Interest Rate Volatility and Stock Returns:
A GARCH (1,1) Model

*Dr. K. Latha
**Dr. Sunita Gupta
***Dr. Renu Ghosh

Abstract

The present study attempts to examine the dual impact of changes in interest rate and interest rate volatility on the mean and variance of portfolio stock returns. The study period is from 1st April 1996 to 30th August 2014 covering a total period of approximately 18 years. Sample used in the study consist of portfolio of financial and non-financial firms listed in the S& P CNX 500 equity index. The effect of interest rate changes and volatility on distribution of stock returns is analyzed using the GARCH (1,1) model.

The effect of interest rate changes is found to be higher for financial firms as compared to non-financial firms. Interest rate volatility is found to be the significant factor affecting mean and variance of non-financial firms stock returns. Overall, the effect of interest rate volatility on stock returns and conditional stock returns volatility is evident from the results. If interest rate becomes more volatile it would also increase the volatility of conditional stock returns. When the interest rate volatility is included in the variance equation it is found that in case of those firm's where interest rate sensitivity coefficient is not significant, coefficient of interest rate volatility is significant implying that if changes in interest rate are small then these firm's are able to hedge themselves but if volatility of interest rate increases beyond a limit, it would also make the conditional returns of these firms' more volatile.

Keywords: Stock returns, Interest rate, GARCH (1,1), Financial Sector and Non-Financial Sector

*Associate Professor, Department of Commerce, Ramanujan College, University of Delhi, Email: dr_k_latha@yahoo.co.in

**Associate Professor, Department of Commerce, Kamala Nehru College, University of Delhi, Email: sunitagupta.knc@gmail.com

***Assistant Professor, Department of Commerce, Rajdhani College, University of Delhi, Email: renu_20092009@yahoo.co.in (Corresponding Author)

1. Introduction

The relationship between interest rate volatility and common stock returns of financial institutions has been the focus of a considerable amount of research in recent years. The impact of interest rate volatility on stock returns volatility of financial institutions provides important implications for monetary policy, risk-returns analysis, financial securities valuation and government policy towards financial markets. According to Elyasiani & Mansur (1998) investigation of the effect of interest rate volatility on stock returns volatility provides new insights about the behaviour of the firm in response to interest rate fluctuations in the market. Also incorporation of the interest rate volatility effect on stock returns volatility conveys critical information about the overall volatility of the financial market and its influences the volatility of individual firm at the micro level. Hence it can serve as a good measure of volatility for the overall market (macro level) and individual firm (micro level) respectively.

Before financial liberalization, interest rates were administered and exhibited near-zero volatility. The easing of financial repression that took place in 1990s has now generated some experience with interest rate volatility in India. Administrative restrictions on interest rates in India have been steadily eased since 1993 (Tripathi & Ghosh, 2012). This has led to increased interest rate volatility. Over the past 18 years, 91-days Treasury-bill yields have been higher than 12% and lower than 4%. As a result policy makers have become aware of interest rate risk and their exposure to it. However before managing interest rate risk it should be measured. Theoretically, there is negative correlation between stock returns and interest rate (Ologunde, Elumilade, & Asaolu, 2006).

The present study contributes to the related literature by studying the sensitivity of stock returns to interest rate changes using data for Indian firms since 1996. Interest rate volatility of financial and non-financial firm is analyzed in the present study. In methodological terms, it uses GARCH (1, 1) model for analyzing the interest rate sensitivity of stock returns instead of using the standard OLS model to enhance utilities of the analysis. The time period under consideration is very recent and characterized by the inclusion of financial and economic crises in global market.

1.1 Objectives of the Study

Main objective of present study is to examine the impact of interest rate and its volatility on the stock returns and its volatility. The idea behind this study is to find out whether stock returns are related to interest rate changes. Therefore, in particular, the present study will have the following research objective:

- To examine the effect of interest rate volatility on stock returns.
- To examine the effect of interest rate volatility on stock returns volatility.

1.2 Data Sources

1.2.1 Period of the Study

The time span of the study ranges from 1st Jan 1996 to 30th August 2014. This eighteen-year period has been chosen because administrative restrictions on interest rates in India have been steadily eased since 1993 which in turn, increased interest rate volatility in India.

1.2.2 Sample

Company Specific Data

The sample for the purpose of study consists of 411 companies forming part of S&P CNX 500 index that has continuous available share prices for the period under consideration. The list of sample companies is provided in Table A and Table B of the appendix. These companies represent a broad spectrum as they belong to all 18 major sectors of the economy. For 89 firms, data was not available continuously. The sample selected for study is further divided into two parts financial firms and non-financial firms for comparing the effect of interest rate movements on these two groups of institutions separately. Financial firms are further segregated into banking firms and non-banking financial firms. The non-financial firms are segregated into different industry namely: Automobile industry, Cement & Cement Products Industry, Chemicals Product Industry, Construction Sector, Consumer Goods Industry, Energy Sector, Fertilizer & Pesticides Product Industry, Health Sector, Industrial Manufacturing Industry, IT sector, Media & Entertainment Industry, Metals Product Industry, Pharma Sector, Service Sector, Telecom Industry and Textile Industry to check the impact of interest rate changes and volatility on these sectors separately.

Weekly stock returns for individual firm are then used to create equally weighted portfolio returns for each group. Present study analyzed portfolio stock returns for each sector considered under study because when the individual firm data is used, the noise is high in the data and results may be unduly influenced by the individual company multinational characteristics. Formation of portfolio returns has the advantage of smoothing out the noise in the individual data due to transitory shocks.

Interest Rate Proxy

The cut-off implicit yield on 91-days Treasury Bills has been used as the interest rate variable because it is the deregulated interest rate in India which is determined by the forces of demand and supply. It is important to mention here that prior to 1993, the rate of return on 91-days T-bills was exogenously fixed at 4.60% p.a. Administrative restrictions on interest rates have been steadily eased since 1993. It was only since January 1993 that a new auction based system was introduced which allowed implicit yield on 91-days T-bills to vary. Data for cut-off implicit yield on 91-days Treasury Bills have been collected from the annual reports of RBI and its website rbi.org.in.

Market-Proxy

The return on the S&P CNX Nifty-500 equity index, the widest equity market index in India is used as a proxy for market portfolio. It is a broad based value weighted market index generally used in research studies. The data regarding index values have also been collected from NSE website and Prowess database.

2. Literature Review

Stock returns sensitivity to interest rates was theoretically advocated by Stone (1974). He was the first one to develop the two-index model by incorporating the interest rate risk as an extra factor for explaining the stock returns of financial companies. "The stock returns interest rate sensitivity has long been the focus of academic research. Arbitrage Pricing Theory (APT) as developed by Ross (1976), argued that a number of systematic factors and not just market factor (captured by market risk premium) significantly explain stock returns. By employing factor analysis, study asserted that there are several systematic factors (Industry specific and company specific) that affects the security's return besides market returns such as unanticipated changes in interest rates, inflation rate, index of industrial production, trade deficit etc. Since Stone (1974) developed the two-index model, Martin & Keown (1977), Lynge and Zumwalt (1980), Choi and Jen (1991) investigated whether inclusion of interest rate as an extra-factor in two-index model adds explanatory power for estimating stock returns" (Latha, Gupta, & Ghosh, 2016).

Christie (1982) examined the relationship between variance of equity returns and various explanatory variables i.e. value, leverage and interest rate effects in U.S. and equity variance is found to have strong positive association with interest rate.

Faff, Hodgson, & Kremmer (2004) study examined the dual impact of changes in interest rate and interest rate volatility on the mean and variance of the distribution of Australian banks and finance companies stock returns. An extensive dataset is considered covering a total period of twenty years from 1978-1998. The total period was divided into three sub periods (pre-deregulation period, deregulation period and post-deregulation period) due to regulatory changes in the Australian financial markets. Data used in the study consisted of monthly share prices of 31 Australian banking and financial sector companies. The effect of interest rate changes and volatility on distribution of stock returns was analyzed using the GARCH-M model. Results of the study suggested that there was consistent inter-temporal trade-off between risk and returns. Interest rate risk for banking and financial companies in Australian financial markets changed considerably during the study period. Also cross-sectional heterogeneity is observed for differential interest rate sensitivity of the firm's i.e. sensitivity of firm depends upon its size and institutional type. With respect to finance companies, time invariant portion of portfolio's variance was significantly affected by deregulation. Also finance companies sensitivity to interest rate was lower in the pre-deregulation period, increased dramatically in the post-deregulation period. Fundamental relationship between interest rates and large banks excess stock returns is changed from positive in pre-deregulation period to negative in the post-deregulation period. Hence, most significant finding of the study was varied interest rate risk of financial institutions in Australia across the three sub- periods.

3. Research Methodology

For each company under study, the log returns are computed. Market returns are computed on the same line as the stock returns. S&P CNX 500- widest equity market index in India is used as benchmark for calculating market returns. Robust analysis of time series data requires that the time series employed in the study should be stationary. Stationarity of time series used in the present study is tested using Augmented Dickey Fuller (ADF test).

3.1 GARCH (1, 1) Model

The Generalized Autoregressive Conditional Heteroscedasticity (GARCH) process, first introduced by Bollerslev (1986) is estimated. In Bollerslev GARCH model the conditional variance is a linear function of past squared innovations and previous own lags. Firstly, the GARCH (1, 1) process specified below incorporating interest rate volatility in the mean equation is used to examine the impact of interest rate and its volatility on stock returns:

$$R_t = \alpha + \beta_1 R_m + \beta_2 \Delta I_t + \theta_1 INT^2 + \mu_t \qquad (1)$$

$$\sigma^2_t = \alpha_0 + \alpha_1 u^2_{t-1} + \alpha_2 \sigma^2_{t-1} \qquad (2)$$

Then, again the following GARCH (1, 1) model incorporating interest rate volatility in conditional variance equation is used to examine the effect of interest rate volatility on stock returns volatility.

$$R_t = \alpha + \beta_1 . R_m + \beta_2 . \Delta I_t + u_t \qquad (1`)$$

$$\sigma^2_t = \alpha_0 + \alpha_1 u^2_{t-1} + \alpha_2 \sigma^2_{t-1} + \theta_1 INT^2 \qquad (2`)$$

Where R_t is the return of stock at time t; α is the intercept term; R_m is the return on the market index i.e. S&P CNX 500 returns; ΔI_t is the changes in interest rate; σ^2_t is the conditional variance since it is one-period ahead estimate for the variance calculated based on any past information about volatility; α_0 is the average volatility; α_1 is the previous period's residual variance the ARCH term, α_2 is the previous period's forecast variance the GARCH term and θ_1 is the coefficient of interest rate volatility. The GARCH specification requires that in the conditional variance equation, parameters α_0, α_1 and α_2 should be positive or non-negative. The sum of ($\alpha_1 + \alpha_2$) is a measure of volatility persistence, closer to one the higher the persistence in volatility. Therefore, in a conditional variance equation the sum of α_1 and α_2 should be less than one to secure the covariance stationarity of the conditional variance. In case the sum is equal to one then the process is known as 'unit root in variance' and the Integrated GARCH model (IGARCH) describes its behaviour. If $\alpha_1 + \alpha_2 > 1$, this would be termed as 'non-stationarity in variance'. "For stationary GARCH models, conditional variance forecasts converge upon the long-term average value of the variance as the prediction horizon increases. For IGARCH processes, this convergence will not happen, while for $\alpha_1 + \alpha_2 > 1$, the conditional variance forecast will tend to infinity as the forecast horizon increases" (Brooks, 2002).

4. Empirical Results

The present section aims at discussing empirical results regarding the effect of interest rate and its volatility on conditional stock returns and its volatility. Time series used in the present study is found to be stationary at the first difference. The section below examines the effect of interest rate volatility on stock returns. Exercise carried out in the present section takes sample of financial and non-financial firms listed in the S&P CNX 500 index for the period 1st Jan 1996- 30th August 2014.

Table 4.1: Effect of Interest Rate Volatility on Stock Returns

Equally Weighted Portfolio Returns	α	β_1	β_2	θ_1	α_0	α_1	α_2	Adjusted R^2
Banking Sector	0.0021 (0.2586)	1.13449* (0.0000)	-1.1384* (0.0001)	-0.5053 (0.1100)	1.30E-05* (0.0044)	0.0570* (0.0000)	0.9277* (0.0000)	0.6082
Non-Banking Financial Sector	0.0011 (0.4707)	0.9880* (0.0000)	-0.5475** (0.0405)	-0.1906 (0.4328)	3.01E-05* (0.0003)	0.0846* (0.0000)	0.8577* (0.0000)	0.6401
Automobile Industry	0.0021 (0.1342)	0.8887* (0.0000)	-0.4402 (0.1013)	-0.1562 (0.5063)	9.02E-06* (0.0073)	0.0746* (0.0000)	0.9061* (0.0000)	0.6324
Cement &Cement Product Industry	0.0014 (0.4373)	1.0111* (0.0000)	-0.4909** (0.0444)	-0.3113 (0.2581)	1.36E-05** (0.0131)	0.0675* (0.0000)	0.9190* (0.0000)	0.5235
Chemical Products Industry	0.0038** (0.0265)	0.8924* (0.0000)	-0.4186 (0.1597)	-0.5801** (0.0288)	1.49E-05* (0.0025)	0.0566* (0.0000)	0.9248* (0.0000)	0.5444
Construction Industry	0.0053** (0.0343)	1.2676* (0.0000)	-0.9547* (0.0049)	-1.3202* (0.0010)	1.08E-05* (0.0023)	0.0492* (0.0000)	0.9434* (0.0000)	0.5013
Consumers Goods Industry	0.0043* (0.0001)	0.7701* (0.0000)	-0.1755 (0.4086)	-0.4459* (0.0056)	4.37E-05* (0.0000)	0.1432* (0.0000)	0.7156* (0.0000)	0.6755
Energy Sector	0.0002 (0.9007)	1.0939* (0.0000)	-0.2487 (0.3358)	-0.2929 (0.1146)	5.58E-06** (0.0113)	0.0755* (0.0000)	0.9171* (0.0000)	0.7014
Fertilizer & Pesticides Products Industry	0.0035 (0.1045)	0.9692* (0.0000)	-0.4424 (0.3631)	-0.8024** (0.0169)	2.25E-05* (0.0056)	0.0430* (0.0000)	0.9406* (0.0000)	0.4499
Health Sector	0.0029 (0.3137)	0.7378* (0.0000)	0.1622 (0.7799)	-0.3732 (0.4262)	2.85E-06 (0.2123)	0.0398* (0.0000)	0.9598* (0.0000)	0.2158
Industrial Manufacturing Industry	0.0032** (0.0154)	0.9064* (0.0000)	-0.3131 (0.1400)	-0.4642** (0.0260)	1.25E-05* (0.0055)	0.0728* (0.0000)	0.8977* (0.0000)	0.6951
IT Sector	0.0024 (0.1704)	1.0637* (0.0000)	-0.0037 (0.9914)	-0.5314*** (0.0510)	6.68E-06** (0.0136)	0.0778* (0.0000)	0.9197* (0.0000)	0.5582
Media & Entertainment Industry	-0.0042*** (0.0966)	1.0654* (0.0000)	0.0396 (0.9235)	0.6826*** (0.0927)	4.28E-06 (0.1483)	0.0804* (0.0000)	0.9216* (0.0000)	0.3588
Metals Industry	0.0021 (0.2861)	1.1908* (0.0000)	-0.2019 (0.6137)	-0.8391* (0.0045)	1.26E-05** (0.0130)	0.0996* (0.0000)	0.8963* (0.0000)	0.5677
Pharma Sector	0.0036* (0.0084)	0.7439* (0.0000)	-0.3258 (0.2687)	-0.4552** (0.0385)	6.72E-06** (0.0391)	0.0750* (0.0000)	0.9149* (0.0000)	0.5637
Service Sector	0.0022 (0.1255)	0.8769* (0.0000)	-0.3779 (0.2159)	-0.4914** (0.0293)	2.33E-05* (0.0006)	0.1208* (0.0000)	0.8510* (0.0000)	0.5659
Telecom Industry	0.0011 (0.7388)	1.0268* (0.0000)	0.3718 (0.5828)	-0.5122 (0.3956)	9.22E-05* (0.0013)	0.0877* (0.0004)	0.8471* (0.0000)	0.4153
Textile Industry	0.0037*** (0.0888)	0.9557* (0.0000)	-0.2104 (0.5172)	-0.7482** (0.0337)	4.15E-05* (0.0006)	0.0841* (0.0000)	0.8768* (0.0000)	0.5082

Note: Values in parentheses indicates p-value.

* Indicates p-value significant at 1% level.

** Indicates p-value significant at 5% level.

*** Indicates p-value significant at 10% level.

Table 4.1 presents the results relating to the effect of interest rate and interest rate volatility on stock returns. GARCH (1, 1) model is used to analyze the impact of interest rate changes and interest rate volatility on portfolio stock returns where θ_1 is the coefficient for interest rate volatility in the mean equation. β_2, the coefficient of interest rate changes is found to be negative and statistically significant for financial sector whereas θ_1, the coefficient of interest rate volatility is negative and statistically significant for non-financial sectors except for automobile, cement & cement product, energy, health and telecom sectors respectively. Interest rate changes and interest rate volatility is found to have negative relationship with stock returns i.e. if interest rate volatility is increased it would decrease the stock returns of respective sector. Therefore, it can be conclude that stock returns in India are not protected from interest risk. Stock returns exhibit strong sensitivity with interest rate changes and interest rate volatility.

The section below examines the effect of interest rate volatility on conditional stock returns volatility of different sector considered under study.

Table 4.2: Effect of Interest Rate Volatility on Conditional Stock Returns Volatility

Equally Weighted Portfolio Returns	α	β_1	β_2	α_0	α_1	α_2	θ_1	Adjusted R^2
Banking Sector	-0.0005 (0.5186)	1.1343* (0.0000)	-1.1770* (0.0001)	-1.61E-06 (0.6693)	0.0363 (0.0000)	0.9559 (0.0000)	0.0015* (0.0026)	0.6077
Non-Banking Financial Sector	0.0001 (0.8590)	0.9886* (0.0000)	-0.5823** (0.0340)	1.35E-05 (0.0831)	0.0919 (0.0000)	0.8526 (0.0000)	0.0030* (0.0021)	0.6397
Automobile Industry	0.0050** (0.0458)	0.8887* (0.0000)	-0.0528 (0.1295)	4.81E-06 (0.1886)	0.0684* (0.0000)	0.9134* (0.0000)	0.0007 (0.1837)	0.6316
Cement &Cement Product Industry	-0.0004 (0.6555)	1.0109* (0.0000)	-0.5195** (0.0376)	1.07E-05 (0.1636)	0.0665* (0.0000)	0.9211* (0.0000)	0.0004 (0.6425)	0.5232
Chemical Products Industry	0.0006 (0.4934)	0.8959* (0.0000)	-0.4503 (0.1598)	4.41E-06 (0.4798)	0.0481* (0.0000)	0.9406* (0.0000)	0.0009*** (0.0994)	0.5421
Construction Industry	-0.0017 (0.1152)	1.2849* (0.0000)	-1.0247* (0.0084)	-4.91E-06 (0.1093)	0.0369* (0.0000)	0.9569* (0.0000)	0.0024* (0.0001)	0.4938
Consumers Goods Industry	0.0018* (0.0008)	0.7695* (0.0000)	-0.1752 (0.4025)	4.17E-05* (0.0003)	0.1538* (0.0000)	0.7053* (0.0000)	0.0004 (0.7212)	0.6726
Energy Sector	-0.0013** (0.0314)	1.0966* (0.0000)	-0.3328 (0.2497)	-2.13E-06 (0.1601)	0.0491* (0.0000)	0.9420* (0.0000)	0.0014* (0.0000)	0.7006
Fertilizer & Pesticides Products Industry	-0.0012 (0.4051)	0.6947* (0.0000)	0.2138 (0.7536)	0.0003* (0.0000)	0.1130* (0.0000)	0.8293* (0.0000)	-0.0119* (0.0036)	0.2385
Health Sector	0.0008 (0.4652)	0.7414* (0.0000)	0.1241 (0.8293)	-5.22E-06 (0.2266)	0.0368* (0.0000)	0.9635* (0.0000)	0.0012*** (0.0904)	0.2170
Industrial Manufacturing Industry	0.0006 (0.2681)	0.9084* (0.0000)	-0.3276 (0.1344)	7.62E-06 (0.1439)	0.0726* (0.0000)	0.8965* (0.0000)	0.0009** (0.0463)	0.6934
IT Sector	-0.0004 (0.6275)	1.0659* (0.0000)	-0.0393 (0.9160)	-2.23E-06 (0.5929)	0.0677* (0.0000)	0.9295* (0.0000)	0.0015*** (0.0503)	0.5587

Media & Entertainment Industry	-0.0002 (0.7763)	1.0627* (0.0000)	0.0841 (0.8395)	-3.18E-05 (0.5897)	0.0757* (0.0000)	0.9262* (0.0000)	0.0011 (0.2462)	0.3584
Metals Industry	-0.0022* (0.0091)	1.1982* (0.0000)	-0.4026 (0.3560)	-1.10E-05* (0.0000)	0.0221* (0.0000)	0.9776* (0.0000)	0.0023* (0.0000)	0.5636
Pharma Sector	0.0012*** (0.0542)	0.7478* (0.0000)	-0.3281 (0.2824)	2.61E-06 (0.4404)	0.0714* (0.0000)	0.9168 (0.9728)	0.0008 (0.1003)	0.5633
Service Sector	-0.0002 (0.7540)	0.8798* (0.0000)	-0.3264 (0.2935)	9.36E-06 (0.1963)	0.1035* (0.0000)	0.8643* (0.0000)	0.0027* (0.0053)	0.5656
Telecom Industry	-0.0016 (0.2100)	1.0287* (0.0000)	0.3833 (0.5480)	0.0001* (0.0034)	0.0954* (0.0014)	0.8186* (0.0000)	-0.0111** (0.0198)	0.4150
Textile Industry	-0.0006 (0.5196)	0.9533* (0.0000)	-0.2293 (0.4925)	5.48E-05* (0.0003)	0.0862* (0.0000)	0.8738* (0.0000)	-0.0021 (0.1120)	0.5062

Note: Values in parentheses indicates p-value.

* Indicates p-value significant at 1% level.

** Indicates p-value significant at 5% level.

*** Indicates p-value significant at 10% level.

Again GARCH (1, 1) model is used to analyze the impact of interest rate volatility on conditional stock returns volatility where θ_1 is the coefficient for interest rate volatility in the conditional variance equation. The coefficient for the interest rate volatility θ_1 is statistically significant for both financial and non-financial sectors. If interest rate becomes more volatile it would also increase the volatility of portfolio stock returns. From the results it can be seen that in case of chemical product, energy, fertilizer & pesticides, health, industrial manufacturing, IT, metal product, service and telecom sectors, interest rate sensitivity coefficient (β_2) is not significant, but coefficient of interest rate volatility (θ_1) is significant implying that if changes in interest rate are small then these sectors are able to hedge themselves but if volatility of interest rate increases beyond a limit, it would also make the conditional stock returns of these banks more volatile. Also the ACH and GARCH coefficients of volatility equation are statistically significant indicating that volatility is time varying and evolves over time as function of its own lagged values. Results of the present study are consistent with the findings of (Brewer, Carson, Elyasiani, Mansur, & Scott, 2007; Leon, 2008; Kasman, Vardar, & Gokce, 2011).

Another point observed with respect to the volatility parameter is that in some cases it is negative which is contrary to the theoretical predictions. Theoretically, volatility parameters should be positive i.e. increased in interest rate volatility should increase the stock returns volatility. Ryan and Worthington (2004) in their study mentioned the "findings of Elyasiani and Mansur (1998) with respect to the volatility parameters who suggested that

volatility is a measure of total risk, rather than the non-diversifiable systematic risk i.e. increase in total risk need not always be accompanied by an increase in risk premium. If fluctuations in volatility are mostly due to shocks to the unsystematic risk, then volatility coefficient can have any sign."

5. Summary & Conclusion

Present study examined the effect of interest rate and its volatility on the stock returns and its volatility. The idea behind this study is to find out whether stock returns are related to interest rate changes. Sample used in the present study consist of financial and non-financial firms listed in the S&P CNX 500 index for the period 1st Jan 1996- 30th August 2014. Interest rate risk of financial firm and non-financial firms is examined by using the methodology of GARCH (1,1) instead of using the traditional OLS model which makes assumption of constant variance. Secondly the effect of interest rate volatility is examined by incorporating it in the mean equation to test whether volatility effects stock returns directly and then the volatility is incorporated in the conditional mean equation to test its effect on stock returns volatility. Stock returns and stock returns volatility of non-financial sectors is potentially affected by the interest rate volatility, whereas the effect of interest rate changes is found to be higher for financial sectors.

Looking at the estimation results for the variance equation in GARCH (1, 1) model, it can be concluded that the volatility for stock returns is time-variant. The ARCH and GARCH coefficients are found to be significant, providing evidence against traditional model (OLS) that assume time-invariant volatility. Consequently, the basic constant-variance OLS model appears to be inappropriate for describing the stock returns in India. ARCH (α_1) and GARCH (α_2) parameters are found to be significant. Also α_2 the GARCH parameter is greater than the ARCH parameter α_1 indicating that the volatility of stock returns in current period is more sensitive to its volatility in the previous period than to new shocks in the previous period. The implication is that market has a memory longer than one period and volatility is more sensitive to its own lagged values than it is to new surprises in the market.

*The effect of interest rate volatility on stock returns and conditional stock returns volatility is evident from the results. **If interest rate becomes more volatile it would also increase the volatility of conditional stock returns**. When the interest rate volatility is included in the variance equation it is found that in case of those firm's where interest rate sensitivity coefficient is not significant, coefficient of interest rate volatility is significant implying that if changes in interest rate are small then these firm's are able to hedge themselves but if volatility of interest rate increases beyond a limit, it would also make the conditional returns of these firms' more volatile.*

References

Bhole, L. M. (2008). *Financial institutions and markets: Structure, Growth and Innovations* (Fourth ed.). New Delhi: Tata McGraw-Hill Publishing Company Limited.

Brewer, E., Carson, J. M., Elyasiani, E., Mansur, I., & Scott, W. L. (2007). Interest rate risk and equity value of life insurnace companies: A GARCH-M model. *The Journal of Risk and insurance, 74* (2), 401-423.

Brooks, C. (2002). *Introductory Econometrics for Finance.* United Kingdom: Chambridge University Press.

Choi, D., & Jen, F. C. (1991). The relation between stock returns and short-term interest rates. *Review of Quantitative Finance and Accounting, 1*, 75-89.

Christie, A. A. (1982). The stochastic bahaviour of common stock variances: Value, Leverage and Interest rate effects. *Journal of Financial Economics, 10*, 407-432.

Elyasiani, E., & Mansur, I. (1998). Sensitivity of the bank stock returns distribution to changes in the level and volatility of interest rate: A GARCH-M model. *Journal of Banking & Finance, 22*, 535-563.

Faff, R. W., Hodgson, A., & Kremmer, M. L. (2004). An investigation of the impact of interest rates and interest rate volatility on Australian financial sector stock return distributions. *EFMA 2004 Base/ Meetings Paper.*

Gujarati, D. N., & Sangeetha. *Basic Econometrics* (Forth ed.). New Delhi: Tata Mc Graw Hill Education Private Limited.

Kasman, S., Vardar, G., & Gokce, T. (2011). The impact of interest rate and exchange rate volatility on bank's stock returns and volatility: Evidence from Turkey. *Economic Modelling, 28*, 1328-1334.

Latha, K., Gupta, S., & Ghosh, R. (2016). Interest rate sensitivity of stock returns: A case study of textile sector in India. *Asian Journal of Multidisciplinary Studies, 4* (4), 56-61.

Leon, N. k. (2008). The effects of interest rate volatility on stock returns and volatility: Evidence from Korea. *International Research journal of Finance and Economics* (14), 285-290.

Lynge, M. J., & Zumwalt, J. K. (1980). An empirical study of the interest rate sensitivity of commercial bank returns: A multi-index approach. *The Journal of Financial and Quantitative Analysis, 15* (3), 731-742.

Martin, J. D., & Keown, A. J. (1977). Interest rate sensitivity and portfolio risk. *The Journal of Financial and Quantitative Analysis, 12* (2), 181-195.

Ologunde, A. O., Elumilade, D. O., & Asaolu, T. O. (2006). Stock market capitalization and interest rate in Nigeria: A time series analysis. *International Research Journal of Finance and Economics* (4), 154-167.

Ross, S. A. (1976). The Arbitrage Theory of Capital Asset Pricing. *Journal of Economic Theory , 13*, 341-360.

Ryan, S. K., & worthington, A. C. (2004). Market, interest rate and foreign exchange rate risk in Australian banking: A GARCH-M approach. *International Journal of Applied Business and Economic Reseach , 2* (2), 81-103.

Stone, B. K. (1974). Systematic interest-rate risk in a two-index model of returns. *The Journal of Financial and Quantitative Analysis , 9* (5), 709-721.

Tripathi, V., & Ghosh, R. (2012). Interest rate sensitivity of banking stock returns in India. *International Journal of Financial Management , 2* (4), 18-28.

Appendix

Table A: List of Financial Firms

Banking Firms	Non-Banking Financial Firms
Axis Bank Ltd.	Housing Development Finance Corpn. Ltd.
Bank Of Baroda	I D F C Ltd.
Canara Bank	L & T Finance Holdings Ltd.
H D F C Bank Ltd.	Power Finance Corpn. Ltd.
I C I C I Bank Ltd.	Rural Electrification Corpn. Ltd.
Kotak Mahindra Bank Ltd.	Bajaj Finserv Ltd.
Punjab National Bank	Bajaj Holdings & Invst. Ltd.
State Bank Of India	Credit Analysis & Research Ltd.
Allahabad Bank	Crisil Ltd.
Andhra Bank	Edelweiss Financial Services Ltd.
Bank Of India	I I F L Holdings Ltd.
Central Bank Of India	Indiabulls Housing Finance Ltd.
Corporation Bank	L I C Housing Finance Ltd.
Federal Bank Ltd.	Mahindra & Mahindra Financial Ser. Ltd.
I D B I Bank Ltd.	Max India Ltd.
I N G Vysya Bank Ltd.	Muthoot Finance Ltd.
Indian Bank	Reliance Capital Ltd.
Indian Overseas Bank	Religare Enterprises Ltd.
Indusind Bank Ltd.	S K S Microfinance Ltd.
Jammu & Kashmir Bank Ltd.	Shriram City Union Finance Ltd.
Oriental Bank Of Commerce	Bajaj Finance Ltd.
Syndicate Bank	Can Fin Homes Ltd.
Uco Bank	Capital First Ltd.
Union Bank Of India	Cholamandalam Invt. & Fin. Co. Ltd.
Vijaya Bank	Geojit B N P Paribas Fin. Ser. Ltd.
Yes Bank Ltd.	Gruh Finance Ltd.
City Union Bank Ltd.	I C R A Ltd.
D C B Bank Ltd.	I F C I Ltd.
Dena Bank	Indiabulls Securities Ltd.
Dhanlaxmi Bank Ltd.	J S W Holdings Ltd.
Karnataka Bank Ltd.	Magma Fincorp Ltd.
Karur Vysya Bank Ltd.	Motilal Oswal Financial Services Ltd.
Lakshmi Vilas Bank Ltd.	Network18 Media & Invst. Ltd.
South Indian Bank Ltd.	P T C India Financial Services Ltd.
State Bank Of Travancore	Sundaram Finance Ltd.

Table B: List of Non-Financial Firm

Automobile Co. Portfolio:	Fertilizer & Pesticides Pro. Co. Portfolio:
Amara Raja Batteries Ltd.	Chambal Fertilizers & Chemicals Ltd.
Amtek Auto Ltd.	Gujarat Narmada Valley Fer. & Chem. Ltd.
Amtek India Ltd.	Gujarat State Fertilizers & Chemicals Ltd.
Apollo Tyres Ltd.	Mangalore Chemicals & Fertilizers Ltd.
Ashok Leyland Ltd.	Monsanto India Ltd.
Bajaj Auto Ltd.	**Health Sector Company's Portfolio:**
Bosch Ltd.	Apollo Hospitals Enterprise Ltd.
Eicher Motors Ltd.	Fortis Healthcare Ltd.
Escorts Ltd.	Indraprastha Medical Corpn. Ltd.
Exide Industries Ltd.	**Industrial Manufacturing Co. Portfolio:**
Federal-Mogul Goetze (India) Ltd.	A B B India Ltd.
Hero Motocorp Ltd.	A B G Shipyard Ltd.
Kesoram Industries Ltd.	A I A Engineering Ltd.
M R F Ltd.	Alstom India Ltd.
Maharashtra Scooters Ltd.	B E M L Ltd.
Mahindra & Mahindra Ltd.	Bharat Forge Ltd.
Maruti Suzuki India Ltd.	Bharat Heavy Electricals Ltd.
Motherson Sumi Systems Ltd.	Carborundum Universal Ltd.
Shanthi Gears Ltd.	Crompton Greaves Ltd.
Sundram Fasteners Ltd.	Cummins India Ltd.
Tata Motors Ltd.	Cyient Ltd.
Wabco India Ltd.	Electrosteel Castings Ltd.
Cement & Cement Products Company's Portfolio:	Elgi Equipments Ltd.
A C C Ltd.	Esab India Ltd.
Ambuja Cements Ltd.	Essel Propack Ltd.
Birla Corporation Ltd.	F A G Bearings India Ltd.
Century Enka Ltd.	Finolex Cables Ltd.
Century Textiles & Inds. Ltd.	Finolex Industries Ltd.
Grasim Industries Ltd.	Flexituff International Ltd.
India Cements Ltd.	H E G Ltd.
Prism Cement Ltd.	Honeywell Automation India Ltd.
Ramco Cements Ltd.	Ingersoll-Rand (India) Ltd.
Shree Cement Ltd.	K S B Pumps Ltd.
Ultratech Cement Ltd.	Lakshmi Machine Works Ltd.

Chemical Products Company's Portfolio:	Pipavav Defence & Offshore Engg. Co. Ltd.
Aarti Industries Ltd.	Reliance Industrial Infrastructure Ltd.
Atul Ltd.	S K F India Ltd.
B A S F India Ltd.	Siemens Ltd.
Clariant Chemicals (India) Ltd.	Supreme Industries Ltd.
D C W Ltd.	Suzlon Energy Ltd.
Deepak Fertilizers & Pet. Cop. Ltd.	Swaraj Engines Ltd.
G H C L Ltd.	T D Power Systems Ltd.
Gujarat Alkalies & Chemicals Ltd.	Thermax Ltd.
Gujarat Fluorochemicals Ltd.	Uflex Ltd.
Pidilite Industries Ltd.	Vesuvius India Ltd.
Supreme Petrochem Ltd.	**IT Sector Company's Portfolio:**
Tata Chemicals Ltd.	Aptech Ltd.
Construction Co. Portfolio:	C M C Ltd.
Anant Raj Ltd.	Core Education & Technologies Ltd.
B F Utilities Ltd.	Eclerx Services Ltd.
B G R Energy Systems Ltd.	Educomp Solutions Ltd.
Brigade Enterprises Ltd.	Financial Technologies (India) Ltd.
D B Realty Ltd.	Firstsource Solutions Ltd.
D L F Ltd.	Geometric Ltd.
Delta Corp Ltd.	H C L Infosystems Ltd.
Era Infra Engg. Ltd.	H C L Technologies Ltd.
G M R Infrastructure Ltd.	Infinite Computer Solutions (India) Ltd.
Gammon Infrastructure Pro. Ltd.	Info Edge (India) Ltd.
Godrej Properties Ltd.	Infosys Ltd.
Hindustan Construction Co. Ltd.	Just Dial Ltd.
Housing Development & Infrastructure Ltd.	K P I T Technologies Ltd.
Hubtown Ltd.	Mastek Ltd.
I L & F S Engg. & Con. Co. Ltd.	Mindtree Ltd.
I R B Infrastructure Developers Ltd.	Mphasis Ltd.
I V R C L Ltd.	N I I T Ltd.
Indiabulls Real Estate Ltd.	Oracle Financial Services Software Ltd.
J Kumar Infraprojects Ltd.	Persistent Systems Ltd.
Jaiprakash Associates Ltd.	Polaris Financial Technology Ltd.
Kajaria Ceramics Ltd.	Rolta India Ltd.
Kolte Patil Developers Ltd.	Sonata Software Ltd.

Lanco Infratech Ltd.	Tata Consultancy Services Ltd.
Mahindra Lifespace Deve. Ltd.	Tata Elxsi Ltd.
Man Infraconstruction Ltd.	Tech Mahindra Ltd.
National Buildings Cons. Copn. Ltd.	Vakrangee Ltd.
Oberoi Realty Ltd.	Wipro Ltd.
Omaxe Ltd.	**Media & Entertainment Co. Portfolio:**
Orbit Corporation Ltd.	D B Corp Ltd.
Parsvnath Developers Ltd.	Den Networks Ltd.
Patel Engineering Ltd.	Entertainment Network (India) Ltd.
Phoenix Mills Ltd.	Eros International Media Ltd.
Prestige Estates Projects Ltd.	H T Media Ltd.
Punj Lloyd Ltd.	Hathway Cable & Datacom Ltd.
Puravankara Projects Ltd.	Inox Leisure Ltd.
Sadbhav Engineering Ltd.	Jagran Prakashan Ltd.
Sobha Ltd.	P V R Ltd.
Sunteck Realty Ltd.	Prime Focus Ltd.
Supreme Infrastructure India Ltd.	Raj Television Network Ltd.
Swan Energy Ltd.	Sun T V Network Ltd.
Techno Electric & Engg. Co. Ltd.	Tv18 Broadcast Ltd.
Unitech Ltd.	Zee Entertainment Enterprises Ltd.
Voltas Ltd.	**Metal Products Company's Portfolio:**
Consumer Goods Company's Portfolio:	Coal India Ltd.
Advanta Ltd.	Gujarat Mineral Devp. Corpn. Ltd.
Agro Tech Foods Ltd.	Hindalco Industries Ltd.
Akzo Nobel India Ltd.	Hindustan Copper Ltd.
Asian Paints Ltd.	Hindustan Zinc Ltd.
Bajaj Corp Ltd.	Indian Metals & Ferro Alloys Ltd.
Bajaj Electricals Ltd.	Jindal Saw Ltd.
Balrampur Chini Mills Ltd.	Jindal Stainless Ltd.
Bata India Ltd.	Jindal Steel & Power Ltd.
Berger Paints India Ltd.	M O I L Ltd.
Britannia Industries Ltd.	Maharashtra Seamless Ltd.
Colgate-Palmolive (India) Ltd.	Mercator Ltd.
D C M Shriram Ltd.	N M D C Ltd.
Dabur India Ltd.	Orissa Minerals Development Co. Ltd.
E I D-Parry (India) Ltd.	Prakash Industries Ltd.
Emami Ltd.	Steel Authority Of India Ltd.

Ess Dee Aluminium Ltd.	Tata Sponge Iron Ltd.
Future Retail Ltd.	Tata Steel Ltd.
Gillette India Ltd.	Usha Martin Ltd.
Gitanjali Gems Ltd.	Uttam Galva Steels Ltd.
Glaxosmithkline Consumer Healthcare Ltd.	**Pharma Sector Company's Portfolio:**
Godfrey Phillips India Ltd.	Astrazeneca Pharma India Ltd.
Godrej Consumer Products Ltd.	Aurobindo Pharma Ltd.
H S I L Ltd.	Biocon Ltd.
Havells India Ltd.	Cadila Healthcare Ltd.
Hindustan Unilever Ltd.	Cipla Ltd.
I T C Ltd.	Dishman Pharmaceuticals & Chem. Ltd.
Jubilant Foodworks Ltd.	Divi'S Laboratories Ltd.
Jyothy Laboratories Ltd.	Dr. Reddy'S Laboratories Ltd.
Kansai Nerolac Paints Ltd.	Elder Pharmaceuticals Ltd.
Kaveri Seed Co. Ltd.	Glaxosmithkline Pharmaceuticals Ltd.
Mcleod Russel India Ltd.	Glenmark Pharmaceuticals Ltd.
Rasoya Proteins Ltd.	Ipca Laboratories Ltd.
Ruchi Soya Inds. Ltd.	Jubilant Life Sciences Ltd.
Shoppers Stop Ltd.	Merck Ltd.
Shree Renuka Sugars Ltd.	Opto Circuits (India) Ltd.
Shrenuj & Co. Ltd.	Orchid Chemicals & Pharmaceuticals Ltd.
Tata Global Beverages Ltd.	Pfizer Ltd.
Titan Company Ltd.	Piramal Enterprises Ltd.
Trent Ltd.	Ranbaxy Laboratories Ltd.
Tribhovandas Bhimji Zaveri Ltd.	Sanofi India Ltd.
Tube Investments Of India Ltd.	Shasun Pharmaceuticals Ltd.
United Breweries Ltd.	Sun Pharma Advanced Research Co. Ltd.
United Spirits Ltd.	Sun Pharmaceutical Inds. Ltd.
V S T Industries Ltd.	Torrent Pharmaceuticals Ltd.
Vaibhav Global Ltd.	Unichem Laboratories Ltd.
Venky'S (India) Ltd.	**Service Sector Company's Portfolio:**
Zydus Wellness Ltd.	3M India Ltd.
Energy Sector Co. Portfolio:	Adani Enterprises Ltd.
Aban Offshore Ltd.	Adani Ports & Special Economic Zone Ltd.
Adani Power Ltd.	Aditya Birla Nuvo Ltd.
Bharat Petroleum Corpn. Ltd.	Allcargo Logistics Ltd.
C E S C Ltd.	Balmer Lawrie & Co. Ltd.

Cairn India Ltd.	Blue Dart Express Ltd.
Chennai Petroleum Corpn. Ltd.	Cox & Kings Ltd.
G A I L (India) Ltd.	Dredging Corpn. Of India Ltd.
G O L Offshore Ltd.	E I H Ltd.
G V K Power & Infrastructure Ltd.	Gateway Distriparks Ltd.
Gujarat Gas Co. Ltd.	Gati Ltd.
Gujarat Industries Power Co. Ltd.	Gujarat Pipavav Port Ltd.
Gujarat State Petronet Ltd.	Hotel Leelaventure Ltd.
Hindustan Oil Exp. Co. Ltd.	I L & F S Transportation Networks Ltd.
Hindustan Petroleum Corpn. Ltd.	Indian Hotels Co. Ltd.
Indiabulls Power Ltd.	Jaypee Infratech Ltd.
Indraprastha Gas Ltd.	M M T C Ltd.
J S W Energy Ltd.	M T Educare Ltd.
Jaiprakash Power Ventures Ltd.	Mahindra Holidays & Resorts India Ltd.
Jyoti Structures Ltd.	Redington (India) Ltd.
K E C International Ltd.	Thomas Cook (India) Ltd.
K S K Energy Ventures Ltd.	Tree House Education & Accessories Ltd.
Linde India Ltd.	**Telecom Company's Portfolio:**
Mangalore Refinery & Pet. Ltd.	Bharti Airtel Ltd.
N H P C Ltd.	Bharti Infratel Ltd.
N T P C Ltd.	G T L Infrastructure Ltd.
Neyveli Lignite Corpn. Ltd.	Idea Cellular Ltd.
Oil & Natural Gas Corpn. Ltd.	Reliance Communications Ltd.
Oil India Ltd.	**Textile Company's Portfolio:**
P T C India Ltd.	Arvind Ltd.
Petronet L N G Ltd.	Bombay Dyeing & Mfg. Co. Ltd.
Power Grid Corpn. Of India Ltd.	Himatsingka Seide Ltd.
Reliance Industries Ltd.	Kewal Kiran Clothing Ltd.
Reliance Infrastructure Ltd.	Lovable Lingerie Ltd.
Reliance Power Ltd.	Mandhana Industries Ltd.
Sterlite Technologies Ltd.	Page Industries Ltd.
Tata Power Co. Ltd.	Raymond Ltd.
Torrent Power Ltd.	S R F Ltd.
	Vardhman Textiles Ltd.