Impact of U.S. Recession on Indian Stock Market

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Abstract

Purpose: The crises of US had led to shocks and collapses in many countries. This paper intends to study the impact of recession on efficiency and volatility of Indian stock market.
Research Methodology: This paper uses the closing prices of all the major indices of NSE and BSE to represent Indian stock market. For efficiency, ACF test and run test were applied. EGARCH-M model is used to study the impact of recession on volatility of stock market.
Findings: The insignificant coefficient of variance in conditional mean equation of EGARCH-M implies that the market doesn't provide higher returns during the high volatility period. The results of EGARCH-M model showed that effect of bad news on stock market volatility has become insignificant for most of the indices in recession period. There is increase in the persistence of volatility. The result of ACF test reported efficiency in CNX 100, S&P CNX Defty, S&P CNX 500, BSE100, BSE 200 and BSE 500 during recession. While the run test reported weak form efficiency in returns of S&P CNX Nifty, CNX Nifty Junior, CNX 100, S&P CNX 500 and CNX Midcap and weak form inefficiency in S&P CNX Defty, BSE200 and BSE 500 in recession period.
Originality/value: This paper will be useful for both investors and regulators in decision making.

Keywords: Recession, Egarch-M Model, Volatility, Efficiency.

1. Introduction

The NBER defines an economic recession as: "a significant decline in the economic activity spread across the country, lasting more than a few months, normally visible in real GDP growth, real personal income, employment, industrial production, and wholesale-retail sales". In contrast, the financial press defines a recession as two consecutive quarters of decline in real GDP – a rule of thumb that is not consistent with the economic cycles in US and other countries.

An economy typically expands for 6-10 years and tends to go into recession for about six months to two years. A recession normally takes place when consumers lose confidence in the growth of the economy and spend less. This leads to a decreased demand for goods and services which in turn leads to a decrease in production, lay-offs and a sharp rise in unemployment.

Developing countries are now relatively open economies which accelerate their economic growth. From 2003 to 2007, the collective GDP of developing countries grew more than 5% each year; in 2006, the growth rate peaked at nearly 8%, with all developing region close to or exceeding 5% growth. With this degree of growth, developments in international markets are bound to affect the economy of developing countries. This has increased the concern of many parties, namely, the investors, bankers, portfolio managers and academicians at large because innovation in other markets, especially coming from US and Japan tends to have substantial influence on local stock market returns and performance. Therefore, it is vital to investigate the impact of US recession on the developing countries.

The turmoil in the international financial markets of advanced economies that started around mid-2007 has exacerbated substantially since August 2008. The failure of Lehman Brothers in mid- September was followed in quick recession by several other large financial institutions coming under severe stress. This made financial markets around the world uncertain and unsettled. A Dec 1 2008, report from the National Bureau of Economic Research stated that the US has been in recession since December, 2007(when economic activity peaked), based on a number of measures including job losses, declines in personal income and decline in real GDP.

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Although the full-fledged crisis struck first in the US, but US is not alone in its vulnerability to shocks and collapses. The US recession have engulfed complete world economy with a varying degree of recessional impact. This impact can be observed from the falling stock market, recession in jobs availability and companies following downsizing in the existing staff and cutting down of the perks and salary corrections. The recession caused substantial reduction in exports, GDP and also led to negative shock to investment in emerging markets. India is not isolated either. Although India's cautious approach towards reforms has saved it from possibly disastrous implications, Indian economy is also facing a slowdown. The prime reason is increasing integration of Indian financial market with international financial market.

Stock market is widely related to macroeconomic fundamentals of an economy. The notion that macroeconomic factors can drive the movement of stock prices is now widely accepted. Due to this correlation, the stock market doesn't remain unaffected from the recession. The stock market moves up and down largely on investors' outlook on future market conditions. During recession, investors become pessimistic and they start selling off their stocks in favor of investment instrument which are not largely affected by market volatility such as Treasury bonds. The sell off of stock causes stock prices to drop even further, causing an overall drop in the stock prices. The stock market volatility is higher during recession as compared to normal condition.

This study intends to achieve following objectives:

1. To measure the impact of recession on efficiency of Indian stock market.
2. To measure the impact of recession on volatility of Indian stock market.
3. To measure the leverage effect with the help of EGARCH-M model.
4. To compare the impact of recession on the indices of NSE and BSE

2. Literature Review

Kaur(2010) investigated the impact of recession of 2007-2009 on the Indian tyre industry with respect to its effect on production, exports, sales and profit of the industry and found that tyre industry has been worst-hit by recession.

Dake and Mathur(2010) analyzed the growth trends of international trade of India especially the export and import trade in the lights of the global recession by dividing the period of Apr 2006 to Mar 2010 into pre recession period(Apr 2006 to Mar 2008) and post recession period(Apr 2008 to Mar 2010). They found falling trend in both exports and imports during recession.

Siddiqui (2009) studied the impact of financial crises of year 2007-2009 on the growth, trade and employment in emerging market economies (EMEs), namely China and India. He found decline in the industrial output which caused decline in employment. The sharp fall in the growth rate led to the increased level of poverty in India.

Bello (2009) investigated the performance of five categories of U.S domestic mutual funds during the recession of 1990 and 2001 and during the 12 months following each recession. The results showed that stock mutual fund performance was higher in post recession period of 1990. However, during the recession of 2001, four of the five mutual fund categories and the S&P 500 index realized negative returns during the recession.

Raghavan(2008) tested the presence and magnitude of the mean and volatility spillover effect from the U.S. and Japan to the three pacific –basin markets during the pre and post financial crisis of 1999. He found that both U.S and the Japanese market appeared to have significant role in transmitting the mean and volatility spillover effect in the pacific basin region.

Lim et al. (2008) investigated the effects of the 1997 financial crisis on the efficiency of eight Asian stock markets by applying the rolling bicorrelation test statistics for the three sub-periods of pre-crisis, crisis, and post-crisis. On a country-by-country basis, the results demonstrated that the crisis adversely affected the efficiency of most Asian stock markets, with Hong Kong being the hardest hit, followed by the Philippines, Malaysia, Singapore, Thailand and Korea. However, most of these markets recovered in the post-crisis period in terms of improved market efficiency.

Ng (2000) analyzed the magnitude and changing nature of return and volatility spillover from Japan and U.S. to the pacific Basin markets. The study found that both the regional (Japan) and world (U.S) factors caused significant volatility in the Pacific- Basin region and the spillover was much more pronounced after the liberalization processes in the Pacific-Basin region.

Liu and Pan (1997) investigated the mean return and volatility spillover effect from the U.S. and Japan to four Asian stock markets, namely, Hong-Kong, Singapore, Taiwan and Thailand for the period from 1984 to 1991. The findings suggested that the spillover effect from U.S. and Japan have increased significantly after the Oct 1987 stock market crisis.

Hamao et al. (1991) investigated if there is volatility spillover from the U.S and the U.K. markets onto Asia Pacific markets trading in different zones during the crisis of 1987. The results reported asymmetric pre-crash (prior to 1987 crash) volatility spillover from New York to London and London to Tokyo. The report also showed that the post-crash volatilities have increased and the effects from Japan were more pronounced after the crash.

Existing literature on the impact of recession focus mainly on advanced economies with little or no attention to the Indian stock markets and no study has been conducted on the impact of recession of December, 2007. In order to fill this gap in the literature, this paper conducts an empirical investigation of the impact of U.S. recession on the Indian stock market.

3. Methodology

3.1. Data Collection

Since National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) are the two major stock exchange of India, we employed closing prices of the major indices of these exchanges to represent Indian stock market. The study also used the closing prices of S&P 500 index (U.S.) to analyze the spillover effect from U.S.The study covers the period from 1 April 2004 to 31 March 2009. In order to see the impact of market contagion on return and volatility spillover effects during the recession, the sample period was divided into two sub- periods with the 2007 financial crisis as the cut-off point. The pre recession period cover from April 1, 2004 to November 31, 2007 and recession period cover from December 1, 2007 to March 31, 2009. Table 1 Exhibits the details of the Indices used for the study.

3.2 Research Methodology

All the results are computed on the basis of R_t which is the rate of return r in period t, computed as logarithmic first difference. The descriptive statistic is calculated to know the nature of time series. To test the efficiency, whole period of study is divided into two parts: before recession and during recession period. Following tests are applied to test impact of recession on efficiency of Indian Stock market:

Table 1: Indices

S.No.	*Indices*	*Exchange*
1.	S&P CNX Nifty	National Stock Exchange
2.	CNX Nifty Junior	National Stock Exchange
3.	CNX 100	National Stock Exchange
4.	S&P CNX 500	National Stock Exchange
5	CNX Midcap	National Stock Exchange
6.	Nifty Midcap 50	National Stock Exchange
7.	S&P CNX Defty	National Stock Exchange
8.	Sensex	Bombay Stock Exchange
9.	BSE MID-CAP	Bombay Stock Exchange
10.	BSE SMALL-CAP	Bombay Stock Exchange
11.	BSE-100	Bombay Stock Exchange
12.	BSE-200	Bombay Stock Exchange
13.	BSE-500	Bombay Stock Exchange

ADF test: Since one of the requirements for random walk is that the time series must contain unit root, we applied ADF test both at level and first difference, to check the stationarity. If the series is stationary at first difference then, it follows the weak form efficiency hypotheses.

The null hypothesis of both the ADF test is:

H_0: The series is non stationary.

H_1: The series is stationary.

ADF test is conducted in the form of the following regression equation:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

Where t is the trend term, β_2 is the coefficient for the trend, β_1 is the constant and ε_t is the error term

ACF TEST: Autocorrelation Function (ACF) test is a statistical tool that can be used to detect the dependence of successive terms in a given time. This test is often used in order to measure the relationship between the stock return at current period and its lagged value. The specification of the autocorrelation test is as follows:

$$\rho_k = \frac{\sum_{t=1-k}^{m} (r_t - \bar{r})(r_{t-k} - \bar{r})}{\sum_{t=1}^{m} (r_t - \bar{r})^2}$$

Where ρ_k is the serial correlation coefficient of returns at lag k; m is the number of observations; r_t is the stock return at time t; while r_{t-k} is the stock return over period t-k; $\bar{r}$ is the sample mean of stock returns; and k is the lag of the period. If the series show random walk, this means that returns are uncorrelated. If there is no serial correlation among returns, the autocorrelation at all lags should be nearly zero, and all Q stat should be insignificant with large p values.

Run test: Run test (also called *Wald–Wolfowitz test* after Abraham Wald and Jacob Wolfowitz) is a non-parametric statistical test that checks a randomness hypothesis for a time series. Run test doesn't require normal distribution. A run is defined as a series of increasing values or a series of decreasing values. The number of increasing, or decreasing, values is the length of the run. To test the randomness of distribution, the data whose value is greater than mean is marked with positive sign and value less than mean is marked with negative sign. Suppose the price changes are independent, the total number of expected runs E(r) can be estimated as for large samples as:

$$E(r) = \frac{2N_1N_2}{N} + 1$$

Where N is total number of observation (N_1+ N_2)

N_1= the number of price changes (+ sign)

N_2= the number of price changes (- sign)

If the number of observation is large (N>30), E(r) has normal distribution. The variance of E(r) (σ_r^2) is given by:

$$\sigma_r^2 = \frac{2N_1N_2(2N_1N_2)}{N^2(N-1)}$$

Prob (E(r) – 1.96$\sigma_r \leq R \leq$ E(r) +1.96σ_r) = 0.95

Where R is actual number of runs.

The standard normal Z test statistics used to conduct a run test is given by:

$$Z = \frac{(R \pm 0.5) - E(r)}{\sigma_r}$$

R= Actual number of runs

E(r) = the expected number of runs

σ_r = std error of expected number of runs

The hypotheses for Runs Tests are:

H_0: The series is random.

H_1: The series is not random.

When |Z| > 1.96, we have to reject the null hypothesis of randomness (at a significance level of = 0.05). Once this occurs, we can conclude that the price changes are not random.

Following tests are applied to test impact of recession on volatility of Indian Stock market:

ARCH LM: Since GARCH family models can be applied only when series is hetroscedastic, ARCH LM test is used to check the heteroscedasticity. Engle (1982) introduced a new approach for modeling heteroscedasticity in a time series. He called it the ARCH (Autoregressive conditional heteroscedasticity) model. The process by which the variances are generated is assumed to be as follows:

$$\sigma_1^2 = \alpha_0 + \alpha_1\mu^2_{t-1} + \ldots\ldots\ldots\ldots + \alpha_p\mu^2_{t-p}$$

This equation is known as p^{th} order ARCH process.

The null hypothesis is:

H_0= There is no arch effect.

H_1= There is arch effect.

EGARCH-M: An EGARCH-M model was introduced by Nelson (1991) in order to overcome the limitations of the GARCH and GARCH-M models. We preferred EGARCH-M model for three reasons. Firstly, this model does not have restrictions of positive signs on ARCH and GARCH coefficients. Secondly, it captures the asymmetric feature of data and does not hold the assumption of symmetrical effect on volatility, allowing for different handling of good and bad news and does not have restrictions of positive signs on ARCH and GARCH coefficients. Thirdly, it introduces conditional variance into mean equation. Following is the specification of EGARCH-M model:

Table 2: Descriptive Statistics

Indices	*Mean*		*Standard Deviation*		*Skewness*		*Kurtosis*		*Jarque-Bera*	
	Before	*During*	*Before*	*During*	*Before*	*During*	*Before*	*During*	*Before*	*During*
S&P CNX Nifty	0.0013	-0.0021	0.0153	0.0267	-1.0850	-0.3439	11.724	4.6384	3105.40 (0.0000)	42.498 (0.0000)
CNX Nifty Junior	0.0013	-0.0031	0.0173	0.0296	-1.3976	-0.3239	12.5010	4.4044	3768.00 (0.0000)	32.19411 (0.0000)
CNX 100	0.0013	-0.0022	0.0153	0.0268	-1.1928	-0.3398	12.2891	4.5355	3529.70 (0.0000)	37.9475 (0.0000)
S&P CNX 500	0.0013	-0.0024	0.0149	0.0259	-1.3988	-0.4058	13.2026	4.6607	4299.62 (0.0000)	45.98662 (0.0000)
CNX Midcap	0.0014	0.0011	0.0154	0.0156	-1.6550	-2.5480	13.9803	23.6437	5052.72 (0.0000)	6084.926 (0.0000)
Nifty Midcap 50	0.0014	-0.0019	0.0173	0.0252	-1.2924	-0.0265	10.5639	6.2823	2454.62 (0.0000)	145.0321 (0.0000)
S&P CNX Defty	0.0014	-0.0028	0.0163	0.0298	-1.0726	-0.2297	11.7776	4.1544	3136.65 (0.0000)	20.77751 (0.0000)
Sensex	0.0013	-0.0022	0.0147	0.0275	-0.8304	-0.1463	10.3021	3.8563	2138.01 (0.0000)	10.9178 (0.0043)
BSE MID-CAP	0.0015	-0.0034	0.0147	0.0240	-1.7679	-0.7207	13.3374	6.1367	4585.59 (0.0000)	160.3794 (0.0000)
BSE SMALL-CAP	0.0018	-0.0037	0.0163	0.0227	-1.4786	-0.7986	8.6625	5.1919	1567.79 (0.0000)	98.9981 (0.0000)
BSE-100	0.0013	-0.0024	0.0147	0.0273	-1.0102	-0.2832	10.9907	4.1659	2609.79 (0.0000)	22.61445 (0.0000)
BSE-200	0.0013	-0.0024	0.0149	0.0266	-1.2649	-0.3131	12.5303	4.2764	3735.10 (0.0000)	27.20693 (0.0000)
BSE-500	0.0013	-0.0026	0.0148	0.0261	-1.3492	-0.3648	12.7152	4.3986	3905.66 (0.0000)	33.4935 (0.0000)

p values are reported in parentheses

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 R_{S\&P500-1} + \lambda\sigma_t^2 + \varepsilon_t$$

Where α_1 is the coefficient of lagged return, α_2 is coefficient of return of S&P500 and λ measures the risk premium.

Variance equation:

$$\log(\sigma_t^2) = \omega + \alpha \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \gamma \left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \beta \log(\sigma_{t-1}^2)$$

Where α measures the impact of recent news on the volatility, γ estimates the asymmetric effect of news and β indicates the persistence of volatility.

4. Findings and Discussion

Table 2 presents the descriptive statistic of the sample, which consists of 13 indices of NSE and BSE for the period of 1 April, 2004 to 31 March, 2009.The mean return of all the indices has decreased during recession. The volatility can be expressed in terms of standard deviation of return. The standard deviation for all the indices has increased in recession period which implies increase in the volatility. The series became less skewed in recession. There are evidences of excess kurtosis for both before and during

Table 3: Unit Root Test

Indices	*ADF (At level)*						*ADF(At first log difference)*					
	Intercept		*Trend & Intercept*		*None*		*Intercept*		*Trend & Intercept*		*None*	
	Before	*During*	*Before*	*During*	*Before*	*During*	*Before*	*During*	*Before*	*During*	*Before*	*During*
S&P CNX Nifty	1.2186	-1.2651	-2.0288	-2.4777	2.8780	-1.7707	-23.3945	-16.9819	-23.4309	-16.9616	23.1827	-16.9137
	(0.9983)	(0.6465)	(0.5842)	(0.3391)	(0.9991)	(0.0728)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CNX Nifty Junior	1.4227	-1.5442	-1.1823	-2.4104	2.7653	-2.08443	-23.036	-15.7479	-23.0621	-15.7373	-22.8823	-15.6197
	(0.9991)	(0.51)	(0.9126)	(0.3734)	(0.9988)	(0.0358)	(0.0000)	(0.0000	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CNX 100	1.2870	-1.2856	-2.2059	-2.3912	2.8577	-1.8710	-23.2381	-16.7999	-23.2737	-16.7811	-23.0308	-16.7204
	(0.9986)	(0.6372)	(0.4852)	(0.3834)	(0.9991)	(0.0586)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
S&P CNX 500	1.3310	-1.2301	-1.7627	-2.1552	2.9570	-2.0127	-23.2143	-16.2235	-23.2401	-16.2059	-22.9938	-16.1213
	(0.9988)	(0.6623)	(0.7221)	(0.5125)	(0.9993)	(0.0425)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CNX Midcap	1.3946	-1.2224	-1.1800	-2.6882	3.0270	-1.8498	-22.8632	-15.0169	-22.874	-15.04	-22.6394	-14.9426
	(0.9991)	(0.6656)	(0.9130)	0.2422	(0.9995)	0.0614	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Nifty Midcap 50	0.8285	-1.4047	-1.5039	-2.6096	2.4752	-2.0260	-22.7388	-15.987	-22.738	-15.9888	-22.5681	-15.7963
	(0.9945)	(0.5803)	(0.8280)	(0.2763)	(0.9971)	(0.0412)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
S&P CNX Defty	1.4717	-1.1334	-1.4907	-2.4138	2.8382	-2.0982	-22.6064	-16.6155	-22.67	-16.592	-28.1086	-16.502
	(0.9993)	(0.7034)	(0.8324)	(0.3716)	(0.9990)	(0.0347)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Sensex	1.1353	-1.2069	-2.5687	-2.5781	2.9777	-1.8144	-23.3849	-16.5488	-23.4125	-16.5259	-23.1205	-16.478
	(0.9978)	(0.6724)	(0.2950)	(0.2907)	(0.9994)	(0.0663)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BSE MID-CAP	0.7648	-1.1746	-2.0600	-2.4177	2.6744	-2.16739	-22.1459	-14.4152	-22.1388	-14.3926	-21.8753	-14.2008
	(0.9934)	(0.6863)	(0.5669)	(0.3696)	(0.9984)	(0.0293)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BSE SMALL-CAP	0.2412	-1.0086	-1.8793	-2.3876	2.4441	-1.9696	-15.6147	-12.8647	-15.6149	-12.8439	-15.3259	-12.6214
	(0.9750)	(0.7511)	(0.6644)	(0.3853)	(0.9968)	(0.0469)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BSE-100	1.4957	-1.1785	-1.6442	-2.4170	3.1072	-1.9132	-23.1972	-16.4553	-23.235	-16.4553	-22.944	-16.3671
	(0.9993)	(0.6846)	(0.7748)	(0.37)	(0.9996)	(0.0533)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BSE-200	1.4850	-1.1645	-1.6025	-2.3174	3.0383	-1.9816	-23.2331	-16.2683	-23.2708	-16.2468	-23.0098	-16.1695
	(0.9993)	(0.6905)	(0.7917)	0.4228	(0.9995)	(0.0556)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BSE-500	1.5146	-1.1289	-1.5162	-2.21154	3.1382	-2.0675	-23.1371	-16.0504	-23.1679	-16.0288	-22.8949	-15.9373
	(0.9994)	(0.7052)	(0.8237)	(0.4811)	(0.9996)	(0.0373)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

p values are reported in parentheses

recession period. The Jarque Bera test rejects the null hypotheses of normality.

To test the stationarity of returns of indices, we have applied ADF test. ADF test is applied at both level and first log difference of stock prices. The result of ADF test is shown in table 3. The null hypothesis of nonstationarity can not be rejected for all the series at the level. However, ADF reject the null hypothesis of unit root in the first difference for all the indices. Therefore all the series are integrated of order one, i.e., I (1).

ACF test is applied to know the predictability of current stock return on the basis of past return. The results of ACF test is shown in Table 4. According to results reported in the table, ACF test reject the null hypothesis of no serial correlation for CNX Nifty Junior, CNX 100, S&P CNX 500, CNX Midcap, S&P CNX Defty, BSE Mid-Cap, BSE Small-Cap, BSE100, BSE 200, BSE500 with exception of S&P CNX Nifty and Sensex in pre recession period. In recession period, ACF test reject the null hypotheses of no serial correlation for CNX Nifty Junior, CNX Midcap, Nifty Midcap 50, BSE Mid-Cap and BSE Small cap with the exception of S&P CNX Nifty, S&P CNX 500, S&P

Table 4: ACF TEST Autocorrelation Test with p Lags

Indices	*Lags*							
	1		*4*		*8*		*12*	
	Before	**During**	**Before**	**During**	**Before**	**During**	**Before**	**During**
S&P CNX Nifty								
ACF	0.063	0.051	0.067	-0.117	-0.019	0.134	-0.048	0.007
Q statistic	3.6721	0.8588	20.176	5.4834	26.447	13.928	43.844	15.777
p – Value	(0.055)	(0.354)	(0.000)	(0.241)	(0.001)	(0.084)	(0.000)	(0.202)
CNX Nifty Junior								
ACF	0.169	0.128	0.069	-0.153	-0.055	0.103	-0.065	-0.061
Q statistic	26.354	5.367	46.786	14.194	67.695	20.949	95.697	22.278
p – Value	(0.000)	(0.021)	(0.000)	(0.007)	(0.000)	(0.007)	(0.000)	0.035
CNX 100								
ACF	0.085	0.062	0.069	-0.121	-0.021	0.13	-0.056	-0.003
Q statistic	6.6954	1.2529	24.154	6.0861	32.11	14.059	54.273	15.45
p – Value	(0.01)	(0.263)	(0.000)	(0.193)	(0.000)	(0.08)	(0.000)	(0.218)
S&P CNX 500								
ACF	0.116	0.097	0.079	-0.121	-0.03	0.127	-0.058	-0.009
Q statistic	12.48	3.0481	32.748	7.9978	41.891	15.587	65.272	16.487
p – Value	(0.000)	(0.081)	(0.000)	(0.092)	(0.000)	(0.049)	(0.000)	(0.17)
CNX MIDCAP								
ACF	0.0178	0.199	0.107	0.17	-0.059	-0.099	-0.05	-0.093
Q statistic	29.264	12.879	54.103	39.454	70.556	53.464	90.02	76.828
p – Value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
NIFTY MID CAP 50								
ACF	0.178	-0.147	0.078	-0.068	-0.052	0.073	-0.05	0.095
Q statistic	29.288	7.0035	48.313	20.605	57.794	24.442	77.888	29.83
p – Value	(0.000)	(0.008)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.003)
S&P CNX DEFTY								
ACF	0.069	0.073	0.058	-0.099	-0.009	0.115	-0.034	0.02
Q statistic	4.3573	1.7223	14.257	5.0658	18.672	12.572	32.234	15.273
p – Value	(0.037)	(0.189)	(0.007)	(0.281)	(0.017)	(0.127)	(0.001)	(0.227)

Indices	Lags							
	1		4		8		12	
SENSEX								
ACF	0.053	0.072	0.077	-0.128	-0.013	0.132	-0.041	0.000
Q statistic	2.5914	1.6903	20.355	7.4765	27.448	15.613	45.033	17.597
p – Value	(0.107)	(0.194)	(0.000)	(0.113)	(0.000)	(0.048)	(0.000)	(0.128)
BSE MIDCAP								
ACF	0.194	0.213	0.108	-0.088	-0.062	0.121	-0.047	-0.032
Q statistic	34.907	14.741	54.939	20.357	68.808	27.173	88.118	27.799
p – Value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.006)
BSE SMALL CAP								
ACF	0.222	0.318	0.095	-0.052	-0.065	0.109	-0.027	-0.016
Q statistic	45.505	32.914	57.899	43.118	65.939	49.398	75.503	50.832
p – Value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BSE 100								
ACF	0.085	0.082	0.077	-0.137	-0.021	0.133	-0.044	-0.012
Q statistic	6.7527	2.2176	24.58	8.3823	32.708	16.343	50.648	17.288
p – Value	(0.009)	(0.136)	(0.000)	(0.079)	(0.000)	(0.038)	(0.000)	(0.139)
BSE 200								
ACF	0.111	0.097	0.078	-0.138	-0.028	0.129	-0.054	-0.009
Q statistic	11.333	3.0856	31.464	9.3948	41.457	16.653	63.357	17.535
p – Value	(0.001)	(0.079)	(0.000)	(0.052)	(0.000)	(0.034)	(0.000)	(0.131)
BSE 500								
ACF	0.121	0.11	0.084	-0.132	-0.034	0.129	-0.055	-0.011
Q statistic	13.576	3.9791	34.46	9.8998	44.683	17.062	67.579	17.841
p – Value	(0.000)	(0.046)	(0.000)	(0.042)	(0.000)	(0.029)	(0.000)	(0.121)

p values are reported in parentheses

CNX Defty, Sensex, BSE100, BSE 200 and BSE500. The results showed that CNX 100, S&P CNX Defty, S&P CNX 500, BSE100, BSE 200, BSE500 became efficient in weak form during recession.

Since Jarque Bera Test rejects the null hypotheses of the normality, we need to apply non parametric test. Therefore, we have applied run test by using mean to see the effect of recession on the efficiency of Indian Stock Market. Table 5 reports the results of Run test. In pre-recession period, run test reject the null hypothesis of random walk for all the indices except S&P CNX Defty, Sensex, BSE100, BSE200 and BSE500 which implies returns of these series are efficient in weak form. During recession period, the run test reject the null hypothesis of random walk for all the indices except S&P CNX Nifty, CNX Nifty Junior, CNX100, S&P CNX 500, CNX Midcap, Sensex and BSE100. Therefore, S&P CNX Nifty, CNX Nifty Junior, CNX100, S&P CNX 500, CNX Midcap became efficient during recession. While returns of S&P CNX Defty, BSE200 and BSE 500 became inefficient in weak form in recession period.

We have applied ARCH LM test to check the presence of hetroscedasticity. Table 6 reports the results of ARCH LM test. This test rejects the null hypotheses of no ARCH effect for all the indices in both pre and during recession period which implies that ordinary regression model will be inefficient to check the effect of recession on Indian stock market. Therefore, we have to apply EGARCH-M model which take care of hetroscedasticity.

EGARCH M test is used to see the impact of recession on volatility of stock market. Table 7 reports the estimates of EGARCH M model. Panel A display the estimates for conditional mean equation, while panel B shows the conditional variance equation estimates. This model

Table 5: Run Test by Using Mean

Indices	*Test Value*		*Cases < Test Value*		*Cases >= Test Value*		*Total Cases*		*Number of Runs*		*Z*		*Asymp. Sig. (2-tailed)*	
	Before	*During*	*Before*	*During*	*Before*	*During*	*Before*	*During*	*Before*	*During*	*Before*	*During*	*Before*	*During*
S&P CNX Nifty	0.00125	-0.00205	436	152	486	171	922	323	429	157	-2.092	0.553	0.036	0.581
CNX Nifty Junior	0.00129	-0.00308	410	153	512	170	922	323	413	139	-2.893	-2.577	0.004	0.10
CNX 100	0.00125	-0.00219	424	149	497	174	921	323	429	149	-1.965	-1.405	0.044	0.160
S&P CNX 500	0.00128	-0.00239	408	153	514	170	922	323	425	145	-2.064	-1.906	0.039	0.057
CNX Midcap	0.00138	0.00111	383	130	539	193	922	323	415	147	-2.293	-1.084	0.022	0.278
Nifty Midcap 50	0.00138	-0.00336	397	153	525	168	922	323	405	135	-3.233	-3.041	0.001	0.002
S&P CNX Defty	0.00135	¯0.00282	432	156	490	167	922	323	439	143	-1.401	-2.155	0.161	0.031
Sensex	0.0013	-0.00219	434	157	481	163	915	320	433	150	-1.611	-1.226	0.107	0.220
BSE MID-CAP	0.0015	-0.00336	379	147	543	176	922	323	399	119	-3.295	-4.742	0.001	0.000
BSE SMALL-CAP	0.0018	¯0.00371	386	144	536	179	922	323	399	119	-3.439	-4.692	0.001	0.000
BSE-100	0.00134	-0.00235	423	153	499	170	922	323	433	151	-1.716	-1.235	0.860	0.271
BSE-200	0.00129	-0.00243	415	153	567	170	922	323	431	143	-1.756	-2.129	0.078	0.033
BSE-500	0.00134	-0.00255	417	148	515	175	922	323	427	143	-1.916	-2.062	0.055	.039

also helps to see the efficiency of the stock market. If the parameter of the exogenous variable α_1 in mean eq for GARCH model is insignificant different from zero, that is $\alpha_1 = 0$, we accept weak form EMH otherwise, we reject the hypothesis that the market is weak form efficient. Also, the closeness of the sum of α and β to 1 indicates a high persistence in the volatility clustering which implies inefficiency in the market. According to results reported in panel A of table 6, $\alpha_1 \neq 0$ for all the indices which implies that returns of all the indices are inefficient in weak form. The results also show that the current returns of all the indices are significantly related to their lagged values in before recession period. But returns of S&P CNX Nifty, CNX 100, S&P CNX Defty, S&P CNX 500, Sensex, BSE 100, BSE 200 and BSE 500 showed insignificant relation with their lagged values. The lagged returns of S&P 500 are not significantly related to returns of all the indices of Indian stock market in both the period which implies that stock prices of India can't be predicted with the help of stock prices of US. The coefficient of risk premium is not significant which implies that investors will not be compensated for taking higher risk.

Considering panel B, α measures the impact of recent news on the stock market volatility. As per the results of table, the impact of recent news on the volatility of stock market was significant in pre recession period. But the effect of recent news has became insignificant for

Table 6: Arch LM Test

Indices	*F-statistic*		*Obs*R-squared*	
	Before	*During*	*Before*	*During*
S&P CNX Nifty	42.2558	5.252867	270.479	42.24478
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CNX Nifty Junior	45.1093	6.2785	283.075	49.1965
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CNX 100	49.6243	5.2477	301.917	42.2094
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
S&P CNX 500	53.2756	5.7538	316.535	45.6857
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CNX Midcap	59.1502	46.4973	338.484	181.5486
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Nifty Midcap 50	42.321	11.1295	270.773	77.7642
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
S&P CNX Defty	32.3509	5.2599	222.549	42.2941
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Sensex	32.2040	6.491119	221.382	50.52792
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BSE MID-CAP	54.6526	11.0753	321.829	77.4788
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BSE SMALL-CAP	33.0712	10.87503	226.275	76.42019
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BSE-100	37.1766	6.0703	246.764	47.8147
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BSE-200	48.3498	6.2364	296.792	48.9182
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BSE-500	50.48101	6.3548	305.492	49.6997
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

p values are reported in parentheses

Table 7: Egarch-M Test

Panel A								
Mean Equation								
Indices	α_0		α_1		α_2		λ_3	
	Before	*During*	*Before*	*During*	*Before*	*During*	*Before*	*During*
S&P CNX Nifty	0.0009	-0.0052	0.1103	0.0389	0.0857	0.0742	1.5271	4.8157
	(0.2076)	(0.0691)	(0.0051)	(0.5032)	(0.1275)	(0.233)	(0.7225)	(0.3062)
CNX Nifty Junior	0.00014	-0.0039	0.2093	0.1482	0.0583	0.0977	3.8466	1.2135
	(0.8647)	(0.3471)	(0.0000)	(0.0177)	(0.3362)	(0.1454)	(0.331)	(0.8164)
CNX 100	0.0007	-0.0050	0.1361	0.0537	0.1687	0.0793	3.1229	4.2973
	(0.3338)	(0.0879)	(0.0006)	(0.3768)	(0.0035)	(0.205)	(0.4460)	(0.3624)
S&P CNX 500	0.0062	-0.0041	0.1572	0.1031	0.0754	0.0744	3.3688	3.0926
	(0.3669)	(0.1396)	(0.0002)	(0.0996)	(0.1713)	(0.2067)	(0.4358)	(0.5204)
CNX Midcap	0.0005	0.0006	0.1993	0.2058	0.0791	-0.0186	3.8255	0.9209
	(0.4192)	(0.4567)	(0.0000)	(0.0059)	(0.1313)	(0.3488)	(0.2882)	(0.8553)
Nifty Midcap 50	0.0007	-0.0047	0.2146	0.2305	0.0840	0.1101	3.0440	2.6911
	(0.3105)	(0.1028)	(0.0000)	(0.0006)	(0.2012)	(0.0686)	(0.3601)	(0.552)
S&P CNX Defty	0.0010	-0.0071	0.1098	0.0636	0.1281	0.0703	0.5604	5.0883
	(0.1527)	(0.0221)	(0.0056)	(0.3068)	(0.0338)	(0.3063)	(0.8842)	(0.2003)
Sensex	0.0011	-0.0060	0.1191	0.0895	0.0678	-0.0753	1.1492	5.2280
	(0.1617)	(0.0218)	(0.0040)	(0.1066)	(0.287)	(0.4426)	(0.8101)	(0.1954)
BSE MID-CAP	0.0010	-0.0020	0.1988	0.2689	0.0449	0.0828	1.2366	-0.6538
	(0.0828)	(0.375)	(0.0000)	(0.0000)	(0.3666)	(0.1101)	(0.7558)	(0.9022)
BSE SMALL-CAP	0.0012	-0.0021	0.2139	0.3688	0.0086	0.0774	1.7543	-0.6125
	(0.1487)	(0.2306)	(0.0000)	(0.0000)	(0.8904)	(0.0924)	(0.6445)	(0.9021)
BSE-100	0.0009	-0.0046	0.1500	0.0699	0.0765	0.0796	1.6825	3.6006
	(0.1668)	(0.1243)	(0.0003)	(0.241)	(0.1552)	(0.2067)	(0.7117)	(0.44)
BSE-200	0.0007	-0.004	0.1613	0.0883	0.0736	0.0783	2.2795	3.0193
	(0.2446)	(0.1414)	(0.0001)	(0.1574)	(0.1704)	(0.2017)	(0.5864)	(0.5199)
BSE-500	0.0008	-0.0036	0.1653	0.1146	0.0683	0.0753	2.3983	2.355652
	(0.2108)	(0.1895)	(0.0001)	(0.0682)	(0.2103)	(0.2054)	(0.5682)	(0.6187)
Panel B								
Variance Equation								
	ω		α		γ		β	
Indices	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*
S&P CNX Nifty	-1.2859	-0.5365	0.2986	0.1091	-0.2160	-0.1542	0.8788	0.9394
	(0.0006)	(0.0664)	(0.0000)	(0.2122)	(0.0000)	(0.0281)	(0.0000)	(0.0000)
CNX Nifty Junior	-1.3482	-0.8631	0.2889	0.1921	-0.2071	-0.1267	0.8678	0.9005
	(0.0000)	(0.0646)	(0.0001)	(0.0643)	(0.0001)	(0.0976)	(0.0000)	(0.0000)
CNX 100	-1.2411	-0.5615	0.2804	0.1147	-0.2212	-0.1508	0.8831	0.9364
	(0.0002)	(0.0808)	(0.0001)	(0.1567)	(0.0000)	(0.0276)	(0.0000)	(0.0000)
S&P CNX 500	-1.3987	-0.6298	0.2799	0.1283	-0.2428	-0.1565	0.8658	0.9293
	(0.0002)	(0.102)	(0.0001)	(0.1523)	(0.0000)	(0.0282)	(0.0000)	(0.0000)
CNX Midcap	-1.2917	-0.7074	0.3348	0.3444	-0.1879	-0.0738	0.8823	0.9494

Panel A								
Mean Equation								
Indices	α_0		α_1		α_2		λ_3	
	Before	During	Before	During	Before	During	Before	During
	(0.0000)	(0.0052)	(0.0001)	(0.0005)	(0.0002)	(0.3535)	(0.0000)	(0.0000)
Nifty Midcap 50	-1.3254	-1.2342	0.3565	0.2668	-0.1772	-0.1808	0.8766	0.8595
	(0.0000)	(0.0156)	(0.0001)	(0.0291)	(0.0003)	(0.0589)	(0.0000)	(0.0000)
S&P CNX Defty	-1.4233	-0.4396	0.3348	0.1102	-0.2294	-0.1472	0.8639	0.95107
	(0.0001)	(0.075)	(0.0000)	(0.098)	(0.0000)	(0.0113)	(0.0000)	(0.0000)
Sensex	-1.2530	-0.3493	0.2749	0.0333	-0.2171	-0.1711	0.8814	0.9564
	(0.0012)	(0.0379)	(0.0001)	(0.398)	(0.0000)	(0.002)	(0.0000)	(0.0000)
BSE MID-CAP	-1.2677	-1.0058	0.3686	0.2645	-0.1755	-0.1394	0.8890	0.8964
	(0.0000)	(0.0078)	(0.0000)	(0.0265)	(0.0005)	(0.0841)	(0.0000)	(0.0000)
BSE SMALL-CAP	-1.1763	-0.9708	0.3369	0.3031	-0.1232	-0.1196	0.8929	0.9074
	(0.0002)	(0.0007)	(0.0000)	(0.0022)	(0.0064)	(0.0589)	(0.0000)	(0.0000)
BSE 100	-1.3482	-0.5971	0.2887	0.1359	-0.2366	-0.1379	0.8725	0.9335
	(0.0004)	(0.1)	(0.0001)	(0.1477)	(0.0000)	(0.0597)	(0.0000)	(0.0000)
BSE 200	-1.3178	-0.6253	0.2868	0.1430	-0.2344	-0.14025	0.8755	0.9307
	(0.0002)	(0.1035)	(0.0001)	(0.1432)	(0.0000)	(0.0615)	(0.0000)	(0.0000)
BSE 500	-1.3137	-0.6453	0.2835	0.1484	-0.2365	-0.1429	0.8761	0.9291
	(0.0002)	(0.1076)	(0.0002)	(0.1431)	(0.0000)	(0.0613)	(0.0000)	(0.0000)

P values are reported in parentheses

Table 8: Arch LM Test

Indices	F-statistic		Obs*R-squared	
	Before	After	Before	After
S&P CNX Nifty	0.9307	0.5405	8.3916	4.9460
	(0.4973)	(0.8444)	(0.4952)	(0.8389)
CNX Nifty Junior	1.2338	0.7532	11.0913	6.8500
	(0.2703)	(0.6598)	(0.2695)	(0.6527)
CNX 100	1.0031	0.4838	9.0373	4.4349
	(0.4356)	(0.8851)	(0.4338)	(0.8805)
S&P CNX 500	1.4072	0.4873	12.6282	4.4663
	(0.1803)	(0.8828)	(0.1802)	(0.8781)
CNX Midcap	1.2991	0.3304	11.6699	3.0426
	(0.2331)	(0.9645)	(0.2326)	(0.9625)
Nifty Midcap 50	0.9537	0.3114	8.5969	2.8688
	(0.4773)	(0.9709)	(0.4753)	(0.9692)
S&P CNX Defty	1.5309	0.5831	13.7214	5.3287
	(0.1323)	(0.8108)	(0.1326)	(0.804756)
Sensex	1.5396	1.1701	13.7979	10.5132
	(0.1294)	(0.3137)	(0.1297)	(0.3105)
BSE MID-CAP	1.2453	0.4024	11.1933	3.6974

Indices	*F-statistic*		*Obs*R-squared*	
	Before	*After*	*Before*	*After*
	(0.2634)	(0.9333)	(0.2627)	(0.9301)
BSE SMALL-CAP	0.6481	0.7746	5.8595	7.0400
	(0.7562)	(0.6400)	(0.7539)	(0.6329)
BSE-100	1.6385	0.5179	14.6700	4.7423
	(0.0999)	(0.8613)	(0.1004)	(0.8561)
BSE-200	1.5964	0.5217	14.2991	4.7764
	(0.1117)	(0.8585)	(0.1121)	(0.8533)
BSE-500	1.6151	0.5053	14.4638	4.6291
	(0.1064)	(0.8703)	(0.1068)	(0.8653)

p values are reported in parenthesest

most of the indices with the exception of CNX Midcap, Nifty Midcap 50, BSE Midcap and BSE Smallcap in recession period. γ measures the leverage effect which means that good and bad news don't have equal effect on the volatility. γ is negative and significant for all the indices in pre recession period which implies that bad news cause greater volatility as compared to good news. But in recession period, the effect of bad news on stock market volatility was insignificant for CNX Nifty Junior, CNX Midcap, Nifty Midcap 50, BSE Midcap, BSE Small cap, BSE100, BSE200 and BSE 500. Seeing α and γ, it can concluded that whenever there is a change in the volatility, it is followed by a higher volatility. The sum of α and β measure persistence of volatility in stock market which has increases during recession period implying that volatility takes a long time to die out following a crisis in the market. β also help to see the weak form inefficiency which has increased in post recession period.

ARCH LM test is applied again to see whether there is any leftover arch effect in the series. Table 8 reports the result of ARCH LM test. ARCH LM test can not reject the null hypothesis of no hetroskedasticity for both the period. Result shows that series don't have any leftover arch effect.

5. Conclusion

The present study examined the impact of recession on the efficiency of Indian stock market by using ACF test and run test. The result obtained from ACF test indicates that CNX 100, S&P CNX Defty, S&P CNX 500, BSE100, BSE 200 and BSE 500 became efficient in weak form during recession period. The run test reported weak form efficiency in returns of S & P CNX Nifty, CNX Nifty Junior, CNX 100, S&P CNX 500 and CNX Midcap during recession. While S&P CNX Defty, BSE 200 and BSE 500 became inefficient in weak form in recession period. The result of EGARCH-M indicates that effect of bad news on stock market volatility has become insignificant in recession period. The coefficient of risk premium indicates that investors will not be compensated for taking higher risk in both before and during recession period. The results showed that volatility of stock market take longer time to die out during recession period. There is, thus, mixed results regarding the impact of recession on the underlying stock market efficiency and volatility. Indices of both NSE and BSE are equally affected by U.S. recession

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