Stock Return, Volatility and the Global Financial Meltdown: The Behavior of Indian Stock Market

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Abstract
This study aims at examining the impact of 2008 U.S. crisis on the stock return volatility of Indian stock market. For this purpose, apart from the conventional approach to measure volatility, a family of ARCH (Autoregressive Conditional Hetroscedasticity) models have been used to detect the presence of volatility in the light of global financial meltdown. So as to capture the influence of crisis on return volatility of Indian stocks, dummy variables have been incorporated in an augmented E-GARCH (Asymmetric-Autoregressive Conditional Hetroscedasticity). Both the conventional as well as modern approaches results indicate that return volatility has been highest during the crisis period (January 8, 2008 to March ,9 2009). The mean returns which have been the lowest during the crisis period soared, rather higher, after the crisis i.e. post crisis period. Both the dummies suggest that volatility has been highest during the crisis period and it came down during the post crisis period. The study suggests that the impact of U.S. financial meltdown on the stock return volatility of Indian stock market has been significant.
JEL Classification: G0

Keywords: Financial instrument, Meltdown, Risk, Stock market, Volatility

1. Introduction

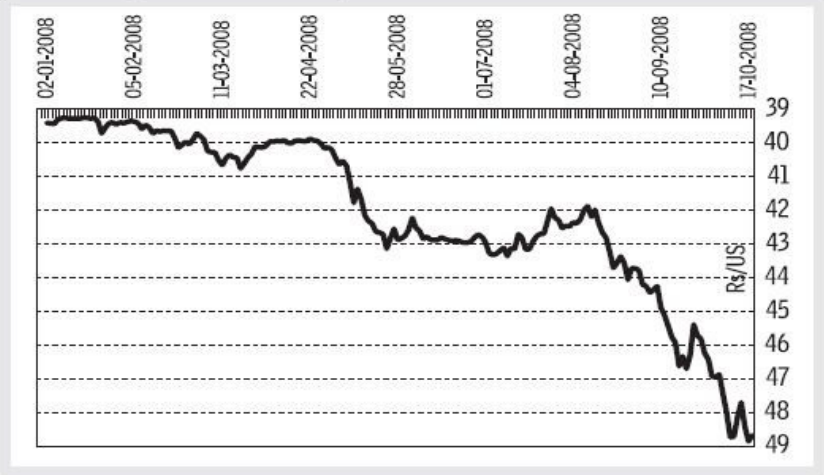
Banking and financial crisis have been considered as common phenomenon throughout the modern history of mankind. There has been 112 banking crisis since late 1970 untill 2007, according to UNCTAD(2008a) (Das et.al., 2012 & Kumar&Vashisht 2009). The common feature of almost all the crisis has been some expedite process i.e. search for the quick and higher returns and a great mismatch between appetite for risk and the capacity for bearing it. The 2008 global financial meltdown has been considered as a dazzaling example of avarice and overindulgence of the corporations in U.S (Occasional Paper Series, Rajya Sabha Secretariat, June (2009)). What makes these crises different from the others is that it came out from the very centre of the globalized economy and were not confined to some specific region. The heat of turmoil was felt in the entire world economy, though of varying dimension, and like a stone in a pond, its ripples moved even outward. It has been recognized that those who break the rules do create repercussions for the people around. Wall street firms broke the financial rules and regulations and the people of the world in general and the U.S. in particular bore the burden of it (Occasional Paper Series, Rajya Sabha Secretariat, June (2009)). The sub-prime crisis, which has been considered as worst after great depression of 1930s got its surface around August 2007 and affected the entire financial and banking system in the United States and Europe. The collapse of Lehman Brothers in mid September, 2008 further aggravated the situation leading to a crisis of confidence in the financial markets (Wikipedia, 2010). The severity and suddenness of the crisis can be judged from the IMF's forecast for the global economy. For the first time in 60 years, the IMF forecasted a global recession with negative growth for world GDP in 2009-2010.

The main root of meltdown was U.S. housing bubble, which peaked in 2006, caused the securities tied to U.S. real estate pricing to plumb. During this period, mortgage brokers attracted by the big commissions, encouraged buyers with poor credit to accept housing mortgages with little or no down payments and without credit checks (Prasad&Reddy,2009). Banks lent money on the assumption that housing prices would continue to rise. Between 1997 and 2006, the price of the typical American house increased by 124% (Wikipedia,2010). And this real estate bubble enhanced the demand for houses as financial assets. Banks and other financial institutions later repackaged these debts with other high-risk debts and sold them to world-wide investors by creating new financial instruments called CDOs or Collateralised Debt Obligations (Sadhu, 2008). In this way, risk was passed on multifold in the worldwide financial markets. Due to surplus inventory of houses and increase in interest rates, there was decline in housing prices in the year 2006-2007 that resulted into an increased defaults and foreclosure activities that collapsed the housing activity (Sengupta,2008). The impact of this meltdown was felt globally because CDOs were sold worldwide and situation became more depriciative because some Wall Street banks had borrowed 40 times more than they were worth (Occasional Paper Series, Rajya Sabha Secretariat, New Delhi, June, 2009). The banks and investment firms that had bought billion of dollars worth of securities based on mortgages were in trouble now. This turmoil started in mid 2007 exacerbated substantially since August 2008 (Mohan, 2009). But when Lehman Brothers and other important financial institutions failed in September 2008, the impact could be seen clearly on the global economy.

Initially Indian economy seemed to be relatively protected from this meltdown. Rather the effect was positive as the country received accelerated foreign institutional investment flows during 2007-08 when the roots of the subprime mortgages had started surfacing in the U.S. The net inflows in 2007-08 amounted to $20.3 billion in India. But India could not insulate itself from the adverse developments

in the international markets later on, albeit its banks had negligible investment in the financial instruments like CDOs. The immediate negative effect of meltdown on India was felt only after the collapse of Lehman Brothers with the outflow of foreign institutional investment from the equity market and increasing interest rates in money market that got uplifted about 20% during the month. Though the different areas of Indian economy such as information technology, exchange rate, foreign exchange outflows, foreign investment, real estate, stock market, volume of exports, rate of unemployment and banking sector have been affected by meltdown in U.S. (Prasad&Reddy,2009), but the most immediate effect was felt on its equity market and foreign exchange market. The downtrend of these markets during the period can be seen in the following figures. Between January and October 16, 2008, the RBI reference rate for the rupee fell by nearly 25% (Chandrasekhar and Gosh, 2008). This sharp depreciation in foreign exchange market is depicted in figure 1.

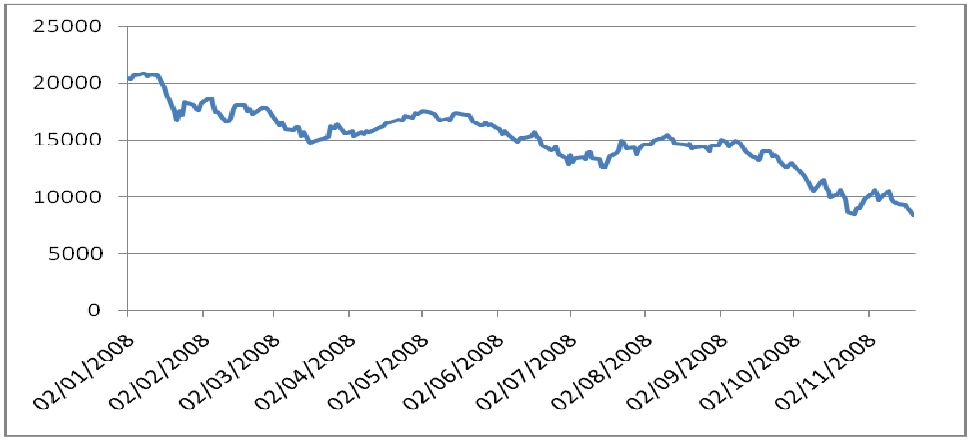
Fig. I: Exchange Rate of the Rupee Versus the Dollar (RBI's reference rate)



Reproduced from Mani and Kumar, 2009

Another market that is worst hit by this crisis is Indian stock market. India Sensex touched above 21,000 mark in the month of January 2008 and plunged below 10,000 during October 2008. The daily movements of Sensex are shown in the following figure 2.

Fig. II: Monthly movements in Indian Stock Market Index (Sensex) during 2008



Source: Authors' Calculations

A falling stock index reflects the dampening of the investment climate while a rising stock index indicates more confidence and soundness of the economy (Dash and Mallick, 2009). Therefore, it is not doubtful to accept that global financial meltdown had dampened the confidence of investors in Indian stock market.

In the present scenario, stock return volatility is a matter of great concern for policy makers and investors. Investor's responsiveness to invest in an economy can be better understood by it. Stock market volatility or high fluctuations in stock return are not healthy for the growth of an economy. Empirical evidence demonstrates that financial stability is supposed to be in danger more by sudden shifts in volatility rather than by a continuous increase in the level of volatility (Mishra, 2010). Studies have been seen analysing the time variations in the volatility with the influence of various market shocks and liberalization reforms. For example, Batra (2004) studied the time variations in volatility in the Indian stock market during 1979-2003 on account of the process of financial liberalization in India. Rao and Gurbandini (2009) studied the impact of global economic meltdown on commodity Exchange (NCDEX). A study by Olowe (2009) has examined the impact of stock market crash and global financial meltdown (2008) on the volatility of Nigerian stock market by making use of E-GARCH (Exponential General Autoregressive Conditional Hetreksedasticity) model using daily return of Nigerian stock exchange. Although Prasad and Reddy (2009), made an analytical attempt study the impact of global financial crisis on the Indian economy as a whole by considering almost every market and Mani and Kumar(2009) studied the impact of global financial meltdown on Indian economy via., downturn of stock market, falling rupee, losses of Indian banks due to exposure of these to the impaired assets, but no serious attempt visualizing the impact of 2008 crisis on Indian stock market seem to have been made.

If the stock market of any economy is more volatile then investors (both domestic as well as foreign) are less likely to invest in such a market where returns are prone to higher risk. This reluctance to invest in such an economy impedes economic growth of that country. Hence, volatility in stock returns indirectly hurdles economic growth. On the other hand, Kumar & Tamimi (2011) observed in case of India that high volatility is associated with low growth and low volatility is associated with high growth which means economic growth also plays an important role in volatility of the stock market. So, keeping in view this relationship of economic growth and stock return volatility, this study aims at studying the impact of U.S. meltdown on the volatility of stock returns in Indian stock market by formulating the following hypotheses in the study.

Null Hypothesis (H_0): The global financial meltdown did not affect the stock-return volatility in the Indian stock market.

Alternative Hypothesis (H_1): The global financial meltdown did affect the stock-return volatility in the Indian stock market.

2. Database and Methodology

2.1 The Data

For testing the hypothesis, time series data on Bombay Stock Exchange (BSE) Sensex has been used for analysis. The daily closing figures of the Sensex for the period January 2, 2007 to November 9, 2010 have been obtained from Yahoofinance.com. The stock returns for the given series have been formulated with the help of following formula

$$R_t = \log P_t - \log P_{t-1} \quad (1)$$

Where R_t represents stock return at time t

P_t represents BSE-Sensex index at time t

P_{t-1} represents BSE-Sensex index at time t-1

The R_t in equation (1) has been used in investigating the volatility of stock return in the Indian stock market. The whole period of the study is divided into (i) Pre Crisis Period (January 1, 2007 to January 7, 2008); (ii) Crisis Period (January 8, 2008 to March ,9 2009); and (iii) Post Crisis Period (March 10, 2009 to November 9, 2010). Movements in BSE index (Sensex) has been used as the guiding factor in dividing the study period into sub periods as above (For movements in Sensex, see Annexure I). Thus the impact of the meltdown on the volatility of Indian stock market has been studied in the present study by comparing the empirical results for these three periods. Also, a model is formulated in which two dummy variables have been introduced to visualize the impact of crisis on volatility.

2.2 Properties of Data

This section explores the basic properties of the return series. First, summary statistics of the stock return series are visualized in order to have an idea of the basic nature of return series for further analysis. Moreover, properties of the data have been compared among the pre-crisis period (January 1, 2007 to January 7, 2008), crisis period (January 8, 2008 to March ,9 2009) and the post crisis period (March 10, 2009 to November 9, 2010). Also, the presence of unit root has been checked by using the Augmented Dickey Fuller (ADF) test; and if the presence of unit root is confirmed then detrending or differencing of the series is required to make the data stationary. The summary statistics of the stock-return series for whole time period, pre-crisis period, crisis period and the post crisis period is given in Table 1.

	Whole Period (January 1, 2007 to November 9, 2010)	**Pre-Crisis Period (January 1, 2007 to January 7, 2008)**	**Crisis Period (January 8, 2008 to March 9, 2009)**	**Post Crisis Period (March 10, 2009 to November 9, 2010)**
Mean	0.004	0.0016	-0.0033	0.0023
S.D	-0.0205	0.0154	0.0282	0.0163
Skewness	0.1853	-0.2196	-0.0815	2.2047
Kurtosis	8.8809	4.4278	3.7657	24.1530
Jarque-Bera (Probability)	1373.002 (0.0000)	23.5223 (0.0000)	7.2518 (0.0266)	8015.02 (0.0000)
No of osbservation	649	253	284	112

Table I. Summary Statistics of Stock Return Series for Whole and Sub periods

Source: Authors'Calculations

It is evident from the table, the daily mean returns for the whole period as well as the sub periods are approximately zero, which goes well with the theory that market returns in the presence of large number of rational profit maximizers should be equally distributed among buyers and sellers (see Tsay (2005), pp.14-17). However, mean returns are comparatively more before the crisis period than during the crisis, even higher in the post crisis period; hence suggesting that financial meltdown has made a setback on the daily returns of the Indian stock market. Returns were negative during the crisis period.

Thus, daily returns in the Indian stock market declined sharply because of the subprime mortgage crisis in the U.S. Further, the presence of skewness and excess kurtosis in the whole as well as in the sub-periods provide the evidence of the nature of departure from normality. However, negatively skewed

return series before and during the crisis period depicts that abnormally low return days occurred more frequently than abnormally high return days. But it is quite likely that the skewness is biased by the presence of kurtosis in the sample period. However, in all the cases, the return series is characterized with asymmetric response to information because the coefficients of skewness and kurtosis are significantly different from 0 and 3 respectively. The measures for excess kurtosis show that the stock market returns series suggest leptokurtic distribution, i.e., the series have a thicker tail and higher peak than a normal distribution. High values of the kurtosis estimate indicate that more observations are outside the conventional standard deviation range from mean (Rui, 1997). Therefore, estimates of standard deviations are of little value if the distribution has high kurtosis. However, standard deviation is highest during the crisis period (January 8, 2008 to March 9, 2009), thereby suggesting more volatility during this period. Moreover, Jarque-Bera test statistic in the whole as well as sub periods are significant showing the tendency towards non-normal distribution.

2.2.1 Unit Root Test

The time series is considered well behaved if it satisfies stationary properties. Therefore, an examination of the movements of the daily stock return series is of paramount importance. Studying the movements in the daily stock-return holds good economic importance, because the randomness or non-stationary movements in return series will not indicate as to whether the volatility in the present return series is due to the shock of external factors, or it is due to internal factors, or due to instantaneous set of information in Indian stock market. Augmented Dickey Fuller test has been used to discern whether present stock-return series is stationary, or unit root is present in the series. Results of ADF test are reported in Table 2.

Table II. Unit Root Test of the Stock Return Series

Stock-Return	ADF Statistic	Probability
With intercept	-10.4512*	0.0000
With intercept and Trend	-10.4679*	0.0000
Without intercept and Trend	-10.4329*	0.0000

Note: (i) * indicates significance level (ii) Lag Length is selected automatically on the basis of SIC criterion.

Source: Authors' calculations

ADF test statistic in all the three cases (with intercept, with intercept and trend, and without intercept and trend) is highly significant, thereby suggesting the rejection of null hypothesis of the presence of unit root in the return series. It thus follows that there is the absence of non stationarity in the present data. Therefore, it is appropriate to examine the return volatility using the original level of the series rather than using detrended series or applying differencing transformation.

2.3 Models Used in the Study

The traditional measure of volatility as represented by variance or standard deviation is unconditional and does not recognize the interesting patterns in asset volatility, e.g., time varying and clustering properties. Researchers have introduced various models to explain and predict these patterns in volatility. Engle (1980) introduced the autoregressive conditional hetroskadasticity (ARCH) to model volatility. The standard approach to modeling volatility is through the GARCH class of ARCH models. Asymmetric GARCH model (E-GARCH) will be used in the present study to estimate the element of time variation in volatility. E-GARCH models allow for asymmetry in the distribution which is found in

most of the financial series. There are two advantages of using E-GARCH over GARCH. First, by using the E-formulation, the restriction of positive constraints on the estimated coefficients in ARCH and GARCH are no longer necessary. Second, a weakness of the GARCH model is that conditional variance depends on the magnitude of disturbance term, but not on its sign. GARCH fails to capture the negative asymmetry apparent in many financial time series (Chen et. al ,(2001)). Therefore, the results based upon GARCH models may be doubtful. Also it does not take into account the non linearity in the conditional variance. If, descriptive statistic of our return series rejects the symmetric distribution then it would be appropriate to apply asymmetric GARCH Model. The model is further augmented with the dummy variable (an outcome of global financial meltdown) to examine the volatility persistence.

Under the E-GARCH methodology, two distinct specifications for mean and variance are generally made. In general, EGARCH (1,1,1) specification is as follows

Mean Specification

In the first step, we specify the conditional mean equation for any time series variable X_t ,

$$X_t = c + \mu_t \qquad (1)$$

Variance equation

In the second step, we identify the conditional variance equation for the variable under consideration. The general specification of the conditional variance in the E-GARCH model is as follows:

$$\log(\sigma^2_t) = \omega + \alpha\log(\sigma^2_{t-1}) + \gamma|\mu_{t-1}/\sigma_{t-1}| + \beta(\mu_{t-1}/\sigma_{t-1}) \qquad (2)$$

In this model specification, α is the GARCH term that measures the impact of last periods' variance. A positive α indicates volatility clustering implying that positive price changes are associated with further positive changes and vice versa. The coefficient γ is the ARCH term that measures the effect of news about volatility from the previous period on current period volatility. Basically, ARCH and GARCH measure the effects of new and old news respectively. ARCH and GARCH indicate how volatility is affected by current and past information respectively. β measures the leverage effect and it is expected to be negative implying that bad news has a bigger impact on volatility than the good news of the same magnitude. This is an additional feature attained by E-GARCH models.

The mean and variance equations for the return series of Indian stock market Index (BSE-Sensex) are given as

$$R_t = c + \mu_t \qquad (3)$$

$$\log\left(\sigma^2{}_t\right) = \omega + \sum_{i=1}^{p} \alpha_i \mu_{t-i} / \sigma_{t-i} + \sum_{j=1}^{m} \gamma_j \mu_{t-j} / \sigma_{t-j} + \sum_{K=1}^{q} \beta_k \log\left(\sigma^2{}_{t-k}\right) \qquad (4)$$

In the above model, α, γ and β capture the ARCH, leverage and GARCH effects respectively and values of p, m and q are determined on the basis of Akaike Information Criterion (AIC). This model will demonstrate the volatility pattern of Indian stock market. However, any sudden shifts in the volatility due to global financial meltdown has been examined with the help of Dummies D1 and D2. The modified mean equation depicting the influence of global financial meltdown is as follows:

$$R_t = c + a_1 D_1 + a_2 D_2 + \mu_t \qquad (5)$$

where a_1 and a_2 measure the change in mean returns due to crisis

To account for the shift in variance as a result of global financial meltdown(2008), the variance equation is augmented as follow

$$\log(\sigma^2{}_t) = \omega + \sum_{i=1}^{p} \alpha_i \mu_{t-i} / \sigma_{t-i} + \sum_{j=1}^{m} \gamma_j \mu_{t-j} / \sigma_{t-j} + \sum_{K=1}^{q} \beta_k \log(\sigma^2{}_{t-k}) + a_3 D_1 + a_4 D_2 \quad (6)$$

In the above model, a_3 and a_4 are expected to explain the sudden shift in Return-Volatility in the stock market due to crisis. The volatility parameters to be estimated include ω, α, γ and β . As the stock returns series show a strong departure from normality, all the models will be estimated with student's-t as the conditional distribution for errors. The estimation will be done in such a way as to achieve convergence.

3. Empirical Results

The results of E-GARCH models stated in section 2.3 are presented in Tables 3 and 4. In Table 3, all the coefficients for ARCH (αs), GARCH (βs) and leverage effect (γs) are significant. The significant values of α_1 and α_2 (i.e. 0.1019 and 0.0440) suggest that two periods' lagged news about the market influence the current returns, meaning thereby that ARCH effect is present in the series. Further, significant positive coefficients of GARCH (β_1 and β_2) i.e. 0.7431 and 0.9216 represent that volatility clustering is present in the series. It implies that positive changes are followed by further positive changes and vice versa. Coefficients of γ_1 and γ_2 are negative and significant (i.e. -0.2073 and -0.0628 respectively), and hence depict the presence of leverage effect which implies that bad news in the previous two periods have a bigger impact than good news on the present volatility of Indian stock market. The reason for significant leverage effect may be that much of the trading in Indian stock market is driven through retail participants who formulate their decision based upon firm-specific information that is normally known with a lag. Also retail traders are less informed and they have little understanding

Table III. Parameter Estimates of E-GARCH Model (Without Dummy)

Variables	Coefficients	Probability
Mean Equation		
c	**0.0004**	**0.0509**
Variance Equation		
ω	**-0.2178****	**0.0005**
α_1	**0.1019****	**0.0000**
α_2	**0.0440****	**0.0473**
γ_1	**-0.2073****	**0.0000**
γ_2	**-0.0628****	**0.0003**
γ_3	**0.2325****	**0.0000**
β_1	**0.7431****	**0.0000**
β_2	**0.9803****	**0.0000**
β_3	**-0.7365****	**0.0000**
ARCH LM(1)		
F-Statistic	**1.5304**	**0.2164**
N*R^2	**1.5311**	**0.2159**

Note(i) Lag Length selection has been made on the basis of Akaike Information Criterion (AIC). (ii)**and* indicates significance at 5% and 10% respectively.

Source: Authors' calculations

regarding the fundamental and technical analysis. Moreover, majority retail traders have limited funds with which they want to stimulate their financial conditions and they do margin trading by following trends in the market. Therefore, any bad news affects market more aggressively than good news because in such conditions an uninformed trader takes decision haphazardly, which leads to high market volatility (Mahajan and Singh, 2009).

In Table 4, the results of E-GARCH including dummy variables D_1 and D_2 for global financial meltdown (2008) are enumerated. In the first part of the Table where the coefficients of mean equation are quoted shows the negative impact of global financial meltdown depicted by the negative significant coefficient of dummy, D1, which has been implicitly taken to visualize the impact of 2008 crisis on mean returns, i.e.to find the difference in mean returns and on volatility, among the pre crisis and crisis period. Similarly dummy, D2, signifies the difference between crisis and post crisis period. The negative significant coefficient of D1 and positive significant coefficient of D2 suggest that 2008 crisis affected the returns negatively, and returns seemed to soar, rather high, after the crisis (post crisis) period. The coefficients α_1, α_2 and α_3 in Table 4 are -0.1613, 0.4599 and -0.3011 which are significant, thereby depicting the presence of ARCH effect which implies that recent past news had had effect on the current period returns. The coefficient of β_1 in Table 4 is positive significant implying the presence of GARCH effect i.e. volatility clustering, which is the main property of this model, is present in the return series when the effect of crisis is included in the model. This elucidates that positive changes in the past are followed by further positive changes and vice-versa. Also, the negative significant coefficient of γ_1 (i.e.-0.19151) supports the presence of leverage effect. Albeit all the important characteristics of volatility are present in the return series of Indian stock market as explained in the results of Table 3, but the positive significant coefficient of dummy D1 suggests that U.S. financial meltdown led to increased volatility in Indian Stock market. And negative significant coefficient of D2 depicted that volatility get moderated after march, 2009. That is when the influence of meltdown came down, it resulted into fall in volatility.

Table IV. Parameter Estimates of E-GARCH Model Including Dummy (D1)

Variable	Coefficients	Probability
Mean Equation		
c	0.0016	0.2049
a_1	-0.0049**	0.0054
a_2	0.0055**	0.0004
Variance Equation		
ω	-0.0039	0.2600
α_1	-0.1613**	0.0000
α_2	0.4599**	0.0000
α_3	-0.3011**	0.0000
γ_1	-0.1951**	0.0003
γ_2	0.2594**	0.0117
γ_3	-0.0631	0.2194
β_1	2.2555**	0.0000
β_2	-1.5939**	0.0000
β_3	0.3378*	0.0600
a_3	0.0011*	0.0933
a_4	-0.0021**	0.0073
ARCH LM(1)		
F-Statistic	0.0779	0.7802
$N*R^2$	0.0781	0.7799

Note(i) Lag Length selection has been made on the basis of Akaike Information Criterion (AIC).(ii)**and* indicates significant at 5% and 10% respectively.

Source: Authors' calculations

The above discussion clearly suggests increased volatility of the Indian stock-return series during the crisis period. It might be due to the loss of confidence of domestic investors in the market because of continuous withdrawal of foreign institutional investments, particularly by U.S. institutional investors. Moreover, the insignificant ARCH-LM test statistic in both the tables show that standardized residuals did not exhibit additional ARCH effect; hence signifying that variance equations are well specified.

4. Summary and Conclusion

The present paper attempted to examine the influence of this meltdown on the volatility of returns in Indian stock market. Summary statistics including mean, standard deviation, skewness, kurtosis and Jarque Berra test were examined to study the basic properties of the data. An increase in the variance or volatility during the crisis period has been indicated by the coefficients of standard deviation in summary statistics. But this yardstick to measure volatility is of little relevance as it is a conventional approach to measure volatility. In the present study, a family of ARCH models have been used to detect the volatility

spillover in the returns of Indian stock market in the light of the global financial meltdown. The influence of crisis in the model has been seen by the use of dummy variables. With the use of E-GARCH methodology it has been found that there is spillover of information in the Indian stock market and with the significant coefficient of dummy in augmented model, it has been concluded that volatility of Indian stock returns has been influenced significantly due to subprime mortgage crisis in the U.S.

Finally, it is contended that every crisis has always left with some powerful lessons. Although India has not been as much affected by the turbulence, but it has conveyed some message to India too. That is, there is need for some checks on regulatory and supervisory institutions with some new objectives of the central bank. This meltdown in 2008 has raised some questions about the adequacy and efficacy of present international financial system to manage the global crisis. Thus, present or existing mechanisms to manage the financial system in developing as well as developed countries need a strong vigilance of financial and monetary authorities of these countries.

References

- Aggarwal, R. N. (2000) "Financial Integration and Capital Markets in Developing Countries: A Study of Growth." Volatility and Efficiency in Indian Capital Market. Institute of Economic Growth: 29-31.
- Alberg, D., Shalit, H. & Yosef, R. (2006) " Estimating Stock Market Volatility Using Asymmetric GARCH Models." Monaster Center For Economic Research, Israel, 10: 1-17.
- Batra, A. (2004) " Stock Return Volatility in India." Indian Council for Research on International Economic Relations. 124: 1-34.
- Chandrasekhar, C.P. & Gosh J. (2008) "India and Global Financial Crisis." Available at http://www.thehindubusinessline.in/bline/2008/10/21/stories/2008102150440900.htm.
- Chen, G-M, Michael, F. & Oliver, R (2001) "The Dynamic Relation Between Stock, Return, Trading Volume and Volatility." The Financial Review. 36: 153-174.
- Chong, C. Y. (2011) "Effects of Subprime Crisis on U.S. Stock Market Returns and Volatility." Global Economy and Finance Journal, No. 4: 102-111.
- Das, A., Kumar N.R., Debnath B. & Mandal S.C. (2012) "Global Economic Crisis: Causes, Impact on Indian Economy, Agriculture and Fisheries." International Journal of Agriculture Sciences, 4: 221-226.
- Dash, A. K. & Mallick, H. (2009) "Contagion Effect of Global Financial Crisis on Stock Market in India." available at www.devstnd.org.uk/..../4ab8f3d388d84SA7-kumardash-dsr09.pdf.
- Financial Crisis of 2007-2008, Wikipedia, the free encyclopedia, 2010.
- Gosh, J. (2000) "The Global Financial Crisis, Developing Countries and India." available at www.networkideas.org/ideasact/jan09/PDF/Jayanti.pdf.
- Kelejian, H. H. & Oates W.E. (1983) "Introduction to Econometrics: Principles and Applications." Harper and Row, Publishers, New York, London.
- Kumar, R. & Vashisht P. (2009) "The Global Economic Crisis: Impact on India and Policy Responses." Asian Development Bank Institute, Working paper series, 164: 1-29.
- Kumar, R. (2009) "Global Financial and Economic Crisis: Impact on India and Policy Response." Global Financial Crisis: Impact on India's Poor, Chapter 1, UNDP, India, pp.1-18.
- Kumar, R., & Tamimi M. (2011) "Economic Growth, Expected Stock Returns and Volatility: A Case of Indian Stock Market" The International Journal of Applied Economics and Finance, 4 : 257-268.

- Mahajan, S. & Singh B. (2009) "A Return-Volatility-Volume Analysis of Indian Stock Market." Ph.D Thesis submitted to the faculty of Business and Commerce at Guru Nanak Dev University, Amritsar, India.
- Malik, N. I., Ullah S., Azam K. & Khan A. (2009) "The Impact of Recent Global Financial Crisis on the Financial Institution in the Developing Countries- the Need for Global Solutions." International Review of Business Research Papers 5(5): 85-95.
- Mani, S. L. & Kumar A. S. (2009) "Impact of Global Financial Crisis on Indian Economy." available at www.indiamba.com/Faculty-Column/FC1094/fc1094.html.
- Mishra , P. K., Malla M., Mishra S., Pradhan B. B. & Mishra S.K. (2010) "Performance of Indian capital Market- An Empirical Analysis." European Journal of Economics, Finance and Administrative Sciences, 23: 49-57.
- Mishra, P. K. (2010) "A GARCH Model Approach to Capital Market Volatility: The Case of India." Indian Journal of Economics and Business. 9: 631-641.
- Mohan, R. (2008) "Global Financial Crisis and Key Risks: Impact on India and Asia." Remarks Prepared for IMF-FSF High Level Meeting on the Recent Financial Turmoil and Policy Responses at Washington D.C, October 9, 2008.
- Olowe, R. A. (2009) "Stock Return, Volatility And The Global Financial Crisis in an Emerging Market: The Nigerian Case." International Review of Business Research Paper. 5: 426-447.
- Pal, P. (2005) "Volatility in the Stock Market in India and Foreign Institutional Investors." Economic and Political Weekly. 765-772.
- Prasad, A. & Reddy C.P. (2009) "Global Financial Crisis and Its impact on India." Journal of Social Sciences, 21: 1-5.
- Raju, M. T., & Gosh A. (2004) "Stock Market Volatility: An International Comparison." Working Paper Series No. 8. Securities and Exchange Board of India.
- Rao, D. N. & Kaur G. (2009) "Effect of Global Economic Meltdown on Commodities Markets: An Empirical Study of Select Agricultural Commodities Traded in NCDEX." All India Management Association, Working Paper Series, December 6, 2009, Availble at SSRN:http://ssrn. com/abstract=1519325.
- Reserve Bank of India Publication (2009) "The Global Financial Crisis and the Indian Economy." Report on Currency and Finance 2008-09.
- Rui, M. (1997) "An Empirical Research of Stock Prices and Trading Volumes." Ph.D Thesis submitted to faculty of college of Business Administration at University of Houston.
- Tsay, R. S. (2005) "Analysis of Financial Time Series." Second Edition. A John Wiley and Sons, Inc. Publication.
- Wang, X. (2010) "The Relationship between Stock Market Volatility and Macroeconomic volatility: Evidence from China." International Research journal of Finance and Economics. 49: 149-160.

Annexure I

Daily Movements of Sensex since January, 2007