{t-i} + \sum_{je\{1,2,4,8,12\}} b_j X_{t-j} + u_t$	-0.54	0.18	1.81	18.01	-	5.16* (5,78)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-0.32	-0.02	1.96	20.69	0.52 (1,82)	0.56 (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-0.35	0.01	2.05	20.28	0.30 (1,78)	2.37@ (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-0.35	0.01	1.99	24.37	0.01 (1,72)	1.78 (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-0.42	0.09	2.01	21.80	0.01 (1,66)	2.36# (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-0.39	0.05	1.99	24.19	0.10 (1,60)	1.98# (12,60)

'*' Significant at 1 % level. '#' Significant at 5 % level. '@' Significant at 10% level.
'$' Corresponds to 'stepwise regression'.

Table 10: Effect of Return Volatility in Financial Markets on Inflation Volatility

(A) Testing the Hypothesis "VOLM Does Not Cause VOLI" (where Y=VOLI and X= VOLM)

Sr. No.	Form of Regression Equation	Regression Statistics				F-Statistics for Testing	
		AIC	$\overline{R}^2$	D.W.	Q(27)	$b_0 = 0$	All b_j's, j ³ 1 are zero
1[$]	$Y_t = m + \sum_{i \in \{1,2,8\}} a_i Y_{t-i} + \sum_{j \in \{8\}} b_j X_{t-j} + u_t$	-1.49	0.14	2.00	17.49	-	2.24 (1,81)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-1.38	0.04	1.86	28.12	0.00 (1,82)	0.30 (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-1.38	0.05	1.98	23.35	0.00 (1,78)	0.07 (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-1.35	0.01	2.01	26.96	0.04 (1,72)	0.34 (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-1.37	0.03	1.99	11.74	0.19 (1,66)	0.39 (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-1.35	0.01	2.03	10.06	0.07 (1,60)	0.41 (12,60)

(B) Testing the Hypothesis "VOLF Does Not Cause VOLI" (where Y = VOLI and X = VOLF)

Sr. No.	Form of Regression Equation	Regression Statistics				F-Statistics for Testing	
		AIC	$\overline{R}^2$	D.W.	Q(27)	$b_0 = 0$	All b_j's, j ³ 1 are zero
1[$]	$Y_t = m + \sum_{i \in \{8,7,8,9\}} a_i Y_{t-i} + \sum_{j \in \{11\}} b_j X_{t-j} + u_t$	-1.48	0.14	1.98	17.92	-	1.76 (1,81)
2	$Y_t = m + a_1 Y_{t-1} + b_o X_t + b_1 X_{t-1} + u_t$	-1.38	0.04	1.86	31.02	0.10 (1,82)	0.53 (1,82)
3	$Y_t = m + \sum_{i=1}^{3} a_i Y_{t-i} + \sum_{j=0}^{3} b_j X_{t-j} + u_t$	-1.40	0.06	1.99	23.95	0.04 (1,78)	0.38 (3,78)
4	$Y_t = m + \sum_{i=1}^{6} a_i Y_{t-i} + \sum_{j=0}^{6} b_j X_{t-j} + u_t$	-1.34	0.01	1.99	24.27	0.00 (1,72)	0.28 (6,72)
5	$Y_t = m + \sum_{i=1}^{9} a_i Y_{t-i} + \sum_{j=0}^{9} b_j X_{t-j} + u_t$	-1.36	0.02	2.00	13.47	0.01 (1,66)	0.31 (9,66)
6	$Y_t = m + \sum_{i=1}^{12} a_i Y_{t-i} + \sum_{j=0}^{12} b_j X_{t-j} + u_t$	-1.34	0.00	2.07	11.19	0.00 (1,60)	0.38 (12,60)

'*' Significant at 1 % level. '#' Significant at 5 % level. '@' Significant at 10% level.
'$' Corresponds to 'stepwise regression'.

5. Conclusion

Volatility in Money and FOREX markets in India is a very recent phenomenon. It is a concern not only for the investor community, but also for the policy planner. While investors are more concerned about the future uncertainty of return, the policy planners are more worried about its genesis and its consequences. Keeping these concerns as the backdrop of this study, we have analysed various properties of return volatilities in money and FOREX markets and their causes and consequences. However, in any type of volatility research, there is the basic problem of defining the volatility suitable for the purpose. Here, for the data limitation, we have estimated volatility measure by using a methodology suggested by Schwert (1989). The advantage of Schwert's methodology is that it requires low frequency data.

Statistical analysis of data indicates that FOREX market is more volatile than the Money market resulting in the risk per unit return being more in the FOREX market. Both the markets' returns exhibit strong fat tails. Further, both the volatility series are observed to be stationary. There are also indications that the volatility in one financial market is getting transferred to another market, reconfirming the integrity of two markets.

We have identified five possible causes of financial volatilities as macroeconomic volatilities, macroeconomic imbalances, macroeconomic policy regimes and dynamics, financial innovations and international integration of financial markets. Though it is important to understand the genesis of financial market volatilities *for* the purpose of policy formulation, the limitation of data have not allowed us to test all the competitive hypotheses. However, based on limited analysis we observe that volatility in output growth of the economy, and possibly inflation volatility are affecting the financial market volatilities.

As regards the consequences of financial market volatilities, it is observed that both output growth and inflation rate are influenced by past values of these volatilities. However, financial market volatilities have influence only on volatility of output growth (but not on inflation volatility).

In the absence of proper theory on volatility, the approach adopted here is largely non-structural, leaving the rooms of further extended research open. One natural extension of the study will be to test all relevant hypotheses under multivariate causality framework. Also, the analysis of international linkages between a given asset class, as in King and Wadhwani (1990) for stock market or in Sutton (1996) for bond market, is not attempted, because its relevance in the Indian context, as of now, appears to be very limited. Future research may address these vital issues.

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