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Idiosyncratic Volatility and Its Effects on Stock Market: Indian Experience

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Abstract

The article studies the behavior of idiosyncratic volatility on the Indian stock market. The Idiosyncratic volatility is the volatility of the specific firm's stock price. We test the effects of the firm specific volatility on the volatility of specific industries index and then test the effects of this volatility of these industries index on the Indian stock market. The data is collected from Bombay Stock Exchange. We analyze the stationary of the stock market volatility through Augmented Dicky-Fuller unit root test and followed by GARCH model to discover the persistence in the stock market volatility. Firstly, we find the plausible effects of the idiosyncratic volatility on the volatility of the specific industries index. Second, we find the effects of these industries index volatility on the overall Indian stock market.

Keywords: Idiosyncratic volatility, GARCH, ADF, Regression

Introduction

Much research in finance has focused on idiosyncratic volatility. The level of idiosyncratic volatility clearly is an important input in the study of diversification of portfolio. (Bekaert, Hodrick, & Zhang, 2010) The volatility of firm specific individual stocks (idiosyncratic volatility) can increase even when the volatility of the whole market remains constant as long as correlations among stocks are declining. (Xu & Malkiel, 2001)The stock market risk-return relation is found to be positive by CAPM model. The CAPM model of Sharpe, Linter, and Black is also useful to predict cross-sectional security and portfolio returns. The CAPM model says only market risk must be taken into consideration into asset price and command a risk premium. The idiosyncratic volatility is the main risk factor omitted in the CAPM model. The stock market volatility is the strong predictor of idiosyncratic volatility and vice versa. However, subsequent studies show that neither idiosyncratic volatility nor stock market volatility forecasts stock market returns in an extended sample ending in 2001. (Guo H. S., 2006) Found that, when combined with stock market volatility, the value-weighted idiosyncratic volatility is negatively and significantly related to stock market returns. Consistent with the CAPM, (Guo H. S., 2006) also documents a positive relation between stock market volatility and returns.

LITERATURE REVIEW

The stock market volatility has been the major area for research. Considerable attention has been given to the stock market volatility during 1980's and 1990's. The volatility of the market during the late 1990s was larger than it was earlier 1980's, which was still considerably below the volatility recorded during earlier periods of the century. What has received far less attention is the behavior of the volatility of individual stocks. (Bekaert, Hodrick, & Zhang, 2010)The individual firm specific volatility is known as the idiosyncratic volatility. The volatility of individual stocks can increase even when the volatility of the market as a whole remains stable, as long as correlations among stocks are declining. The stock market risk-return relation is found to be positive, as stipulated by the capital asset pricing model; however, idiosyncratic volatility is negatively related to future stock market returns. (Guo H. S., 2006) There has been lot of studies on idiosyncratic volatility and its effects on the overall stock market volatility and the expected returns. The idiosyncratic volatility provides proxy for the investment opportunities with the various market factors. (Guo & Savickas, 2008) The idiosyncratic volatility has been increasing over a period of time in the US context and the idiosyncratic volatility has a positive relation to future expected returns. (Malkiel & Yexiao, 2006) The idiosyncratic volatility is said to be negative if there exists a positive correlation between the stock market volatility and expected returns. (Xu & Malkiel, 2001)

RESEARCH PROBLEM

The stock market volatility is the strong predictor of idiosyncratic volatility and vice versa. The idiosyncratic volatility provides proxy for the investment opportunities with the various market factors. (Guo & Savickas, 2008) The firm specific volatility or the changes in the specific stock price is known as the idiosyncratic volatility. The changes in the firm's stock price are due to two main factors. Firstly, due to the technological advancements or the innovations this further leads to growth. Second is due to the uncertainty of the firm's reaction on the growth and the investment options. (Guo & Savickas, 2008) These changes in the firm specific stock prices affect the market of that particular industry further affecting the Indian stock market. There have been several studies on the idiosyncratic volatility in the US context which proves that there exists a plausible relation between idiosyncratic volatility, stock market volatility and expected returns. (Xu & Malkiel, 2001)This study therefore would try to find the effects of firm specific volatility on the Indian stock market volatility.

OBJECTIVE

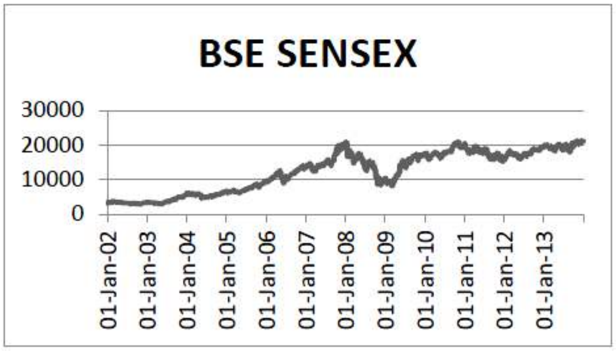
The main objective is to find the effects of idiosyncratic volatility on the overall stock market in Indian context. As the idiosyncratic volatility is predicted by the stock market volatility and vice versa, hence the main perspective of this study is to find the effects of the changes in individual firm stocks on the stock market volatility.

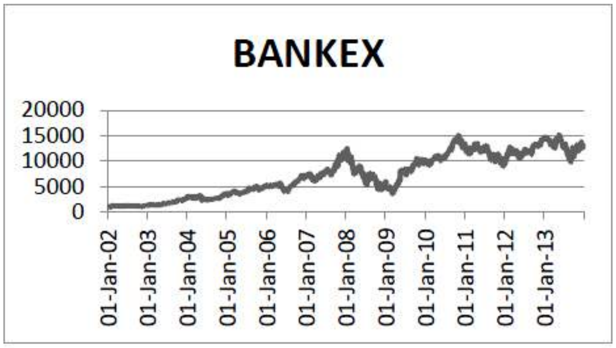
DATA AND METHODOLOGY

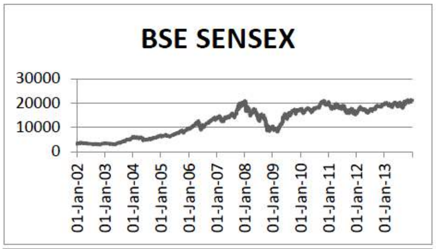
The study is carried out through secondary data which is collected from BSE (Bombay Stock Exchange). The data was based on the daily data of the stock prices from 2002 to 2013. The stock market volatility is based on the stock prices from BSE. The idiosyncratic volatility is the firm specific volatility which is based on the stock prices of the specific firm which is collected from BSE. The firm specific stock prices were extracted through the BSE website and the sample of these companies stock prices were collected on the basis on their performance in the stock market. Further, we considered the various industries index stock prices which was again collected from the BSE and categorized the various companies under these industries. BSE SENSEX was considered as a proxy for the Indian stock market and the various industries such as Banking industry, oil and gas industry, IT industry, metal industry etc. was taken into consideration for analysis. There were various companies under each industry and at least one of the companies considered under each industry is a risk free stock.

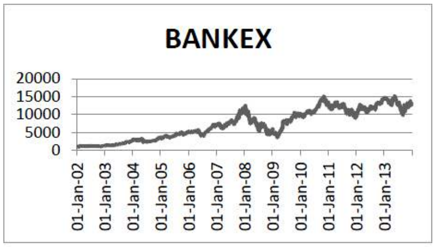
Figure-1

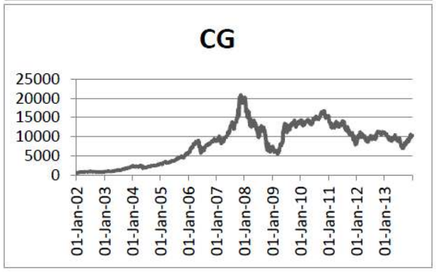
Graphical Representation

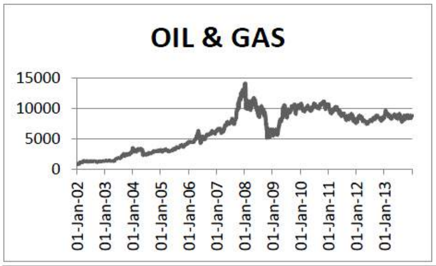


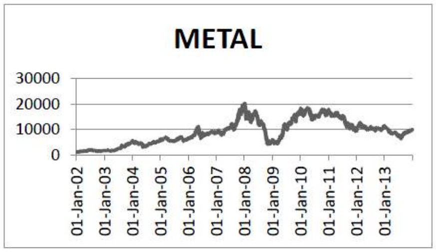


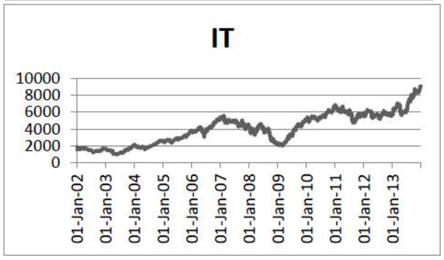












The above figures represent the graphical representation of the BSE SENSEX and various other industries indices such as bank, oil and gas, metal etc. We can observe a big spike in the stock market volatility during 2008 which is due the major stock market crash which is also called as the "panic of 2008". The financial crisis during the 2008 was due to the failures of massive financial institutions in the United States, due primarily to exposure of securities of packaged subprime loans and credit default swaps issued to insure these loans and their issuers, rapidly devolved into a global crisis resulting in a number of bank failures in Europe and sharp reductions in the value of stocks and commodities worldwide.

Table-1
Descriptive Statistics

	SENSEX	BANKEX	CG	OIL GAS	METAL	IT
Mean	12352.40556	7271.635824	8142.534276	6462.705394	8968.268195	4007.371514
Standard Error	108.4969281	77.41194415	91.79523839	60.63099617	88.79407661	34.05087006
Mode	3024.35	1183.05	850.64	1383.14	6210.37	1639.27
Standard Deviation	5940.64029	4238.613225	5026.15605	3319.789278	4861.830452	1864.421179
Sample Variance	35291207.06	17965842.07	25262244.64	11021000.85	23637395.35	3476066.332
Kurtosis	-1.435018774	-1.366205552	-1.006069749	-1.303494185	-0.951766114	-0.865739207
Skewness	-0.271308773	0.081813186	0.026466603	-0.199984855	0.191154077	0.158161959

Table-1 represents the descriptive statistics pertaining to BSE SENSEX and various industries indices. The standard deviation in the above table represents the risk factor of the particular stock price. As shown in Table-1 the risk is much lesser in IT industry followed by the oil & gas industry when compared to other industry stocks in the market. The value for kurtosis is lower than the critical value. As the value for kurtosis is lower than the critical value and hence with higher variance and standard deviation we can say that there exists higher volatility in the market.

Table-2
Correlation

	BANKEX	CG	IT	METAL	OIL & GAS	BSE SENSEX
BANKEX	1	0.841837	0.919019	0.810982	0.887707	0.97311
CG	0.841837	1	0.734114	0.959603	0.968335	0.910579
IT	0.919019	0.734114	1	0.712988	0.783584	0.928434
METAL	0.810982	0.959603	0.712988	1	0.933348	0.868373
OIL & GAS	0.887707	0.968335	0.783584	0.933348	1	0.947914
BSE SENSEX	**0.97311**	**0.910579**	**0.928434**	**0.868373**	**0.947914**	**1**

The above shows the correlation analysis between various industries and the BSE Sensex; we

The above shows the correlation analysis between various industries and the BSE Sensex; we can see that there exists a high positive correlation between all the industries and the BSE Sensex. As shown as above we can say that banking industry and oil & gas industry has a high positive correlation between the stock market and followed by other industries having a positive correlation.

As shown in Figure-1 we observe that there exists a big spike during the 2008, due to the global financial crisis. To minimize the out layers effect of 2008 crash and from Figure-1 we can also see strong co-movements of stock market volatility during the period. We can also observe from Figure-1 that the stock market prices are serially correlated. We can also observe a stochastic trend in the stock prices. Hence to check if the market is stationary, we use the Augmented Dicky-Fuller (DF test) unit root test.

$$\Delta yt = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t$$

Table-3

Augmented Dickey-Fuller test

Augmented Dickey-Fuller test statistic	t-Statistic	Prob.
BSE Sensex	-50.77986	0
Bank	-47.75704	0
CG	-47.49974	0
IT	-40.45408	0
METAL	-49.56114	0
Oil & Gas	-51.08084	0
Test critical values:	1% level	-3.961105
	5% level	-3.411307
	10% level	-3.127495

We consider two exogenous specifications one with constant and another with linear trend and for both the specification we number of lags for the ADF unit root test. As shown in the Table-3 we can see that the ADF unit root test for the various stock markets is statistically significant with 5% significance level. We reject the null hypothesis of the stochastic trend in all the stock market indices where the data set is has to be differenced to market to make it stationary and hence we accept the null hypothesis where we conclude by saying that the data is said to be stationary.

The idiosyncratic volatility of a specific firm is directly not observable. It is estimated through the specific firm's stock returns relatively. However, it is difficult to estimate the beta factor of the idiosyncratic volatility or the firm specific volatility over a period of time. Such beta factor estimates are critical in computing the idiosyncratic volatility. The volatility

of each underlying specific firm's stock price can be estimated through the standard deviation of the stock periodic returns (as mentioned above in Table-1). Forecasting the confidence intervals may be time varying, so that more accurate intervals can be obtained by modeling the variance of the errors. More efficient estimators can be obtained if heteroskedasticity in the errors are handled properly. However, since volatilities are persistent or prolong over a period of time, as we have learned from the Autoregressive Conditional Heteroskedasticity (ARCH) literature, such an estimator of volatility will be biased and inefficient. ARCH models are used to characterize and model observed time series. They are used whenever there is reason to believe that, at any point in a series, the error terms will have a characteristic size or variance. In principle, one should adopt a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) type of volatility estimator. Hence, we use GARCH model to analyze the data set. The GARCH model can be specified with GARCH (p, q) where p is the order of the GARCH terms and q is the order of the ARCH terms . The model can be given as:

$$\delta_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \cdots + \alpha_q\varepsilon_{t-q}^2 + \beta_1\delta_{t-1}^2 + \cdots + \beta_p\delta_{t-p}^2 = \alpha_0 + \sum_{i=1}^{q}\alpha_i\,\varepsilon_{t-i}^2 + \sum_{i=0}^{p}\beta_i\,\delta_{t-i}^2$$

We start to model the conditional volatility as being a GARCH (1, 1). A GARCH (1, 1) specification should be enough to interpret the conditional variance that fits the high frequency time series data. The conditional mean and the conditional variance equations could be defined as:

$$r_t = \beta_0 + \beta_1 r_{t-1} + \varepsilon_t$$

$$\delta_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \beta_1\delta_{t-1}^2$$

$$with\ \alpha_0 > 0\ and\ \alpha_1, \beta_1 > 0$$

The GARCH (1, 1) analysis was made for all the indices and the BSE Sensex with the constant. In the model, measures the coefficient of the constant variable or the random variations, is the coefficient of the square of the residuals or the error coefficients and is the coefficient of the GARCH lag. The sizes of and determines the dynamics of the volatility in the stock prices. If the GARCH error coefficients ( ) are high then it means that there exists an intensive reactions of volatility in the market, if the GARCH lag ( ) coefficients are high then it means that there is slow reaction of volatility in the market or it

takes long time to react in the market. If the GARCH error coefficients ( ) are high and the GARCH lag ( ) coefficients are low then it means that the volatility tend to be more spiky.

Table-4
GARCH Analysis

Coefficients	C	RESID(-1)^2	GARCH(-1)	
	α_0	α_1	β_1	$\alpha_1 + \beta_1$
BSE SENSEX	22930289	1.429513	-0.976427	0.4531
BANKEX	10872234	1.365047	-0.939582	0.4255
IT	149336.4	1.478819	-0.622624	0.8562
OIL GAS	7140677	1.338974	-0.909594	0.4294
CG	16413737	1.36434	-0.944421	0.4199
METAL	12510221	1.488344	-0.909566	0.5788

As the above results the GARCH error coefficients ( ) are high and the GARCH lag ( ) coefficients are low hence it means that the volatility tend to be more spiky or there exists high volatility in the market. We can see that the estimates of are positive and are considerably smaller than the variances shown in Table-1. This is due to the changing conditional variances over time and their eventual contribution to unconditional variances. Our results also show that there is continuous volatility in the stock prices as measured by the sum of and in GARCH (1, 1) model ranging from 0.4199 to 0.8562 and the average of these values would be 0.52715 which is greater than 0 and close to 1 which shows a stronger presence of ARCH and GARCH effects.

We use regression analysis to analyze the effects of the firm specific stock market. Where we took the square of the residuals obtained from the GARCH model as a dependent variable and the various companies as the independent variable. The analysis was carried on by industry wise, where the particular industries square of the residuals was the dependent variable and the companies under each industry is considered as the independent variable.

Table-5
Regression Analysis Industry wise

Regression Statistics	Multiple R	R Square	Adjusted R Square	Standard Error
Bank	0.8132655	0.661401	0.66083488	10692665.22
CG	0.8081441	0.653097	0.652517007	16305599.22
IT	0.5234526	0.274003	0.272789032	3536211.698
Metal	0.4647757	0.216016	0.214705887	21682957.94
Oil & Gas	0.8665827	0.750966	0.750549262	8147202.493

The above table represents the regression analysis pertaining to each industry, where square of residuals of each industry obtained from GARCH is taken as a dependent variable and the various companies under each industry has been taken as independent variable. We can see that the value of adjusted R square is close to 1 or 100% which is said to be significant where the regression model is said to be best fit. In bank, Capital goods and Oil & gas which says that the 66%, 65% and 75% respectively fit the model and hence being statistically significant.

Table-6
Regression Analysis of Industries and BSE Sensex

Dependent Variable: BSE Sensex

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Bank	0.339108	0.005233	64.80002	0
CG	0.165243	0.006545	25.24777	0
IT	1.154231	0.008433	136.8759	0
Metal	-0.12296	0.004954	-24.81876	0
Oil & Gas	0.766757	0.009019	85.01736	0
R-squared	0.995787			
Adjusted R-squared	0.995782			
Durbin-Watson stat	0.026143			

From the above regression analysis where BSE Sensex is taken as a dependent variable and various industries such as bank, CG, IT, metal and oil & gas is taken as independent variable we can say that the adjusted R square is significant as the value is 0.995782 which is close to 1 or the value is 99.57% by which we can conclude by saying that the model is said to be best fit. The coefficients of the various industries are also said to be significant which is based on the t-statistic values. We can see a positive linear relationship between the bank, CG, IT and oil & gas and the BSE Sensex and metal shows a negative linear relationship with the BSE Sensex. Hence, we conclude by saying that there exists a relationship between the idiosyncratic or the firm specific stock prices to the industries stock price and further we can also see that there exists a relationship between the various industries and the BSE Sensex or the Indian stock market through regression analysis.

CONCLUSION

This paper investigates the plausible effects of the idiosyncratic volatility on the Indian stock market volatility. The study focuses on the empirical relationship between the firm specific volatility on the Indian stock market. The study is to find the effects of the firm specific stock price on the Indian stock market from 2002-2013. We can see that there exists a high value of variance and standard deviation which means the stock market has a high risk. Then we can also see that the various industries indices are positively correlated with the BSE Sensex. We also test the stationary of the data set through ADF unit root test where we reject the null hypothesis of the stochastic trend in all the stock market indices where the data set is has to be differenced to market to make it stationary and hence we accept the null hypothesis where we conclude by saying that the data is said to be stationary. We analyze the persistence of volatility of the data using the Auto Regressive Conditional Heteroscadasticity (ARCH) and Generalized Auto Regressive Conditional Heteroscadasticity. Our results also show that there is continuous volatility in the stock prices as measured by the sum of and in GARCH (1,1) model ranging from 0.4199 to 0.8562 and the average of these values would be 0.52715 which is greater than 0 and close to 1 which shows a stronger presence of ARCH and GARCH effects. We can analyze the effect of companies with industries and further industries with the BSE Sensex. Our results show that the coefficients of the various industries are also said to be significant which is based on the t-statistic values. We can see a positive linear relationship between the bank, CG, IT and oil & gas and the BSE Sensex and metal shows a negative linear relationship with the BSE Sensex. Hence, we conclude by saying that there exists a relationship between the idiosyncratic or the firm specific stock prices to the industries stock price and further we can also see that there exists a relationship between the various industries and the BSE Sensex or the Indian stock market through regression analysis.

The idiosyncratic volatility has been the major area of study in the US context. Many researchers have been conducted to find the effects of the stock price of firm specific on the stock market volatility. Earlier studies which was conducted on NASDAQ stocks on US context, say that idiosyncratic volatility is said to be negative if the stock market volatility is positively related to the expected returns. The study could help the investors on the investment opportunities by having a closer look over the firm specific stock prices to adjust their holdings. This would also help the investors in their investing opportunities as the idiosyncratic volatility reflects the firm specific stock price and the book value of the stocks.

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